Three Studies in Healthcare Costing and Quality. New evidence from England and Wales on the Impact of the Reference Cost Index and Payment by Result Systems

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Declaration

I confirm that this is my own work and the use of all material from sources has been properly and fully acknowledged.

Signed: 

Date: September 2021

To

My parents: father (Awadh) and mother (Modhi);

my siblings: Joseph, Mariam, Mohammed, Yasser and Maha;

my close friend, soulmate, and wife (Haya);

my princesses (Haneen and Leen).

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Table of Contents

Table 1: List of Abbreviations

No.	Acronym	Full Name
1	ABC	Activity-Based Costing
2	ANOVA	One-way Analysis of Variance
3	BPT	Best Practice Tariffs
4	CCG	Clinical Commissioning Groups
5	CMS	Centers for Medicare and Medicaid Services
6	CQC	Care Quality Commission
7	CQUIN	Commissioning for Quality and Innovation
8	DEA	Data Envelopment Analysis
9	DRG	Diagnostic Related Groups
10	FP	For-Profit
11	FT	Foundation Trusts
12	GDP	Gross Domestic Product
13	GMM	General Method of Moments
14	GP	General Practitioner
15	HRG	Healthcare Resource Groups
16	ISTC	Independent Sector Treatment Center
17	LOS	Length of Stay
18	MAX	Maximum
19	MFF	Market Forces Factor
20	MIN	Minimum
21	NFP	Not-For-Profit
22	NHS	National Health Service
23	NICE	National Institute for Health and Clinical Excellence
24	Non-FT	Non-Foundation Trusts
25	NRCI	National Reference Cost Index
26	OECD	Organisation for Economic Co-operation and Development
27	OLS	Ordinary Least Square
28	PbR	Payment by Results
29	PCT	Primary Care Trusts
30	PFI	Private Finance Initiative
31	RCI	Reference Cost Index
32	SDD	Same-day Discharge
33	SSN	Servizio Sanitario Nazionale
34	STD	Standard Deviation
35	VBC	Volume-Based Costing

List of Figures

List of Tables

Chapter 1: Introduction

Chapter 2. Trend Analysis of the Reference Cost Index in National Health Service Trusts in England and Wales from 1997 to 2016

Chapter 3. The Relationship of National Health Service Trust Characteristics to the Reference Cost Index

Chapter 4. Reference Cost Index Reduction and Care Quality of National Health Service Healthcare

Appendix 1

Appendix 2

Appendix 3

Appendix 4

Abstract

Healthcare provision accounts for a high proportion of public finances worldwide. Therefore, efficiency, quality and value for money are paramount. This thesis focuses on healthcare resource usage in the National Health Service (NHS), in England and Wales where reforms have long sought to ensure value for money and accountability. However, evaluating healthcare performance is complex. Since 1997, the National Reference Cost Index (NRCI) costing system has been applied to generate reliable data for all NHS clinical treatments and to drive improvements to the system. This thesis encompasses three studies.

Study 1 Contributes to knowledge in the field of healthcare accounting by presenting an updated mapping of RCIs and an examination of trends within the NHS trusts. The study investigated trends and changes to RCIs, trust[1] numbers, trust types and variations between the mean RCI of each group (i.e., region, type and foundation status) from the national average. Descriptive statistics were used, from 1997 (the introduction of the Reference Cost system) to 2016: for 1997 to 2009 data were collected from the National Archives of the Department of Health website; data for 2010 to 2016 were collected from the NHS Reference Costs Collection website. Furthermore, the study's focus is on NHS trusts' characteristics rather than patient characteristics or productivity which have attracted previous research attention, extending our understanding of healthcare costs, trends, patterns figures and differences between foundation and non-foundation trusts over the various regions and trust types, for the first 20 years of NRCI application.

[1] NHS Trust is a legal entity that provides goods and services for the purposes of the health service (NHS, 2019b).

Study 2 examines cost variations between 2009 and 2016 by analysing the relationship between specific organisational characteristics (i.e., location, the type of service, foundation status and size), which were taken as individual uncontrollable variables, and RCIs. The National Archives of the Department of Health website provided the data for 2009, while NHS Reference Costs Collection website were used for data from 2010 to 2016. Size data was from England NHS website. Patient classification and gender, collected from NHS Digital website, were taken as control variables. Ordinary Least Square (OLS) regression technique was used and cost differences across trusts were identified. The study is distinct from previous work in this field as it focuses on trust characteristics and, to the author's knowledge, is the first to analyse the associations between combined trust characteristics and RCIs over an extended time period. Furthermore, the study uses data for all HRGs, rather than selecting specific categories, as previous research has done. Study 2 takes contingency theory as its theoretical framework, since it suggests that applying a single cost system for organisations which differ as to their geography, type, size, ownership and technology may not be appropriate and that variations should be taken into account.

Study 3 examines the relationship between RCI reduction and the quality of trust services provided, in the context of the introduction of Payment by Results (PbR) in the NHS to improve the cost efficiency of trust management. The study applied seven quality measures: mortality rates, Same-day Discharge (SDD), infection rates, mean Length of Stay (LOS), emergency and in-patient and out-patient waiting times. Data were collected from three NHS websites for the period 2010 to 2016. Data for RCIs and foundation status were from the NHS Reference Costs Collection website. Data for the dependent and other control variables were extracted from the NHS Digital website and the National Archives of the Department of health. Study 3 uses panel fixed effect regression. This study contributes to the fields of costing and

healthcare quality by examining the association between cost and the quality of trust services provided. Study 3 is the first, to the researcher's knowledge, to use infection rates as a measure of quality, or to evaluate quality while making a distinction between trusts at the upper and lower ends of the RCI scale.

Chapter 1: Introduction

Introduction

Healthcare provision worldwide requires considerable financial input, accounting for a large percentage of public finances globally. Healthcare providers have to manage increasing service costs and growing requirements for up-to-date medical technology, which are expected to raise the quality of the service provided (Gok and Altindağ, 2015). Additionally, the challenge of treating aging populations (Atella et al., 2019) increases overall expenditure (The World Bank, 2015; Labro, 2015; Gebreiter and Ferry, 2016; Malmmose, 2018). As a result, the performance of healthcare systems has been a matter of international concern (e.g., Smith, 2002; Ferrari, 2006; The World Bank, 2015; Labro, 2015) and health services in many countries have undergone reorganisation with a view to combining efficiency, service quality and value for money. Examples of countries in which healthcare reform has been a priority include those in Eastern Europe and the West (Mossialos et al., 2002; Kounetas and Papathanassopoulos, 2013; Cantor et al., 2018; Atella et al., 2019).

England and Wales's reforms of the National Health Service (NHS) have long striven to give value for money to taxpayers (Bojke et al., 2017; Gaughan et al., 2018) and to tackle the waste of resources from inefficient health services which burdens the system and hinders the ability of the service to offer quality care to patients who require it (Appleby and Thomas, 2000). Various attempts have been made over previous decades to introduce both management and financial reforms (e.g., Bourn and Ezzamel, 1986a; Broadbent et al., 1991; Broadbent, 1992; Preston et al., 1992; Harrison et al., 1994; Hood, 1995; Jones and Dewing, 1997; Llewellyn, 1998; Jones, 1999). However, clinicians have often rejected cost-saving initiatives, which as a result, have been poorly implemented and have failed to provide appropriate support for managerial decision-making (Pollitt et al., 1988; Preston et al., 1992; Jacobs, 1995;

Abernethy, 1996; Doolin, 1999). Thus, maximising efficiency has been high on the government agenda to ensure that budgets are used effectively and efficiently (Bourn and Ezzamel, 1986a; Broadbent et al., 1991; Broadbent, 1992; Preston et al.,1992; Harrison et al., 1994; Hood, 1995; Jones and Dewing, 1997; Llewellyn, 1998; Jones, 1999; Lapsley, 2001). Reform of public services in general and of healthcare, in particular, has been an important issue in the field of accounting, where it has given rise to several innovations (Kaplan and Norton, 1992; Hood, 1995; Jackson and Lapsley, 2003; Lapsley and Wright, 2004), as a means of enhancing efficiency and accountability including in the public health sector (Chow et al., 1998; Aidemark, 2001; Zelman et al., 2003; Modell, 2004), and encompassing the many complex factors involved in evaluating healthcare performance.

1. Objective

The objective of this thesis is to describe, through a trend analysis, the patterns, differences and variations in NHS trusts costs over a twenty-year period. The thesis provides a comparison of Reference Cost Index (RCIs) between 1997 and 2016 in terms of region, type, and foundation status. The thesis also examines variations in cost between 2009 and 2016 by testing the association between organisational characteristics (i.e., location, the type of service provided, foundation status and size) and RCIs, using contingency theory as a lens through which to examine the issues involved. Furthermore, the thesis aims to determine whether RCI reduction is negatively associated with the quality of trust services provided, by examining seven quality measures (i.e., mortality rates, Same-day Discharge (SDD), infection rates, Length of Stay (LOS), emergency and in-patient and out-patient waiting times).

2. The choice of UK healthcare

This thesis focuses on the efficient use of healthcare resources in England and Wales because of the size of the budgets and the risks that any inefficiency in the service poses to patients who require treatment within the service. Efficiency can be defined as maximising output without increasing input, or minimising input without compromising output. The Reference Cost system follows this approach as trusts that provide services included in the RCI at a lower cost than the average NHS provider have an index below 100, NHS trusts that reduce their comparative costs for the same output will see a fall in their RCI.

Furthermore, UK healthcare trusts are held accountable for their use of resources since these are supplied through general taxation. England and Wales are particularly interesting as a sample when analysing resource use because, since 1997, the costing system known as the NRCI has provided a mechanism to produce reliable data for all NHS clinical treatments and to facilitate cost comparisons by means of "reference costs" which highlight cost variations and are used to inform managerial decision-making (Department of Health, 1997).

According to the Department of Health (2014, p.17), "The RCI provides a comparison of costs at the aggregate level for each trust." It is therefore meaningful to examine changes across this composite system because the whole system has been designed to enhance comparability, through the use of Healthcare Resource Groups (HRGs) as the basis of RCI calculation. This is one of the reasons the Reference Cost system has been developed. There have been some changes over the twenty-year period which this study acknowledges and addresses by considering the statistics for different time periods within the overall twenty-year.

The Reference Cost system is the largest ever cost information resource to be used in healthcare. The data collection system covers all hospitals that use HRGs, unlike those used elsewhere in the world which only collect representative samples (Schreyögg et al., 2006). The UK provides a useful focus for this study because its public benchmarking system is recognised worldwide as leading the field in healthcare governance (McKee, 2002). When cost variations across trusts are known and published, the resulting pressure on institutions who are not performing to the required standards can lead to improvements (Northcott and Llewellyn, 2004; Tillema, 2010), which may benefit patients and the general public (Dawson and Street, 1998).

3. Basic Concepts: National Reference Cost Index and the Market Forces Factor

The calculation of RCI is made by dividing actual costs by expected costs, as explained by the Department of Health (2014). To calculate expected costs, the national average unit cost for the organisation is multiplied by the activity of that organisation. Comparisons are made between similar organisations (i.e., trusts are compared against trusts and Primary Care Trusts (PCTs) against PCTs). All data, except those related to services which are commissioned or contracted out, is taken into account when calculating the RCI. Activity and unit costs from different services and organisations are collected. Weighting of unit costs is according to the activity. Calculation of a national weighted average is then made. Merely dividing total expenditure by patient numbers does not produce meaningful unit costs. Casemix adjustments are therefore made when possible, whereby each case of patient care receives a classification according to its complexity, or mix, which is expressed as HRGs. HRGs are groupings of treatments which are equivalent in terms of resource use, as determined by clinicians, and are representative of UK clinical practice. The version of HRG currently in use is HRG4+, which was introduced in 2012.

The system of using RCIs has developed over the years following its introduction. In 1999, the use of RCIs was extended to cover other types of treatment (Llewellyn and Northcott, 2005). Accident and Emergency services, certain community-based and outpatient services were included in the system from 2000. In 2002, the Ambulance Service came under the auspices of the scheme. In the same year, financial incentives were put in place and a Payment by Results (PbR) system was instigated, with funding for treatment based on average costs (Llewellyn and Northcott, 2005).

The year 2005 heralded the first appearance of Foundation Trusts (FT). FTs are accountable to the public, staff, patients and partner organisations, and are allowed to retain surpluses, borrow money and raise investment from both public and private sectors, but are still performance rated annually. Non-Foundation Trusts (Non-FTs) cannot choose what services they provide or boost their finances by carrying out private work, so trusts aspire to be awarded foundation status (Department of Health, 2005). For more details on the history of the development of the Reference Cost system (see Appendix 1, Table A).

While the costs to trusts of such necessities as consumables and equipment are the same nationwide, other expenses are dependent on location. The Market Forces Factor (MFF) is a method used to adjust all costs reported by trusts to take into account differences in the factor costs they incur. It is an index covering geographical variations in land prices and the costs of buildings, and labour (Department of Health, 2013), since these so-called "unavoidable costs" or "uncontrollable costs" vary in different areas of the country (Department of Health, 2013).

The purpose of MFF is to estimate differences in uncontrollable costs. Since healthcare providers in areas such as London and the South East face higher staffing costs and land and

building expenditure as a result of external market forces, the MFF is used to compensate for this as the PbR tariff provides organisations with extra funding using the MFF, which offers a level basis for ensuring equivalent amounts of healthcare per pound are provided in all areas of the country. The MFF is also used to adjust the RCI (Department of Health, 2013).

As explained by The Department of Health (2013), the fixed national price for each healthcare activity is paid by commissioners according to the national tariff, based on the national average costs which every NHS trust reports. Initially, MFF was used for resource allocation for commissioners of healthcare providers. Those receiving additional funding to compensate for the high costs in their area could afford to provide the same level of services as those in less costly areas, although trusts can select locations within a limited area, they must remain within their region and cannot control any extra costs incurred. MFF is therefore applied as a proportion of the tariff price paid over and above the tariff for each unit of activity. If a trust's uncontrollable costs are 20% higher than providers in other regions, they should be given 20% of extra funding, thus reimbursing them for uncontrollable cost differences.

An overall MFF value for an organisation is created by multiplying the index value for each MFF element by its proportion of total running costs. In this method a weight is applied to each element of the MFF, which is equivalent to its weight within total costs. A total figure for the organisation is reached by adding together the weighted index values. (A single overall MFF value has an impact on the income of an organisation which is equivalent to the effect of using the index value for each element separately. Thus, the proportion of expenditure represented by a single element is reflected in total income).

The elements of provider costs used to account for MFF variations are:

(1.) non-medical staff,

(2.) medical and dental staff,

(3.) land, and

(4.) buildings.

Cost variations for each element are separately calculated initially, then combined to provide an overall index for each organisation. The MFF value for each NHS organisation thus reflects its uncontrollable costs and an index is used to determine the relativities between organisations. All organisations receive a ranking within the index. To make the adjustment, each organisation's index is divided by its MFF to ensure that comparisons between organisations throughout the country are "fair" (the term fair used in the NHS document to indicate that unavoidable costs incurred by some trusts as a result of external market forces are taken into account when calculating their RCIs and setting tariffs).

Two versions of the MFF index are used: (1) The underlying index is used to calculate RCI. (2) The payment index is used in PbR. The basis for both the underlying and the payment indices is the same data set, which is converted into different indices for different purposes. An index comprises a set of values which all relate to a single base value. An index can be used in different ways if the base value is changed. The first version of the index to be calculated is the underlying index. It is this underlying index which is the basis for allocating Clinical Commissioning Groups (CCGs), and the average value forms the base to which all other index values relate. The average value of the underlying index is 1.0. Organisations incurring higher uncontrollable costs than average organisations receive a value above 1.0, while those with lower than average costs are allocated a value below 1. The RCI is calculated using the underlying index. One example of how the MFF affects the underlying index value of a trust in a low-cost region is the case of the Royal Cornwall Hospitals NHS Trust. In 2007,

after MFF adjustment, their RCI increased from 92 to 102 (MFF value of 0.9). Conversely, in an example of a trust from a high-cost region, for the same year, the RCI for University College London Hospitals NHS Trust, with an MFF value of 1.27, the index decreased from 129 to 101. For a further example of how RCIs are calculated, taking into account the MFF, please see Table 1.

Table 1: An Example of Reference Cost Index calculation[2]

		A	B	C	D= C/A	E	F= B*D	G= B*E	H= F/G*100
Trust	HRG	MFF	Activity	Unit cost (£)	Unit cost adjusted for MFF (£)	National average unit cost adjusted for MFF (£)	Actual cost adjusted for MFF (£)	Expected cost adjusted for MFF (£)	RCI adjusted for MFF
Trust A	HRG1	1.1	10	12	10.9	11.2	109.1	112	
Trust A	HRG2	1.1	20	22	20	23.6	400	472	
Total							**509.1**	**584**	**87**
Trust B	HRG1	0.9	15	10	11.1	11.2	166.7	168	
Trust B	HRG2	0.9	15	25	27.8	23.6	416.77	354	
Total							**583**	**522**	**112**

Note: This table shows an example of how RCIs are calculated taking into account the Market Forces Factor. RCI= reference cost index; HRG= healthcare resource group; MFF= market forces factor.

To calculate the national tariff, the payment index is used. In this version of the index, the base value is the minimum and all other values relate to this (as opposed to the average which is used in the underlying index). The minimum value for the payment index is 1.0. The organisation incurring the lowest uncontrollable cost receives 1.0 as its value. Those incurring higher costs than the minimum are allocated a value above 1.0. Thus, if an organisation incurs uncontrollable costs which are assessed as being 5% above those of the lowest cost provider, they are allocated an index value of 1.05. When the MFF is applied to reimburse providers, each organisation's index value is multiplied by the tariff price set for each unit of activity. The tariff price includes the lowest possible level of uncontrollable costs faced by an NHS organisation. The provider incurring the lowest cost receives no extra funding for their activity,

[2] This table was extracted from the NHS website: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/380322/01_Final_2013-14_Reference_Costs_publication_v2.pdf

while the funding received by all other providers includes an extra proportion of the tariff price to compensate them for their uncontrollable costs. Each provider's PbR income/total income is calculated according to the following formula:

Total income = (Activity * Tariff price) * MFF value

For example: 1000 units of activity for HRG A are undertaken by trust Y. The tariff price of HRG A is £300, the trust has an MFF value of 1.25

Total income = 1000 * £300 * 1.25 = £375,000

Thus, trust Y receives £75,000 more than the lowest cost provider to compensate for higher uncontrollable costs.

Cornwall Partnership NHS Foundation Trust is the provider incurring the lowest level of uncontrollable costs, so they receive the lowest payment index value. The setting of the lowest value of the payment index as 1.0 ensures that no MFF payments to providers are below zero. This base minimum of 1.0 allows for a single national price to be used, in accordance with PbR funding policy, by giving the same price to all providers then allocating separate compensation for their uncontrollable costs. If the MFF underlying version of the index were to be applied in calculating PbR, it would be the middle range of providers' uncontrollable costs which were included in the tariff price, so those with costs below this median, would receive less than the tariff price once the MFF had been applied. Thus, the payment index differentiates between controllable costs and uncontrollable costs. All providers receive the tariff according to the costs incurred by all providers. The MFF then allows those incurring uncontrollable costs above the minimum to be compensated appropriately.

To produce the payment index, the underlying index is converted by dividing each of its values by the minimum value, thus generating an index with 1.0 as its base value. Thus, the

values allotted to an individual provider in the underlying and payment indices will differ, although the between-provider relatives remain constant. Thus, if one trust has 20% higher costs than another, its MFF will be 20% higher than the other trust, regardless of whether the underlying index or the payment index is used.

4. The Structure of the Thesis

This PhD thesis contains three studies. The first study provides descriptive statistics to determine trends, patterns and differences in cost variations over the period from 1997 (the introduction of the Reference Cost system) to 2016. Data for years between 2010 and 2016 were extracted from the NHS Reference Costs Collection website, while data for the years between 1997 and 2009 were gathered from the National Archives of the Department of Health website. The study examines trends and how figures have changed in terms of RCIs, trust numbers, types of trusts and differences between the mean of RCIs of each group (i.e., region, type and foundation status) from the national average. Study 1 contributes to the knowledge in the field of healthcare accounting by presenting an updated mapping of RCIs and examining trends within the NHS. The focus of the study is on trust characteristics, in contrast to many previous studies which have examined patient characteristics or productivity (e.g., Oh et al., 2016; Lovecchio et al., 2016; Huang et al., 2017; Bettin et al., 2018). The study extends our understanding of the trends and patterns of the figures across regions and types, for the first twenty-year following the introduction of the Reference Cost sytem. It also examines the differences between FTs and Non-FTs.

The second study aims to examine variations in costs between 2009 and 2016 by testing the relationship of certain trust characteristics (i.e., location, the type of service, foundation status and size) on their RCIs. RCI data for 2009 were collected from the National Archives

of the Department of Health website. For the years between 2010 and 2016 NHS Reference Costs Collection website data were used. Data concerning size were extracted from England NHS website. The control variables were patient classification (i.e., emergency, in- and out-patients) and gender, and this information was taken from NHS Digital website. Many studies in the field of accounting and economics have considered the impact of trust characteristics, such as ownership, on decision making (e.g., Krishnan and Yetman, 2011; Holzhacker et al., 2015). These studies assume that trust characteristics are important and impact decision-making and efficiency. Study 2 considers the relationship of the individual uncontrollable variables of location, trust type, foundation status and trust size on RCIs between 2009 to 2016, and uses Ordinary Least Square (OLS) regression technique. This study is distinct from earlier work in the field which has focused on patient characteristics (e.g., Hollingsworth, 2008; Castelli et al., 2015b; Cantor and Poh, 2018), because it examines trust characteristics, and I know of no previous research which has analysed the associations between the combined trust characteristics and RCI over an extended period. The impact of location has previously been considered, but in these cases the focus has been on specific HRGs, rather than all treatments provided by the NHS (e.g., Daidone and Street, 2013). The theoretical framework for Study 2 is contingency theory, which suggests that organisational structures are not all the same and that it may be difficult and inappropriate to apply a "one size fits all" approach.

In 2002, the NHS in England introduced PbR to improve the cost efficiency of trust. Study 3, therefore, examines the relationship between RCI reduction and the quality of services provided by trusts. Seven quality measures were used in the study: mortality rates, SDD, infection rates, LOS, emergency and in-patient and out-patient waiting times. Data were taken from two NHS websites for the period between 2010 and 2016. Data for RCIs and foundation status were extracted from the NHS Reference Costs Collection website. The NHS Digital

website provided the data for the dependent and other control variables. The design of Study 3 used panel fixed effect regression. The contribution of this study to the field of accounting, costing and healthcare quality is that it examines the relationship between cost and the quality of services provided. To the best of the researcher's knowledge infection rates have not previously been used as a measure of quality. This study is also the first to undertake a quality evaluation while distinguishing between trusts at the upper end of the RCI scale and those at the lower end.

The overall structure of the rest of this PhD thesis is as follows. Chapter 2 presents the descriptive statistical Study 1; Chapter 3 presents the second study which examines the associations between organisational characteristics and cost, while Chapter 4 presents the third study which examines the relationship between RCI and the quality of services provided. In the conclusion, the results are summarised and the limitations of the research are acknowledged.

Chapter 2: Trend Analysis of the Reference Cost Index in National Health Service Trusts in England and Wales from 1997 to 2016

Trend Analysis of the Reference Cost Index in National Health Service Trusts in England and Wales from 1997 to 2016

Context: The NHS in England and Wales introduced the Reference Cost system in 1997, in order to provide reliable and comparable cost data for maximising efficiency and reducing variation in treatment costs.

Objective: To describe, through a trend analysis, patterns and differences in variations in costs over a twenty-year period. The study also provides a comparison of RCIs between 1997 and 2016 in terms of region, type and foundation status.

Data Sources: Data for years between 2010 and 2016 were extracted from NHS Reference Costs Collection website, while data for years between 1997 and 2009 were gathered from the National Archives of the Department of Health website.

Study Design: Descriptive statistical tests.

Main Findings: Cost variations between trusts between 1997 and 2016 were reduced. The variation in 1997 was higher than it was in 2016 by 5%. In comparison with the national average, RCIs for six of the regions and three trust types are significantly higher. Non-FTs have significantly higher RCIs than the national average. There are also significant differences in RCI among regions, types and foundation status.

Conclusion: Overall, it is possible to observe that there is a slow movement towards the average, with the service providers with the lower RCIs moving costs upwards towards the average and service providers with the higher RCIs moving costs downwards. Further workis needed to examine in more detail the remaining variations between trust characteristics and their RCIs.

Key Words: NHS, RCI, Cost efficiency, Reference Cost system

1. Introduction

The performance of healthcare systems is a worldwide concern, mainly due to the higher costs associated with the provision of this service (e.g., Smith, 2002; Ferrari, 2006; The World Bank, 2015; Labro, 2015). A high proportion of public finances is devoted to healthcare throughout the developed countries, with costs set to rise due to the expense of purchasing up-to-date medical technology and the challenges of treating aging populations (Atella et al., 2019). Reorganisation of health services to improve efficiency, effectiveness, quality and value for money has therefore been high on the political agendas in Eastern European countries and in the West (Mossialos et al., 2002; Kounetas and Papathanassopoulos, 2013), including England and Wales, where governments have sought to ensure that the NHS gives value for taxpayers' money (Bojke et al., 2017; Gaughan et al., 2018). Inefficient health services waste resources and reduce the ability of the system to provide adequate care (Appleby and Thomas, 2000).

To address the problem of waste, there were various earlier attempts to introduce management and financial reforms in the NHS in England and Wales during the 1980s, as discussed by numerous authors (e.g., Bourn and Ezzamel, 1986a; Broadbent et al., 1991; Broadbent, 1992; Preston et al., 1992; Harrison et al., 1994; Hood, 1995; Jones and Dewing, 1997; Llewellyn, 1998; Jones, 1999). However, such initiatives have often lacked acceptance from clinicians and have not been implemented in such a way as to genuinely support the decision-making of the management of the NHS providers (Pollitt et al., 1988; Preston et al., 1992; Jacobs, 1995; Abernethy, 1996; Doolin, 1999).

The Reference Cost system was therefore introduced in 1997 as a mechanism to reduce variations in the cost of healthcare provision. It aimed to enable trusts' managers to "tackle

unacceptable variations in performance and raise overall standards across the NHS by sharing information and comparing performance" (Department of Health, 1997, p.2). This has made the UK a leader in using public benchmarking in healthcare governance (McKee, 2002). This costing system, covering all treatments and all NHS trusts, is the largest ever cost information resource, providing reliable data for all NHS clinical treatments and allowing cost comparisons by means of "reference costs" to highlight and reduce variations in costs and to facilitate managerial decision-making (Department of Health, 1997). The cost-collection system in England is unique because it is the only one that collects all data from all trusts, rather than just using representative samples (Schreyögg et al., 2006). However, it has been suggested that the information has not been used effectively to guide setting treatment tariffs[3] (Street and Maynard, 2007). Nevertheless, improved efficiency results from putting pressure on poorly performing institutions (Northcott and Llewellyn, 2004; Tillema, 2010), thus providing quality healthcare at a reasonable cost, which was a priority for patients and the general public as a whole (Dawson and Street, 1998).

This study contributes to the literature by presenting an updated mapping of RCIs and its trends within the NHS. The research focuses on trust characteristics rather than patient characteristics or productivity, as has been the case with many previous studies across the world (e.g., Oh et al., 2016; Lovecchio et al., 2016; Huang et al.., 2017; Bettin et al., 2018). This will enhance our understanding of the trends and patterns, across regions, types and the differences between FTs and Non-FTs, covering data for the first twenty-year following the introduction of Reference Cost system. The breadth of this descriptive study and length of time it covers makes the data more robust. It is meaningful to look at changes across such a

[3] The amount paid for a specific treatment.

range of providers because the Reference Cost system is standardised with the purpose of facilitating comparability between trusts. Changes during the years do not affect the results because trusts are compared with each other for any given year. However, the efficiency comparisons can only relate to services included in the RCIs, many of an individual provider's services in non acute trusts, particularly in the early years of the study may be excluded.

The following sections of this chapter are organised as follows: section two reviews the relevant literature; section three presents the research questions; section four presents the data and methodology; section five details the results and section six concludes with suggestions for future work.

2. Prior Literature

The Department of Health (2014, p.4) has defined the NRCI as "the average unit cost to the NHS of providing defined services to NHS patients in England in a given financial year". RCI data have been collected on an annual basis since 1997. However, in order to produce such an index, it is first necessary for the organisations within the service to identify their unit costs and understand them. When organisations are large and decentralised, as is the NHS, consistency of cost calculation is vital. However, since the work of the NHS differs so vastly from manufacturing, where total expenditure can be divided by numbers of goods produced, other ways of calculating unit costs must be developed. Total expenditure cannot simply be divided by the number of patients treated because the cost per patient will vary according to the needs of that patient and the treatment they receive. Costs will be influenced by the type of patient treated and the nature of the treatment given. HRGs provide a national standard framework to adjust for variations in casemix by producing groups of treatments which are clinically comparable and require similar resources. It is clinicians not accountants who group

the treatments, because the intention behind HRGs is that they should be clinically coherent and allow for a "common language" comprehensible to clinicians and managers alike.

This is important because if inefficient trusts are to recognise that they have a problem, they need to be convinced either that the patients they treat are the same as those treated elsewhere, or that suitable adjustments have been made in calculating their performance in comparison with other health institutions. Calculation of HRGs is undertaken in retrospect and is based on the actual costs a trust has incurred, and uses the national average cost for the previous 3 years for all patients falling into that particular HRG (Castelli et al., 2015a). An individual costed HRG is made up of a weighted average calculated from the cost of these groups of treatment. The overall cost of an HRG is then divided by its total activity.

The Reference Cost system allows comparisons to be made between these average unit costs for each NHS trust and to produce a single figure for each NHS trust, which makes it possible to compare the actual cost of its treatments with the same treatments calculated in terms of average costs nationally (Department of Health, 1997). The RCI is a simple number reached by the following calculation. The actual total costs incurred by a trust, are taken to be the costs for its HRG x the number of such resource groups. The expected costs of the trust are the national average costs of HRGs x the number of such resource groups. The RCI is reached by dividing actual costs by expected costs. Adjustment to the RCI is made to take into consideration discrepancies in cost resulting from differences in location, and those MFF which trusts cannot control. This is a much more detailed weighting system applying across locations throughout England than the previous London weighting, and the adjustment alters RCIs considerably. Benchmarking clubs could be used as a way of encouraging hospitals to lower their costs. Therefore the NHS ranks trusts in accordance with their RCI values and the

results published on the Department of Health website. An average performance in terms of cost is given an index score of 100. A score exceeding 100 suggests an above-average cost of performance, while a score below 100 indicates a below-average cost. An RCI score of 95 suggests a trust is performing more efficiently than the average, while a score of 105 indicates costs 5% above the average and hence a lower level of efficiency.

Patient-level information and cost systems (PLICS) have also been used by the NHS, since the mid-2000s, to calculate the costs of individual patient care episodes. These IT systems combine activity, financial and operative data and aim to reduce waste and enhance efficiency. PLICS utilize a 'bottom up' rather than a 'top down approach' and are based on all patient-associated cost drivers (Ellwood et al., 2016).

2.1.Payment by Results in Healthcare Systems

PbR systems of various kinds have been used worldwide to encourage cost efficiency (Grašič et al., 2015; Longo et al., 2017). Any system of PbR to healthcare providers requires differentiation of patients according to the type of treatment required (Bojke et al., 2017). The healthcare sector is diverse and complex. This makes it difficult to ensure that payment for treatment is fair and meets the needs of patients (Grašič et al., 2015). Payment systems should thus take into account the various aspects of trusts' complex needs and motivate providers to provide an adequate level of service and ensure good patient outcomes. Efficiency needs to be increased and transparency maximised (Busse, 2012). The oldest method of tackling issues of fairness when calculating payments is the Diagnostic Related Groups (DRG), used by the US Medicare system since 1983 for the billing of patients and insurers (Jackson, 2001). HRGs, which are the British version of DRGs, classify patients depending on diagnosis, treatments and certain patient characteristics (Atella et al., 2019). Tariffs then reflect the national average

costs for the HRG across all trusts (Bojke et al., 2017; Longo et al., 2017). Thus, HRGs need to account for all the possible variables if the RCIs are to be correct and the PbR system is to work fairly. However, Geissler et al. (2011) acknowledge that no payment system can work perfectly in every respect.

Northcott and Llewellyn (2002) stress the importance of addressing such issues as variations in how standard costs for procedures are produced, differences in clinical practice, differences in trust running costs and variations in the LOS if comparative costs data is to be used effectively. Healthcare payment systems similar to DRGs in the US and HRGs in the UK are being increasingly adopted around the world (e.g., Netherlands, Australia, Italy, Germany and Spain) (Jackson, 2001). However, there is still limited knowledge about which design features work best (Busse, 2012). Hence, the current study aims to contribute to the knowledge in the field of healthcare accounting by determining the association between RCIs and variations in costs over a twenty-year period, and by testing trends related to location, type of trust (whether it is specialist, general, mental health, ambulance or community) and foundation status.

Some empirical evidence suggests that the Reference Cost system is associated with greater standardisation of trusts (Llewellyn and Northcott, 2005). Between 1997 and 2000 only 60% of trusts managed to keep their RCIs within 10% of the national average, but by the fifth year after the introduction of the Reference Cost system, this figure had risen to 72%. According to Guven-Uslu (2005), thereis management support for performance measurement. However, some clinicians distrust the system because it is difficult to ensure the comparability of cost data (Bourn and Ezzamel, 1986b; Jones, 1999; Llewellyn and Northcott, 2005; Scarparo, 2006; Guven-Uslu and Conrad, 2008; Kurunmäki and Miller, 2008; Chapman et al., 2014). However,

this may not have been exclusively due to the influence of the Reference Cost system. Ten other possible influences on their RCIs and cost reporting for this period have been identified and grouped into four categories by Llewellyn and Northcott (2005):

1. Variations in approaches to costing. This category includes differences in the way costs are allocated, as well as variations in the way "care profiles" are generated and costed.
2. There were also variations in the basic clinical activities undertaken to meet the legitimate needs of patients, but not subject to the HRG3 adjustment.
3. Information quality. Clinical coding varied, as did the way in which activities were counted. Trust information systems also varied as to their capacity for data collection.
4. Efficiency differences in cost performance.

3. Research Questions

This study aims to examine the current trends in RCIs in England and Wales. Given the exploratory nature of the research, and based on the literature presented above, our further analysis is guided by three questions:

1. What are the trends for trusts in each region, different trust types and foundation status over the first twenty-year since the introduction of the Reference Cost system?
2. Which regions, types and foundation status differ significantly from the national average for RCIs?
3. How do the mean RCIs of each region, type and foundation status compare with one another?

4. Data and Methodology

4.1. Data

A large amount of secondary quantitative data was used for this study. Data for 1997-2009

was gathered from the National Archives of the Department of Health website [4]. Data for 2010-2016 was obtained from the NHS Reference Costs Collection website [5]. These data contained the name of the trust and the MFF adjusted RCI for each trust for each year and provided a table for every year of the Reference Cost system. Organisation codes were only introduced in 1999, so matching names and codes for 1997 and 1998 was problematic. This led to the exclusion of 70 observations for those years. The data tables were then collated to provide an overview of the entire period of the scheme. This produced a total of 4,946 observations, once those which could not be matched had been excluded.

4.2.Methodology

Descriptive statistics were calculated, using the 99 percentile for the maximum of RCI, and 1 percentile for the minimum, to exclude any outliers in order to examine variations and movements towards the average. The number of trusts for each year was noted and this made it possible to see which trusts had RCIs below the national average (i.e., 101%)[6]. Calculations were made for all trusts and separately for each region, type and foundation status.

In order to provide a more comprehensive picture, the above results were tabulated and the table was then extended to include trust characteristics. The first of these characteristics is region. Following government information, ten regions in England and Wales were identified: West Midlands, Wales, South West, South East, North West, North East, Greater London, East of England, East Midlands and Yorkshire and The Humber[7]. The region in which each

[4] This data is available at: https://webarchive.nationalarchives.gov.uk/+/http://www.dh.gov.uk/en/Managingyourorganisation/Financeandplanning/NHScostingmanual/index.htm
[5] This data is available at: https://www.gov.uk/government/collections/nhs-reference-costs
[6] One percent was allowed for small deviation from the average which is 100%.
[7] Details of these ten regions are available at: https://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/maps/regions--former-government-office-regions--gors---effective-at-31st-december--2011.pdf

trust is operating was identified by means of the postcode of that trust.

The second characteristic is the type of organisation. There are five different organisational types within the NHS: acute, specialist, ambulance, community and mental health[8]. The type of each trust was identified using NHS websites and the websites of the individual institutions. Ambulance was not included in the data until 2002. The third characteristic is whether or not a trust is a FT. A trust can only be a FT if it has demonstrated best practice and sustainable financial viability (Department of Health, 2005). From the names provided for each identification code across the twenty-year, it was possible to highlight when a trust received foundation status.

Two statistical tests have been conducted. The first test, the one-sample t-test, compares the mean of RCI for each characteristic classification (i.e., regions, types and FTs and Non-FTs) with the national average and secondly, One-way Analysis of Variance (ANOVA) is used to compare the means of RCI between each classification. To compare the variation between the mean of RCIs of various regions and types, Games Howell Post Hoc was used to overcome the limitation of unequal sample size.

Three periods were examined, the entire twenty-year period (from 1997 to 2016), since the introduction of the Reference Cost system. From 2002 to 2016, following the introduction of PbR, and the inclusion of ambulance trusts, and from 2005 to 2016 covering the period following the introduction of foundation status.

[8] Some trust types did not have HRGs from 1997. However, they appeared in the Department of Health publication of RCIs for 1997 because they offer acute services. For example, there were no mental health HRGs in 1997. However, the document for that year includes 24 mental health trusts.

5. Results:

5.1.Descriptive Statistics

Table 1 and Chart 1 (A, B, and C) provide a general overview of RCIs over the two decades prior to 2016. The results set out in Table 1 and Chart 1 (A, B and C) show that the number of trusts increased between 1997-2016 by 38 new trusts. However, when PbR were introduced in 2002, trust numbers were 273. Thus, 39 trusts merged, possibly to reduce costs. The highest RCI scores for all trusts decreased toward the national average from 148 in 1997 to 128 in 2016. The results for the minimum of RCI between 1997-2016 increased by 10 points over the period. The variation between trusts decreased over the period as the standard deviation was 14% in 1997 and 9% in 2016.

There was a 4% increase in trusts falling within the acceptable national average range (i.e., between 99 and 101), between 1997-2016 and, surprisingly, a 4% decrease in the number of trusts falling below 101. Thus, in 2016 more trusts were exceeding the national average than in 1997 (see Appendix 2, Table A for further details).

Table 1. Descriptive Statistics of RCIs of all Trusts from 1997 to 2016 (five-year intervals)

All Trusts	1997	2002	2007	2012	2016
Number of Trusts	196	273	238	244	234
MAX	148.28	151.38	142.56	136.08	128.19
Median	99.00	99.72	99.11	99.86	100.41
MIN	73.76	71.93	81.90	78.17	83.63
STD	13.71	14.62	10.58	19.03	9.09
Average	100.29	101.21	100.41	101.58	100.54
Number of Trusts within 99-101	10	27	16	26	20
% of Trusts within 99-101	5.08	9.89	6.72	10.66	8.55
Number of Trusts below 101	113	153	135	138	124
% of Trusts below 101	57.36	56.04	56.72	56.56	52.99

Note: This table reports the summary of the statistics for all NHS trusts between the period 1997 to 2016. For the sake of brevity, only the statistical results for every five years are reported. See Appendix 2, Table A for the full table. RCI= reference cost index; Number of trusts= number of trust that their RCI was published; MAX= the 99 percentile of RCIs in a given year; MIN= the 1 percentile of RCIs in a given year; STD= standard deviation; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; Number of trusts below 101= number of trust that their RCI was below 101%.

Chart 1A. The Maximum and the Minimum Reference Cost Index for all Trusts from 1997 to 2016

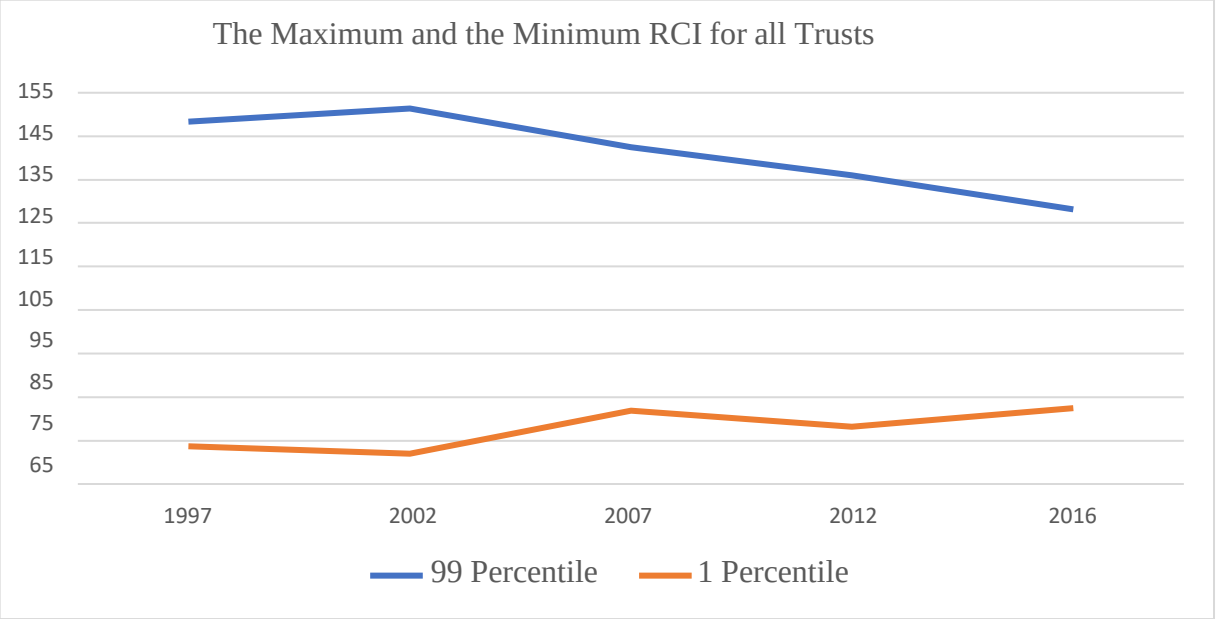


Chart 1B. Percentage of Trusts with Reference Cost Index within and below the National Average from 1997 to 2016

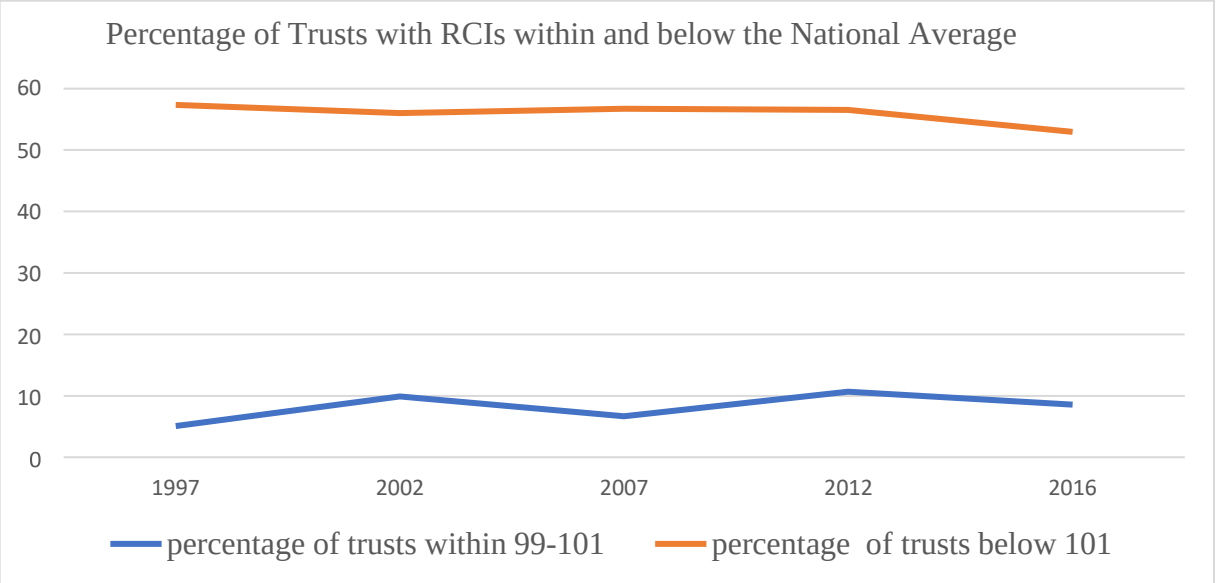
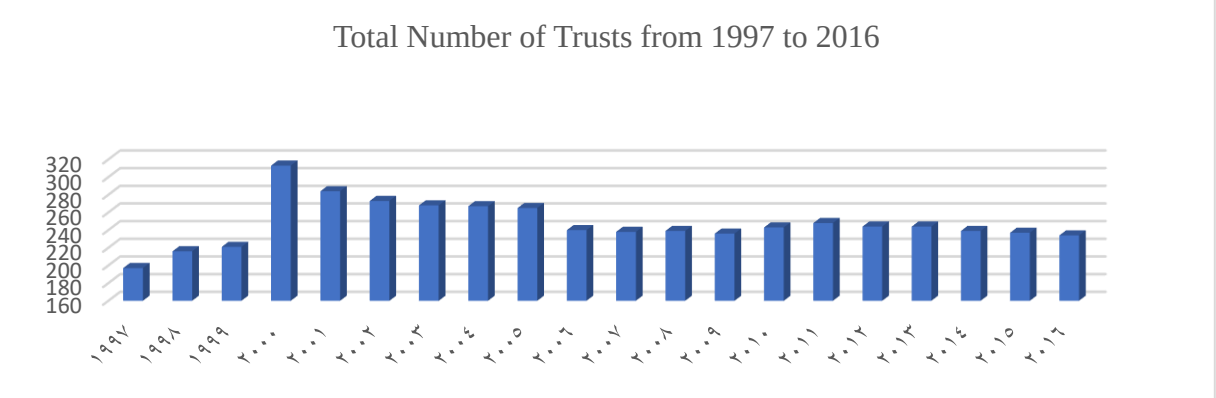


Chart 1C. Number of Trusts from 1997 to 2016



5.2.Descriptive Statistics for Trust Region

Previous literature, such as Llewellyn and Northcott (2005), has highlighted managerial concerns about trusts in Greater London and the South East being disadvantaged due to their location. Therefore, this study examines the significance of regional variations. There were no clear trends that could be applied to all regions. From 1997 to 2016 the number of trusts in all regions increased, except for Yorkshire and The Humber, which decreased by two trusts. However, the number of trusts from 2002, following the PbR system, decreased in seven regions. The maximum RCI increased in East Midlands and East of England between 1997-2016 and remained approximately the same in Greater London, Yorkshire and The Humber and the South West. The minimum was below the average and increased towards the national average in Greater London, Yorkshire and The Humber, the South West, East of England and the East Midlands, while the minimum RCI in the North West and Wales were below the average but decreased further over the period. The variation did not increase in any region. It either decreased or remained constant.

There are only three regions that had a higher percentage of trusts with an RCI below 101: the North East, and also South East and Greater London. The latter are two of the regions whose managers complained that they were disadvantaged (Northcott and Llewellyn, 2003). The differences in patterns between the regions and the lack of any definite trends across the entire country, suggest that region is an important characteristic when discussing cost. Therefore, it would make sense for region to be taken into account in other calculations at least as a control variable (see Appendix 2, from Table B to Table K).

5.3.Descriptive Statistics for Types of Trust

When examining trends for the types of trust, data was taken from 2002 to 2016 because

2002 was the year when the ambulance trusts started reporting their RCIs. All types of trust decreased in number, except for community trusts. Overall, the variation in RCIs between trusts in each type decreased, which suggests that the Reference Cost system is having the desired effect on costs and standardising the work of the trusts. Community and mental health trusts demonstrated similar trends. In both cases, all trusts had a slight increase in their maximum RCI over the period and the minimum remained constant. A percentage was calculated by taking the number of trusts in a given type with an RCI below the national average, in a given year, divided by the total number of trusts of the same type, in the same year. This percentage for both community and mental health trusts was higher in 2016 than it had been in 2002. However, between 2002 and 2009 only two community trusts were reporting their data. The percentage for specialist trusts was also higher but the maximum and minimum trends were not the same as those for community and mental health trusts but were the same as those for acute and ambulance trusts, where their maximum RCIs decreased and their minimum increased (see Appendix 2, from Table L to Table P).

5.4.Descriptive Statistics for Foundation Status

A further important characteristic is whether a trust is FT or Non-FT. It would be expected that a FT would perform better than a non-FT because of the standards required to gain foundation status. There were no data from before 2005 because this was the year in which FTs began. In 2005 only 12% of trusts achieved foundation status but this number increased gradually until, in 2016, 65% of trusts had become FTs, leaving only 35% as Non-FT. FTs and Non-FTs usually went in different directions. FTs showed a slight increase in the maximum while the RCIs for Non-FTs decreased. FTs already had minimum RCIs below the national average but decreased still further. Non-FTs showed an increase towards the average. Non-FTs showed a decrease in variation in RCI, while FTs remained the same. Both FTs and Non-

FTs showed a slight decrease in the percentage of trusts falling below the national average. It is noteworthy that during the years 2011 and 2012 Non-FTs had better average RCIs than FTs. The year 2012 was an exception, with an unusually high maximum of 353%, but the data for 2011 are difficult to explain (See Appendix 2, Table Q and Table R).

5.5. Comparison between the National Average Value, which is 100, and the Mean of Reference Cost Index of Trusts in each Region, Type and Foundation Status

This section compares and assesses the differences in mean RCI and the national average. Trusts were grouped by regions, types and foundation status using one-sample t-test.

Taking the whole period from 1997 to 2016 (Table 2), the average RCI of six regions (i.e., West Midlands, Wales, North West, North East, Greater London and East Midlands) was significantly higher than the national average[9]. East of England, Yorkshireand The Humber had averages that were significantly lower than the national average. For the other two periods 2002-2016 and 2005-2016, please see Appendix 2, Table S. In terms of type (data from 2002 to 2016), acute had RCIs below the national average, while specialist, community and mental health trusts were significantly higher than the national average (Table 3). Two further tables covering the time periods from 1997 to 2016 and 2005 to 2016 can be found in Appendix 2, Table T. For the FTs and Non-FTs between 2005 and 2016, Non-FTs had RCIs which were significantly above the national average (Table 4).

[9] The calculation of the national average is explained in Chapter 1 and in the literature section.

Table 2. Results of One Sample t Test of the Mean RCI of each Region on the National Average

Regions	1997-2016			
	N	Mean	t	Mean Difference
West Midlands	558	101.85	3.633	1.847**
Wales	48	105.4	3.148	5.396**
South West	555	99.59	-0.807	-0.410
South East	566	100	-0.001	-0.000
North West	898	101.08	2.538	1.083*
North East	451	101.43	2.815	1.433**
Greater London	904	101.63	3.164	1.625**
East of England	441	98.272	-3.310	-1.728**
East Midlands	439	102.64	3.559	2.640**
Yorkshire and The Humber	86	97.718	-2.096	-2.282*

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table 3. Results of One Sample t Test of the Mean RCI of each Type on the National Average

Types	2002-2016			
	N	Mean	t	Mean Difference
Acute	2194	98.929	-7.299	-1.071**
Ambulance	237	101.651	1.695	1.651
Community	137	102.480	3.003	2.480**
Mental health	857	101.187	2.268	1.187*
Specialist	290	111.719	13.210	11.719**

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table 4. Results of One-Sample t-Test of the Mean RCI of each Foundation Status on the National Average

Foundation Status	2005-2016			
	N	Mean	t	Mean Difference
Non-foundation	1443	101.248	4.796	1.248**
Foundation Trusts	1464	100.352	1.139	0.352

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

5.6.Comparison between the Means of Reference Cost Indices of Trusts in each Characteristic (i.e., Region, Type and Foundation Status)

In the previous section, the analysis showed that the RCI of trusts from some regions, types and Non-FTs were significantly different from the national average (100%). In this section,

the differences in RCI between the regions, types and FTs and non-FTs are tested using ANOVA test.

Significant differences were found for all characteristics tested. Tables 5 (Panel A and Panel B) show the significance (p-value ≤ 5%) of the mean differences in RCI within regions and types respectively. The Welch and Brown-Forsythe tests were conducted for these results, to confirm the robustness of the ANOVA tests (see Table 5 Panel C and Panel D). Further ANOVA tests were conducted to compare the means of RCI for both regions and types covering the time periods: 2002 to 2016 and 2005 to 2016, indicating the existence of a significant difference in each case (see Appendix 2, From Table V to Table AC). Furthermore, given that Wales has a low number of NHS trusts, the ANOVA tests for three time periods were re-run, excluding Wales, and the results remained significant and unchanged. However, the only time period which was tabulated was for 1997-2016 (see Appendix 2, Table AD and Table AE)[10]. The one-way ANOVA test only reveals the existence of a significant difference. It does not show between which region or type this occurs.

In order to compare the mean of RCIs of trusts in each region with every other individual region, the Games Howell Post Hoc test was conducted (see Table 6). East of England had a lower mean of RCI than six other regions (i.e., West Midlands, Wales, the North West, the North East, Greater London and the East Midlands) which makes it the region with the most other regions significantly above it. The South East is the only region that has no significant difference from any other region.

[10] In Wales most health services are provided by health boards. Wales has no FTs and only three health trusts (an ambulance trust, a specialist cancer trust and a public health trust). Many NHS trusts and FTs in England provide acute health services.

These results suggest that the MFF, as explained in the introduction, might be working for Greater London and the South East, contrary to the claims in Northcott and Llewellyn (2003). Table 7 shows the results of the Games Howell Post Hoc Test for trust type. Acute has a lower mean of RCI than any other type, while the mean RCI for specialist is higher than that of all the others. In terms of foundation status, the independent sample test was used. The mean of RCIs of FTs was found to be significantly lower than that of Non-FTs for the years 2005-2016 (Table 8). There might also be other factors which have influenced RCIs and cost reporting for this period, as discussed by Llewellyn and Northcott (2005).

Table 5. Results of Comparing the Means of Reference Cost Indexes

Panel A. Results of ANOVA Test between Regions from 1997 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8610.376	9	956.708	5.754	0.000
Within Groups	820696.449	4,936	166.268		
Total	829306.826	4,945			

Panel B. Results of ANOVA Test between Trust Types from 2002 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42934.134	4	10733.534	91.228	0.000
Within Groups	436502.877	3710	117.656		
Total	479437.011	3714			

Panel C. Results of Welch and Brown-Forsythe Tests for Regions from 1997 to 2016

	Statistic	df 1	df 2	Sig.
Welch	6.710	9	765.433	0.000
Brown-Forsythe	6.299	9	2229.070	0.000

Panel D. Results of Welch and Brown-Forsythe Tests for Trust Types from 2002 to 2016

	Statistic	df 1	df 2	Sig.
Welch	58.046	4	521.030	0.000
Brown-Forsythe	60.373	4	1151.670	0.000

Table 6. Results of Games Howell Post Hoc Test to Compare the Means of RCIs of each Region with every Other Individual Region from 1997 to 2016

Regions	Wales	South West	South East	North West	North East	Greater London	East of England	East Midlands	Yorkshire and The Humber
West Midlands	-3.549	2.257	1.847	0.764	0.413	0.330	3.604**	-0.793	3.976*
Wales		5.806	5.396	4.313	3.963	3.879	7.153**	2.756	7.525*
South West			-0.410	-1.493	-1.843	-1.927	1.347	-3.050*	1.719
South East				-1.083	-1.434	-1.517	1.757	-2.640	2.129
North West					-0.350	-0.434	2.840**	-1.557	3.212
North East						-0.083	3.191**	-1.207	3.563
Greater London							3.274**	-1.123	3.646
East of England								-4.397**	0.372
East Midlands									4.769*

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table 7. Results of Games Howell Post Hoc Test to Compare the Means of RCIs of each Type with every Other Individual Type from 2002 to 2016

	Ambulance	Community	Mental health	Specialist
Acute	-2.723*	-3.551**	-2.259**	-12.790**
Ambulance		-0.829	0.464	-10.067**
Community			1.293	-9.239**
Mental health				-10.531**

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table 8. Results of Independent One-Sample t-Test to Compare between the Means of RCIs of FTs and non-FTs from 2005 to 2016

	Levene's Test	t-test for Equality of Means		
	F	t	df	Mean Difference
Equal variances assumed	3.546	-2.217	2905	-0.897*
Equal variances not assumed		-2.220	2830.528	-0.897

Note: RCI= reference cost index; FTs= foundation trusts; Non-FTs= non-foundation trusts. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

6. Conclusion

Previous research has recognised the importance of working towards greater efficiency in healthcare. In England and Wales considerable attention has been given to the NHS budget. The NHS is funded by general taxation and trusts must be accountable for efficient use of

resources. The Reference Cost system and RCIs have been used in the NHS in England and Wales since 1997 to provide cost data to prompt efficiency improvements and reduce treatment cost variations. This research aimed to describe trends and patterns in cost variations over a twenty-year period. It also sought to examine the variations in RCIs between regions, types and foundation status, to provide descriptive statistics and to identify trends. Data were drawn from NHS Reference Cost Collections and the National Archives of the Department of Health website and analysed using descriptive tests, ANOVA and one-sample t-test.

The results demonstrate that overall variations between trusts decreased over the period, suggesting that, since the introduction of the Reference Cost system and RCIs, costs between trusts have been standardized. While there were significant differences in costs between regions, there were no clear trends across all regions. The variation in cost did not increase in any region: it either decreased or remained constant. When examining RCIs by hospital type (acute, specialist, community, mental health or ambulance): acute hospitals had lower RCIs while specialist hospitals had the highest; again the RCIs showed reducing variation, but there were differing trends in RCIs by hospital type when looking at maximum and minimum percentiles. When examining foundation trust status or not, the analysis of RCIs confirmed FTs as more efficient. However, there were differences between the characteristics tested (i.e., region, type and foundation status). One limitation of this study is that it does not examine the association between organisational characteristics and costs. Such analysis requires the collection of additional data and further statistical analysis. However, this will be addressed in the next chapter which will consider the association between organisational characteristics and RCIs. This is important under the current public healthcare payment system, where costs must be controlled while standards are maintained. Understanding these

characteristics will provide the data to underpin potential action and the policy decisions required to improve efficiency and standardisation across the entire healthcare sector.

Chapter 3: The Relationship of NHS Trust Characteristics to the Reference Cost Index

The Relationship of National Health Service Trust Characteristics to the Reference Cost Index

Context: The Reference Cost Index has been used in the NHS in England since 1997, to generate comparable cost data to improve efficiency and reduce variation in treatment costs.

Objective: This study aims to examine variations in costs between 2009 and 2016 by testing the relationship of certain organisational characteristics (i.e., location, the type of service provided, foundation status and size) on RCIs. Contingency theory is used as a basis for this study, as a lens through which to examine the issues involved.

Data Sources: Data for 2009 were gathered from the National Archives of the Department of Health website, while data for the years between 2010 and 2016 were extracted from NHS Reference Costs Collection website. Size data were gathered from England NHS website and the control variables (i.e., patient classification and gender) were obtained from NHS Digital website.

Study Design: OLS regression.

Main Findings: This study found that the East of England, South East and South West were the most efficient regions, while East Midlands and the North West and Yorkshire and The Humber were the least efficient. In terms of type, mental health and acute were most efficient and specialist and community least efficient. FTs were found to be more efficient than Non-FTs. Smaller trusts were found to be more efficient than larger trusts.

Conclusion: Contingency theory suggests that there is no one ideal costing system to fit all types of institutions. Thus, the factors examined in this study are likely to be associated with the RCIs of trusts which differ as to the nature of their work and other pressures from their specific circumstances. The results indicate that MFF adjustment for regional differences and the last version of the HRG, HRG4+, has gone some way towards improving the Reference Cost system, but greater refinement both in the cost system and adjustments to RCI may be needed to take into account other variations in trusts such as the factors examined in this study.

Key Words: NHS, RCI, Cost efficiency, Cost System, Benchmarking.

1. Introduction

A large proportion of public finance worldwide is devoted to healthcare provision, mainly due to high costs and increasing expenditure, associated with the need to purchase up-to-date medical technology, and the challenges of treating aging populations (The World Bank, 2015; Labro, 2015; Gebreiter and Ferry, 2016; Malmmose, 2018). Consequently, obtaining value from healthcare budgets is a concern of governments. In the United Kingdom, governments have long striven to maximise the efficiency of the NHS, to address issues of waste, to improve efficiency and obtain better value from its budget (e.g., Bourn and Ezzamel, 1986a; Broadbent et al., 1991; Broadbent, 1992; Preston et al., 1992; Harrison et al., 1994; Hood, 1995; Jones and Dewing, 1997; Llewellyn, 1998; Jones, 1999; Lapsley, 2001).

To apply efficiency in a health care context in England and Wales, the Reference Cost system was introduced into the NHS in 1997. It was designed to reduce cost variations between NHS trusts, to tackle variations in performance and to improve standards through information sharing and performance comparison (Department of Health, 1997). The Reference Cost system has developed over the twenty-year it has been in place (please see Table A Appendix 1). Chapter 2 in this PhD thesis provided descriptive statistics of RCIs and concluded that there had been a move towards the national average over the period. Nevertheless, there are still considerable variations in RCIs across trusts. Many accounting and economic studies have examined the effect of trust characteristics, such as ownership, on decision making (e.g., Krishnan and Yetman, 2011; Holzhacker et al., 2015). An underlying assumption across these studies was that trust characteristics matter and variations on decision making and consequently on efficiency could be influenced by those characteristics.

Previous studies have recognised that there are numerous potential variables that may affect health service cost (Llewellyn and Northcott, 2005). However, despite some distrust of the

cost systems among clinicians (Bourn and Ezzamel, 1986b; Jones, 1999; Llewellyn and Northcott, 2005; Scarparo, 2006; Guven-Uslu and Conrad, 2008; Kurunmäki and Miller, 2008; Chapman et al., 2014), there is empirical evidence suggesting that Reference Costs have improved cost standardisation (Llewellyn and Northcott, 2005). The introduction and literature review presented in Chapters 1 and 2 of this thesis examined the previous work on policy and showed how Reference Costs were introduced and have developed throughout the years summarized in Table A. The literature review for the current study will consider more granular cost systems applied in the health service through Patient Level Information and Cost Systems (PLICS) using activity-based costing (ABC) techniques; and studies covering efficiency, patient classification and patient and trust characteristics.

This study examines and discusses the system which has been applied for more than twenty-year to the healthcare payment system in England and Wales, using a combination of data not previously applied to the study of health care efficiency. The study measures the relationship between the location, trust type, foundation status and trust size and RCI from 2009 to 2016. The focus on trust characteristics, rather than patient characteristics or productivity, distinguishes this study from previous studies (e.g., Hollingsworth, 2008; Castelli et al., 2015b; Cantor and Poh, 2018). This study analyses the association between individual uncontrollable variables (i.e., location, trust type, foundation status and size) and RCIs employing linear regression. Patient classification and some of the patient characteristics will be used in this study as control variables. To the best of my knowledge, no studies have examined the association between the combined trust characteristics and RCIs over an extended period. Where the influence of location has been examined, it has mostly focused on selected HRGs, rather than considering all treatments provided by the NHS (e.g., Daidone and Street, 2013). It reinforces the view presented by contingency theory, illustrating that organisational structures may differ and that a “one size fits all” approach is challenging to

apply. Nevertheless, the study demonstrates that, since the introduction of the Reference Cost system, progress has been made in the assessment of cost efficiency of NHS trusts with varied structures and characteristics.

The following section provides the theoretical framework. Section three provides a review of previous research in this field and discusses recent studies on healthcare treatment costing and the various studies which have assessed trust efficiency. Section four presents the data and the methodology of the current study. Section five displays the results. Section six presents the discussion, and the final section provides conclusions and suggestions for future research.

2. Theoretical Framework

Contingency theory was initially developed in the early to mid-1960s but became a popular theory within management accounting research in the 1970s (Otley, 1980), in response to rapidly changing circumstances and environmental uncertainty. It has become significant within management accounting because academics have recognised that an accounting system's organisational context is important (Otley, 2016). Contingency theory dominates the design of control systems for explaining variations in the relationships between organisational variables, contingency variables and environmental variables (Dent, 1990).

This theory provides a contrasting approach to traditional management theories, such as scientific management theory, bureaucratic theory and administrative theory, which suggest that there is one ideal way to structure an organisation. In this respect, they overlook the significance of the relationship between contextual variables and organisational structure and suggest that a single way of organising affairs is applicable regardless of the situation (Emmanuel et al., 1990). This theoretical background provides a useful alternative to these universal approaches by acknowledging that organisational structure is influenced by other

variables. Since environmental factors (e.g., technology, size and structure) have a role to play, there can be no universally applicable accounting system for all organisations under every possible context (e.g., Otley, 1980; Haldma and Lääts, 2002; Gerdin and Greve, 2004). Thus, there must be an association between the context of an organisation and the control system used (Islam and Hu, 2012).

The application of Reference Costs, as a control system, across all NHS trusts throughout England and Wales could be regarded as problematic in the context of contingency theory, as the system is applied to different trusts with different organisational structures (FT or Non-FT) and different sizes, doing different types of work (from acute care to mental health, specialist and community services), in vastly differing regions. Efforts have been made to ensure that differences in treatments are taken into account, through the introduction of the most recent version of the HRG classification, HRG4+, and the MFF adjustments made for regional variations. Nevertheless, inconsistencies may remain.

The literature review below highlights various factors, both internal and external which may affect a trust's ability to keep its costs within the national average. Type, region, size and foundation status may all have a role to play in influencing how well a trust managesto keep its costs within the average. For this reason, contingency theory has been selected as providing the most useful theoretical framework to inform this study and help develop appropriate hypotheses to test through quantitative analysis.

3. Literature Review and Hypotheses

Payment for healthcare treatment in England and Wales is based on the figures produced by the RCIs (as discussed in chapters I and 2). PbR of various kinds have been used worldwide to encourage cost efficiency in health care (Lowe and Doolin, 1999; Roeder et al., 2002;

Lungen and Lapsley, 2003; Grašič et al., 2015; Holzhacker et al., 2015; Longo et al., 2017). The working of these systems has been explained in chapters 1 and 2. Any system of PbR to healthcare providers requires differentiation of patients according to the type of treatment required (Fetter et al., 1980; Fetter and Freeman, 1986; Bojke et al., 2017). The healthcare sector is diverse and complex. This makes it difficult to ensure that payment for treatment is fair and meets the needs of patients (Grašič et al., 2015). Payment systems should thus take into account the various aspects of trusts' complex needs and motivate providers to provide an adequate level of service and ensure good patient outcomes. Efficiency needs to be increased and transparency maximised (Busse, 2012).

Many studies argue that such PbR systems affect healthcare services significantly and improve the efficiency of healthcare organisations more than the previous system (Shleifer, 1985; Sloan et al., 1988; Chua, 1995; Lowe and Doolin, 1999). However, healthcare managers face difficulties in making strategic decisions due to uncertain revenues associated with the PbR system (Eastaugh, 1999; Kuntz et al., 2008). Therefore, several accounting and economic studies examine the effect of PbR and the operating risk that it presents on trust costs, behaviour and their decisions.

Healthcare costs have important implications for the social and institutional environment of trusts, as it has an impact on the lives of human beings. Consequently, numerous researchers have studied healthcare costs and the changes in healthcare services (e.g., Kurunmaki et al., 2006; Jones and Mellett, 2007; Cardinaels and Soderstrom, 2013; Chapman et al., 2014); for example, examining the associations and the effect of aging populations on healthcare cost (e.g., Fries, 1989; Zweifel et al., 1999), demographic changes and technology (e.g., Hopwood, 1992; Lapsley, 2001) or physicians' behaviour, involvement and attitudes (e.g., Bourn and Ezzamel, 1986b).

The introduction of the PbR has led to a degree of manipulation of financial reporting by trust managers. For example, in the US, more overhead costs have been allocated to outpatient services because their payment system uses a fixed price for inpatients. Financial manipulation has also affected the public-private patient balance in the US (Eldenburg and Kallapur, 1997). Kessler (2007) and Bai (2016) found that Californian trusts can charge private patients more than public patients and, as a result, trusts will reduce the number of public patients and increase the number of private patients.

The introduction of PbR has also led to the development of new accounting techniques which more accurately associate clinical activities with their financial outcomes (Chen et al., 2015). One important example of such a technique is the Activity-Based Costing (ABC) method. ABC is a management accounting innovation (Wegmann and Stephen, 2009), based on activities, which was developed by Kaplan and Cooper in the late 1980s and promoted and implemented in the 1990s (Dragija and Lutilsky, 2017). The system maintained a high profile for several years, attracting the interest of academics and practitioners (Malmi, 1999; Liu and Pan, 2007). The ABC method is a suitable technique for evaluating the cost of each healthcare activity, but since healthcare institutions vary as to their specificity, ABC needs to be implemented in ways which are appropriate (Dragija and Lutilsky, 2017). The aim of using an ABC system is to allocate costs fairly and accurately and to evaluate product profitability, focusing on the best way of allocating indirect costs to cost objects, thus rejecting the traditional costing assumption that resources are directly consumed by products and services (Awashi, 1994). The ABC is a system which can help control costs because it identifies the activities and resources which are most costly (Cannavacciuolo et al., 2015).

In an ABC system, products are seen as consuming activities and it is the activities which consume resources (Horngren et al., 2003). Activities and cost objects are linked by cost and

activity drivers (Aldogan et al., 2014), a cost driver being any activity or factor directly affecting resource consumption. An activity can be any action, event or work sequence involved in the production of a product or service which incurs an expense (Weygandt et al., 2009). Since direct costs can be traced directly to services, customers or products, the greatest focus in an ABC system is on indirect cost, in contrast to the attention paid to cost centres by traditional accounting systems (Lanen et al., 2013), such as Volume-Based Costing (VBC), where each cost object (such as a unit of a trust) is allocated indirect costs by means of a single cost driver. The results thus produced are often approximate or inaccurate. However, the ABC method has a higher level of accuracy (Cao et al., 2006).

The introduction of the ABC method coincided with the growth of information technology which fundamentally altered the structure of production costs, with a move to the prevalence of indirect costs and a decrease in such direct production costs as labor and materials, and the system seemed to meet the requirements of these changes by providing precise data on product or service costs (Dragija and Lutilsky, 2017). In contrast, a traditional cost accounting system would not produce information quickly and accurately enough to meet modern management needs (Cooper and Kaplan, 1991). ABC's use of more cost centers and various kinds of cost drivers, as well as the assignation of activity costs to cost objects based on the usage of cost drivers, means that it can assess more accurately the resources required for each cost object (Drury, 2013). Using various cost drivers highlights cause and effect connections between activities and cost objects (Dragija and Lutilsky, 2017). The accuracy of the ABC method assists planning and the setting of prices (Homburg, 2004), and the identification of activities which do not add value allows these to be decreased or eliminated (Walther and Skousen, 2009; Dragija and Lutilsky, 2017).

Another advantage of ABC is that it is applicable for costing of both services and products.

Furthermore, it is appropriate in both the public and private sectors, supporting performance management techniques, for example balanced scorecards and continuous improvement (Eldenburg and Wolcott, 2005). It helps promote cost-reduction initiatives (Brimson and Antos, 1994), allows accountants to be more aware of how a service functions and why costs are incurred (Kirton and Hazlehurst, 1991) and enhances accounting performance measures, from the perspective of processes (Kohlbacher, 2010). However, its benefits differ according to subject (Dragija and Lutilsky, 2017).

O'Reilly et al. (2012) suggested that the ABC methodology was applicable to healthcare systems with varied organisational structures, funding systems and public/private sector involvement. Its implementation in five healthcare systems in Europe has led to greater efficiency and improved sustainability of the healthcare systems (Dragija and Lutilsky, 2017). Nevertheless, despite its advantages the ABC's adoption rate has remained low, giving rise to the debate about the so-called "ABC paradox" (Gosselin, 1997). In 1997, Dowless noted that ABC was not being used widely in the healthcare sector, while Lawson (2005), noted a decline in ABC use with fewer healthcare organisations even contemplating adopting the method.

Although ABC is an attractive method of accounting with many advantages, including its scientific approach and its sophistication (Wegmann and Stephen, 2009), the healthcare sector has been reluctant to adopt it because it is complex and challenging to implement in practice. Traditional methods are less complicated in terms of time, methodology and resource consumption. It is only realistic to adopt it if its advantages outweigh the disadvantages (Dragija and Lutilsky, 2017). Furthermore, if direct costs, direct material and direct labour consume a higher proportion of costs than overheads, ABC is not a suitable accounting method to use, and it can be difficult to identify an activity or cost object's cost driver (Drury, 2013). Popesko (2013) pointed out that the complex structure of trusts in terms of outputs, activities

and customers create barriers to trust managers considering ABC adoption. Additional staff with experience in ABC implementation may need to be employed and existing information management systems may need to be modified (Dowless, 1997). A further obstacle to the use of ABC has been a lack of senior management commitment (Lawson, 2005) and concerns that it might be a temporary trend which may rapidly be replaced by another new system (Kaplan, 1990).

In the NHS, PLICS are used to help calculate and reduce costs. These are IT systems which are used to calculate the costs of individual patient care episodes, by combining activity, financial and operative data. They began to be introduced in the mid-2000s as a result of the Department of Health recommendation that the patient be used as a cost object when drivers of healthcare costs were analyzed (Ellwood et al., 2016), and are still in use at the time of writing. By 2013, PLICs were being used by 120, mainly acute hospital trusts, with a further 86 undergoing the planning or implementation process (DoH, 2013), with the aim of improving the NHS economy as a whole, rather than just that of individual trusts, although initially it was the latter which saw the greatest benefits from the system. PLICS encourage waste reduction by identifying variation and providing clinicians with the financial information on which to base decisions which could enhance efficiency. PLICS data can be applied to allow benchmarking of activity at the patient level either against local protocols or in the context of national treatment practices. PLICS can assist when services are redesigned, can highlight the need to move services to alternative care settings and can help reduce the numbers of superfluous tests, interventions and referrals. PLICS data is collected and stored on a national database (Ellwood, et al., 2015). The PLICSs costing methodology differed from such methods as HRG costing, in that they took a ‘bottom up’ rather than a ‘top down approach’ and endeavored to take all patient-associated cost drivers into account (Ellwood et al., 2016). According to Llewellyn et al. (2016) and Ellwood et al. (2016), PLICS were used

by trusts to drive improvements to costs and to help meet Cost Improvement Programmes (CIPs). They note, however, that, at that time, a lack of PLICS data and an unwillingness of trusts to share data meant that the potential of the system had not been realized.

3.1. Efficiency Studies using Data Envelopment Analysis

Many studies have investigated the efficiency of trusts, often using Data Envelopment Analysis (DEA) and measuring numerous inputs and outputs (Hollingsworth, 2008; Castelli et al., 2015a; Cantor and Poh, 2018). This is a one-stage efficiency analysis, in which achieving a high score for efficiency is the main aim (Kaya Samut and Cafri, 2016) and productivity has been the focus of many DEA studies (Giancotti and Mauro, 2015). Dixon et al. (2018) argue that productivity, while not usually key to NHS reform, should be given greater importance. While clinicians associate it with working harder and patients with cost-cutting, it really means more efficient working and waste reduction. It should not involve reducing quality. Atella et al. (2019), for example, demonstrated how policy objectives in England and Italy led to differential growth rates, with the NHS in England prioritising the reduction of waiting times, increasing activity and improving quality, and the Servizio Sanitario Nazionale (SSN) in Italy prioritising cost restriction and rationalising provision.

However, while numerous DEA studies have been published over the years, they have had only a limited practical impact on trust management and policy makers. This is partly due to concerns that the technique may not be robust enough and that the insights it provides are limited (Castelli et al., 2015a). One limitation of the method is that efficiency is taken to be a single aggregate measure. This means that they can provide a measure of a trust's relative overall efficiency but cannot explain why some trusts perform better than others. Neither can DEA analysis investigate how a single factor (e.g., location) can have an impact on efficiency (Chen et al., 2005).

The present study uses OLS regression technique to analyse the association between single factors and RCIs. It identifies several characteristics of trusts which are variables outside the control of trust management. This is important because if the evidence on which policies are based is to be sound, uncontrollable variables must be identified and taken into account. Many studies to date have only taken some uncontrollable causes into account or have not accounted for interactions between them (Crémieux and Ouellette, 2001). By examining the uncontrollable characteristics (e.g., region, type, size and foundation status) selected for in the current study, it should be possible to better understand efficiency problems and their association with high RCIs, which could reflect factors beyond their control. The current study focuses on trust characteristics and their association with trust costs.

3.2. Trust Characteristics

The region, the type of trust, the foundation status and size could affect trusts' RCIs (e.g., Dredge, 2003; Roht et al., 2013; Herrera et al., 2014; Rezaee and Karimdadi, 2015; Giancotti et al., 2017; Longo et al., 2017; Atella et al., 2019). Both location (whether rural or urban) and provision of specialised services also affect cost (Palmer, 2005) and all of these characteristics are tested in the current study, using OLS regression to produce results that make it possible to identify associations between specific characteristics and RCIs.

Statistically significant geographical variations in cost have been identified by various studies, although these have not separated them from other influences (Lave and Lave, 1970; Vitaliano, 1987; Zuckerman et al., 1994). Indeed, there have been very few studies that take geographical location into account in DEA when assessing trust efficiency. Yet each region has its special status and issues, such as variations in labour costs, which need to be taken into account (Rezaee and Karimdadi, 2015). Research has highlighted significant regional economic disparities in many countries (Beenstock and Felsenstein, 2007). Although there is

an assumption in the healthcare literature that regions are homogenous, wages will be higher in areas where the concentration of experienced workers is high and there are fewer low earners, such as women, young people and those from ethnic minorities (Beenstock and Felsenstein, 2008). Demographic shifts, for example, an aging population or urbanisation, also affect the demands on the healthcare system (Mitropoulos et al., 2013). Such external, demographic factors can be regarded as environmental variables affecting the management and organisational structure of healthcare services (Mitropoulos et al., 2016), although the effect of location may be moderated by the range of services being offered (Mitropoulos et al., 2013). In Italy, for example, there are regional differences in trusts' capacity to deliverthe services required, with a distinct North-South divide. Different population sizes alsoaffect the quality of provision, with regions of under 2 million inhabitants scoring morehighly in surveys on patient satisfaction (Elba et al., 2017).

In England there are clearly documented regional economic discrepancies. In terms of housing, London and the South East are the most expensive England regions and have higher than average housing costs (Office for National Statistics, 2019). Rienzo (2017) has identified economic differences across the England, in terms of expenses, wages, housing costs and regional demographics, including human capital. Housing costs represent the largest part of overall household expenditures and have been shown to vary greatly across the England regions (Cinzia, 2010). According to the Office for National Statistics, between 2004 and 2018, average house prices in the North East were approximately a third of those in London and a half of those in the South East (Office for National Statistics, 2019). Variations also exist in levels of total expenditure, excluding housing. Regional prices have been shown to be important in regional analysis (Hayes, 2005). In 2016, London, the South East and the South West had higher relative regional consumer price levels than the national average (Office for National Statistics, 2018b). Furthermore, average weekly earnings show regional variations,

with Londoners having 25% higher gross weekly earnings than England average (Office for National Statistics, 2018a). Blanchflower and Oswald (2005) have highlighted the huge regional differences in wages in the private sector, while public spending per person also demonstrates regional differences (Brien, 2018).

The NHS recognises these regional economic differences and has therefore introduced the MFF, which is an adjustment to take account of non-controllable regional variations in costs. (For further details about how MFF works and how it is calculated, please see page 19). This means that regional variations should be taken into account. Similar approaches with payment adjustments have been followed in other countries, including the US (Street and Maynard, 2007). However, Daidone and Street (2013) noted that costs for treating patients were higher in London, despite regional adjustment, and that the MFF was not completely resolving the problem of regional variations. These results, combined with the ideas expressed through contingency theory, suggest that region remains a factor in healthcare costs despite the adjustments introduced so far.

H1: RCIs differ between regions

Specialist service is defined in England as services that "support people with a range of rare and complex conditions" (NHS Specialised services, 2019). It may be needed if a patient has a particularly severe condition, if there are serious underlying problems, or if complications arise. Such services are therefore provided by trusts with the appropriate infrastructure and medical teams (Daidone and Street, 2013). In the US, specialisation of For-Profit (FP), physician-owned trusts have been criticised due to the practice of "cream-

skimming" for financial purposes (Shactman, 2005; Schneider et al., 2008)[11]. In England, using specialist trusts is supposed to give the advantages of a "focused factory"[12] (Skinner, 1974), such as increased efficiency and quality, but not necessarily a reduction in costs (Longo et al., 2017). Indeed, if the payment system does not reflect the increased cost of treating more expensive patients, specialist trusts will be at a disadvantage (Bojke et al., 2018). Daidone and Street (2013) recognised the risk of financial disadvantage for trusts with specialist care teams if patients needing specialist care are more costly to treat than others in the same HRG, as discussed in Chapter 2 of this thesis. Analysing costs for over 12 million patients in 163 trusts for the fiscal year 2008/9, they estimated the extra costs associated with specialised care. They discovered that, while nineteen types of specialised care are no more expensive than others with the same HRG allocation, patients with cancer, spinal, neurological, rheumatological, colorectal or orthopaedic issues are more expensive to treat, as are children and those with cystic fibrosis. Those requiring specialist care tended to have longer LOS, which increased costs (Longo et al., 2017). Some of these specialisms were later covered by the top-up system for a restricted number of trusts (Longo et al., 2017).

Bojke et al. (2017) demonstrated that certain care markers (e.g., LOS) make a significant difference to base costs. They note that failing to take these additional costs into account, penalises trusts providing complex care services and recommend either refining HRGs to take complex care into account or using a top-up payment. In a US example, using patient, trust and geographic confounders as independent variables, Russell et al. (2016) demonstrated that childhood cancers and chemotherapy increased the cost severity of treatment, although other factors, such as diagnosis, age and type of trusts were also important.

[11] Cream-skimming refers to the practice of selecting the most profitable cases to treat.
[12] A focused factory refers to trusts specialising in particular types of treatments at which they are then able to excel.

Longo et al. (2017) used RCI data to examine a sample of specialist orthopaedic trusts and trauma departments in general trusts. Given the refinements to the payment system to ensure fairness and the advantages of specialist trusts in terms of expertise and focusing on a limited number of services, specialist trusts were expected to be more profitable than general trusts. However, this was not the case. Their regression results demonstrated a 13% average lower profit margin for the specialist trusts. Furthermore, two out of three specialist trusts were making a loss.

Since different types of treatment and specialisms have been shown to be associated with RCIs, the second hypothesis for the study is as follows:

H2: RCIs differ between types of trust.

Ownership and its impact on trusts' decisions and budgets have been studied in accounting and economic literature (e.g., Krishnan and Yetman, 2011; Holzhacker et al., 2015). The main reason for managers to act differently is the trust objective. The objective of trusts run FP is to maximise the profit, while Not-For-Profit (NFP) and public trusts aim to maximise the number of patients they treat (Dranove, 1988; Hoerger, 1991). Therefore, the impact of ownership has been studied as a factor affecting efficiency (Chang et al., 2004) and the role of the private sector in healthcare provision is a matter for debate (Kruse et al., 2018). Those who favour private provision argue that the competitive market and the drive to maximize profit will also improve efficiency, transparency and accountability, consumer choice and responsiveness (Hsu, 2010). It is also argued that, under the right conditions, private trusts could perform better than those under public provision (Kruse et al., 2018).

Those who are proponents of public provision highlight the incompatibility of profit

maximisation and public health. Managers of NFP trusts, which rely heavily on donations, are more motivated to shift administrative expenditures to the programme services in order to be more efficient, because the more efficient the trust, the more donations they receive (Weisbrod and Dominguez, 1986; Harvey and McCrohan, 1988; Khumawala and Gordon, 1997; Krishnan and Yetman, 2011). Another reason for managers to shift administrative costs is that managers have a compensation based on programmatic efficiency (Baber et al., 2002). The way in which ownership of health care institutions impacts on the provision of health care is important internationally (Chalkley and Sussex, 2018) and ownership of trusts has been discussed by many commentators since the 1980s (e.g., Gruca and Nath, 2001; Xirasagar and Lin, 2006; Shen et al., 2007; Bernet et al., 2011). Much of the evidence has been collected from the US, especially that which predates 2000 (Chalkley and Sussex, 2018). Much research has tried to establish how the type of ownership of trusts affects efficiency (Czypionka et al., 2014). Despite this, empirical studies have not produced any conclusive results (Chalkley and Sussex, 2018). However, all the above literature emphasises that trust managers should change their strategy and accounting choices in order to adapt the payment system and to reduce the operating financial risk.

Studies suggesting that private is more efficient than public provision have been undertaken in several countries including the US (Cowing and Holtmann, 1983), Taiwan (Chang et al., 2004), Germany (Robra and Werblow, 2006), Portugal (Barros et al, 2013) and Zambia (Masiye, 2007). Researchers who have found public provision to be more efficient than private include Custer and Willke (1991), Menke (1997) and Helmig and Lapsley (2001). The lack of observed efficiency differences between public and private providers was reported by a number of researchers (e.g., Vita, 1990; Steinmann and Zweifel, 2003; Staat, 2006; Farsi and Filippini, 2008; Herrera et al., 2014).

Further distinctions can be found between the private and public sectors. Privately owned trusts can be run for FP or NFP; public trusts can be state-owned or run by public bodies (Saltman, 2003). Studies suggesting that FP trusts are more efficient than either public or NFP trusts include: Wilson and Jadlow (1982), Staat and Hammerschmidt (2000) and Tiemann and Schreyögg (2012). However other studies suggest that managers will foster their own interests at the expense of operational efficiency (Chang et al., 2004), therefore suggesting that FP trusts are less efficient than NFP or public providers (Rosko and Chilingerian, 1999; Rosko, 2001; Daidone and D'Amico, 2009; Lee et al., 2009; Herwartz and Strumann, 2012). However, the evidence is still inconclusive as some researchers have found no efficiency differences between FP and NFP and public providers (Becker and Sloan, 1985; Berta et al., 2010; Herr et al., 2011).

In the current study, the association between foundation and non-foundation status and RCIs are tested, neither of which are FP, as previously mentioned in Chapter 2. However, FTs have considerable freedom as to how they manage their resources and which services they provide (Department of Health, 2002). Thus, in terms of organisational structure and governance, the FTs are similar to private NFP trusts while Non-FTs are more similar to public trusts. Even in this context, the prior results are mixed and inconclusive. Some studies from various countries have found NFP to be more efficient than public; others found that public healthcare providers are more efficient than NFP, while some have found no efficiency differences between the two (e.g., Mutter and Rosko, 2007; Barbetta et al., 2007; Herr, 2008; Tiemann and Schreyögg, 2009; Lindlbauer and Schreyögg, 2014; Sommersguter-Reichmann and Stepan, 2015). Efficiency is key factor in whether or not a trust can achieve their more independent status. Therefore, although they are not privately owned, their level of financial and decision-making freedom means that they are likely to be more efficient than Non-FTs. Therefore, it might be expected that:

H3: The RCIs of foundation trusts are lower than those of non-foundation trusts.

Size has been discussed in terms of scale efficiency, since one large trust may require lower levels of investment in staff and buildings than two smaller ones (Athanassopoulos et al., 1999; Weaver and Deolalikar, 2004). Azevedo and Mateus (2014) have argued in favour of economies of scale for trusts since fixed costs are spread while the volume of output increases. Administrative costs can be reduced; there are greater opportunities for specialisation and the market position of the organisation may be strengthened, allowing improved negotiations with suppliers. This has led to pressure on smaller trusts to merge. Although there is extensive literature on economies of scale, the evidence concerning the effect of size is inconsistent (Azevedo and Mateus, 2014). However, consistent evidence has been found supporting economies of scale for trusts with between two and three hundred beds (Giancotti et al., 2017). Various activities, such as use of labour, may not have many fixed costs which can be 'spread' with an increase in capacity. Thus, there may be a decrease in scale returns. There are some advantages to units remaining smaller because an increase in the size of the trust may lead to problems of co-ordination and congestion (Asmild et al., 2013) and a further disadvantage of mergers is that they may decrease competition (Gaynor et al., 2012). These findings concur with the earlier work of Hefty (1969), who found that the long-term average cost curve for trusts is U-shaped.

H4: RCIs differ between trusts of different sizes.

4. Data and Methodology

4.1. Data

Secondary quantitative data extracted from two NHS websites were used for this study.

MFF adjusted RCIs data for 2009 was gathered from the National Archives of the Department of Health website[13]. Data for 2010-2016 was obtained from the NHS Reference Costs Collection website[14]. These data contained the name of the trust and the RCI for each trust for each year and provided information for every year of the Reference Cost system. The RCI data was complemented with the trust characteristics, which are the independent variables to be used in this study. Trust size was assessed for each year of the sample and this data was extracted from the England NHS website[15]. The control variables used in this study are gender and patient classification, whether cases were in-patient, out-patient or emergency. Data on these control variables were collected from NHS Digital website from 2009 to 2016[16].

4.2. Dependent Variable

The dependent variable is the trust average cost this was measured by the RCIs of each trust.

4.3. Independent Variables

The independent variables are region, type, foundation status and size. Following the UK Office for National Statistics, ten regions were identified for this study: West Midlands, Wales, South West, South East, North West, North East, Greater London, East of England, East Midlands and Yorkshire and The Humber[17]. The region in which each trust is operating was identified by means of the postcode. The second independent variable is the type of trust. There

[13] This data is available at: https://webarchive.nationalarchives.gov.uk/+/http://www.dh.gov.uk/en/Managingyourorganisation/Financeandplanning/NHScostingmanual/index.htm
[14] This data is available at: https://www.gov.uk/government/collections/nhs-reference-costs
[15] This data is available at: https://www.england.nhs.uk/statistics/statistical-work-areas/bed-availability-and-occupancy/bed-data-overnight/
[16] This data is available at: https://digital.nhs.uk/
[17] Details of these ten regions are available at: https://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/maps/regions--former-government-office-regions--gors---effective-at-31st-december--2011.pdf

are five different organisational types within the NHS: acute, specialist, ambulance, community and mental health.

The type of each trust was identified using NHS websites and the websites of the individual institutions. The third independent variable was a foundation status. A trust can only be a FT if it demonstrated best practice. From the names provided for each identification code, it was possible to highlight when a trust received FT status. The fourth independent variable is size. This was measured by the number of available beds overnight. Some researchers mentioned in the literature review used both overnight bed capacity and the number of discharges as their measures. Asmild et al., (2013) used both approaches and found the results to be comparable.

4.4. Control Variables

Patient gender and classification were selected as control variables because according to the literature (e.g., Diwakar et al., 2016; Huang et al., 2017; Bettin et al., 2018), these are factors that have a significant impact on the treatment cost. Gender has been selected as a control variable due to the different medical conditions affecting men and women. Examples from the literature of those who have used gender as a control variable include Titler et al. (2007) Daidone and Street (2013), Castelli et al. (2015b) and Oh et al. (2016).

In terms of classification, patients can be classified in terms of whether they are an in- or out-patient or an accident or emergency case. Out-patients do not stay in trust overnight with clinicalsupervision, while in-patients are those who stay at least one night in trust (NHS, 2019a). trusts try to reduce the LOS as a cost-cutting strategy and numbers of out-patient surgical procedures are therefore rising (Crawford et al., 2015). considerable differences in cost between in-patient and out-patient surgeries have been noted. For example, Marla and

Stallard (2009) have highlighted the savings that can be made when radical mastectomy is carried out as an outpatient procedure rather than keeping patients in trust overnight. Meanwhile, Crawford et al, 2015 found that orthopedic surgeries were less expensive when carried out as outpatient procedures. Using outpatient procedures also reduces scheduling delays and avoids overnight costs (Aronowitz et al., 1998). Oh et al. (2016) found that out-patient costs were 54% lower than those for in-patients for foot and ankle surgery. Huang et al. (2017) demonstrated significant cost savings for out-patients receiving total knee arthroplasty, while ankle surgery following fracture has also been shown, in selected patients, to be more cost-effective than in-patient procedures (Bettin et al., 2018).

Furthermore, uterine polypectomy has been shown to be more cost-effective in an out-patient setting (Diwakar et al., 2016), while breast cancer surgery on an out-patient basis resulted in a 40% saving over an in-patient treatment over two to three days (Marla and Stallard, 2009). However, out-patients were shown to be twice as likely to need further surgery and were three times as likely to suffer post-discharge complications (Lovecchio et al., 2016). Accident and emergency admissions have been shown to result in longer stays in trust than for those patients admitted directly to trust. However, costs may not be significantly lower (Castelli et al., 2015b). A number of reasons have been identified for increased UK Accident and Emergency costs, including the four-hour target-time for waiting for assessment and new General Practitioner (GP) contracts to reduce their out-of-hours obligations (National Audit Office, 2006).

4.5. Methodology

In order to investigate the relationship between the RCI and region, type, size and foundation status, OLS regression was run. The model is as follows:

$$Cost_t = \beta_0 + \beta_1 Region_j + \beta_2\, Type_j + \beta_3\, Foundation_t + \beta_4\, Size_t + \beta_5\, MalePatients_t + \beta_6\, InPatients_t + \beta_7\, OutPatients_t + Year\ FE_t + \epsilon_t$$

Where the *Cost* is the RCI, $Region_j$ is a dummy variable equals 1 if the trust is located in *j* region and 0 otherwise, $Type_j$ is a dummy variable equals 1 if the trust is categorised as *j* type and 0 otherwise, *Foundation* is a dummy variable equals 1 if the trust is foundation and 0 if it is not, *Size* is the natural log of the total number of available beds overnight, *Male Patients* equals total number of male patients divided by the total number of patients (i.e., male and female), *In-Patients* equals total number of in-patients divided by the total number of all patients, *Out-Patients* equals total number of out-patients divided by the total number of all patients and *Year FE* is years fixed effect.

The common practice with dummy variables, is to take one of each variable separately, as a reference, for each calculation. Thus, the results represent a comparison between those variables entered into the calculation and those retained as a reference, producing a single comparison each time, rather than comparing one to all the others. This procedure was unsuited to the current study. For example, if we took Greater London out, as a reference, the results would be a comparison between Greater London and each individual region, rather than London as compared to the rest of the regions combined. Therefore, to produce a comparison between one region and all the others, the procedure was reversed so that just one region at a time was entered into each calculation and all the rest retained as the reference point. The same procedure was applied for type. This means that ten regressions were run for the regions, five for type and one for foundation status.

Two time periods were chosen for data analysis. The first one was from 2009 to 2016. It would have been preferable to start the period from the introduction of the Reference Cost system in 1997, but at that point, no data was available on patient gender, as this information

was only introduced in 2009. The second one was from 2012 to 2016 which covers the period following the introduction of HRG4+.

5. Results:

Table 1 provides descriptive statistics of the main variables of interest to this study. The sample used was from 2009 to 2016 and the number of observations included in the model was 1,118. The minimum RCI was 78 and the maximum was 139, where the mean was 99. There were more female than male patients by almost 40% (i.e., female patients = 57%; male patients = 43% on average). In terms of patient classification, it was noted that on average, 66% of patients were classified as out-patients, while only 16 % were in-patients, as shown in Table 1.

Table 1. Descriptive Statistics of RCIs, Size and the Control Variables from 2009 to 2016

	RCI	Size	Male Patients %	In-Patients %	Out-Patients %
N	1,118				
Mean	99	691	43	16	66
Std. Deviation	7	368	4	4	10
Minimum	78	0	6	0	1
Maximum	139	2,196	57	27	98

Note: RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients, Out-Patients= the total number of out-patients divided by the total number of all patients.

According to **H1**, it was expected that different regions would vary in terms of RCI. The results in Table 2 show that for the overall time period, 2009 – 2016, the North West, East Midlands and Yorkshire and The Humber had RCIs significantly higher when compared with the other regions ($\beta = 2.976$, p-value ≤ 0.01; $\beta = 1.649$, p-value ≤ 0.05; $\beta = 4.214$, p-value ≤ 0.01, respectively). The East of England is the most efficient region being furthest from the RCIs of other regions ($\beta = -2.254$, p-value ≤ 0.01). The South East and South West also fell significantly below the other regions ($\beta = -1.931$, p-value ≤ 0.01; $\beta = -1.723$, p-value ≤ 0.01, respectively). The other regions, including Greater London, were not significantly different.

Between 2012 and 2016 (see Appendix 3, Table A), the significant regions remained significant and those which had not been significantly different did not change, except for Wales which became significantly lower than the other nine regions. Based on the results of Table 2, we find support for **H1.**

RCI was expected to differ between trust type, as suggested by **H2**. The results for type (see Table 3) between 2009 and 2016, show that acute and mental health fell statistically significantly below the other types ($\beta = -2.700$, p-value ≤ 0.01 and $\beta = -4.683$, p- value ≤ 0.01, respectively). Results suggest that the least efficient type were specialist trusts as it presents a coefficient that was higher than the others ($\beta = 6.139$, p-value ≤ 0.01), while the values for the community were significantly higher ($\beta = 2.466$, p-value ≤ 0.10). Between 2012 and 2016 (see Appendix 3, Table B), Specialist remained significantly higher than the national average, despite the introduction of HRG4+, although the coefficient decreased to $\beta = 3.345$. Based on these results, **H2** is supported.

Table 4 presents results for **H3,** which suggests that FTs were expected to be more efficient than Non-FTs, and **H4**, which considers the differences in RCIs between trusts of varying sizes. The results show that FTs were more efficient than Non-FTs ($\beta = -2.183$, p-value ≤ 0.01). These results remain the same between 2012-2016 (see Appendix 3, Table C). The potential effect of size on RCI was significant. Results suggest that the larger the trust, the higher the RCI ($\beta = 4.153$, p-value ≤ 0.01). Size remains significantly higher between 2012-2016, although the coefficient decreased to $\beta = 2.528$. Therefore, **H3** and **H4** are supported.

Table 2. Results of OLS Regression Test of RCI Relations with Regions from 2009 to 2016

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
West Midlands	0.337									
	(0.493)									
Wales		-3.234								
		(-1.483)								
South West			-1.723***							
			(-2.914)							
South East				-1.931***						
				(-3.535)						
North West					2.976***					
					(6.313)					
North East						-0.025				
						(-0.036)				
Greater London							-0.692			
							(-1.205)			
East of England								-2.254***		
								(-3.544)		
East Midlands									1.649**	
									(2.526)	
Yorkshire and The Humber										4.214***
										(3.014)
Acute	-8.424***	-8.467***	-7.745***	-8.574***	-7.812***	-8.465***	-8.432***	-8.051***	-8.020***	-8.693***
	(-7.086)	(-7.138)	(-6.414)	(-7.260)	(-6.673)	(-7.120)	(-7.106)	(-6.788)	(-6.704)	(-7.335)
Community	-3.801**	-3.863**	-3.241**	-3.454**	-3.392**	-3.839**	-4.338***	-3.632**	-4.173***	-4.577***
	(-2.419)	(-2.464)	(-2.055)	(-2.208)	(-2.198)	(-2.446)	(-2.674)	(-2.326)	(-2.657)	(-2.893)

(Continued)

(Continued)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mental Health	-12.677***	-12.654***	-11.654***	-11.791***	-12.541***	-12.718***	-13.180***	-12.283***	-12.246***	-12.974***
	(-7.513)	(-7.510)	(-6.782)	(-6.949)	(-7.571)	(-7.506)	(-7.622)	(-7.308)	(-7.240)	(-7.716)
Foundation Trusts	-1.651***	-1.751***	-1.628***	-1.795***	-1.899***	-1.683***	-1.739***	-1.696***	-1.753***	-1.762***
	(-4.001)	(-4.288)	(-4.017)	(-4.430)	(-4.742)	(-4.087)	(-4.257)	(-4.198)	(-4.318)	(-4.346)
Size	4.925***	4.920***	4.256***	4.912***	5.006***	4.918***	5.011***	4.682***	4.554***	5.145***
	(5.305)	(5.306)	(4.473)	(5.323)	(5.490)	(5.213)	(5.381)	(5.060)	(4.864)	(5.547)
Male Patients	0.175***	0.176***	0.199***	0.188***	0.213***	0.177***	0.163***	0.181***	0.169***	0.182***
	(3.947)	(4.021)	(4.497)	(4.313)	(4.901)	(4.046)	(3.609)	(4.156)	(3.855)	(4.175)
In-patients	-0.368***	-0.364***	-0.334***	-0.349***	-0.427***	-0.368***	-0.409***	-0.349***	-0.375***	-0.381***
	(-5.213)	(-5.150)	(-4.685)	(-4.952)	(-6.098)	(-5.182)	(-5.203)	(-4.954)	(-5.324)	(-5.403)
Out-patients	-0.061***	-0.058**	-0.054**	-0.045*	-0.046**	-0.060***	-0.066***	-0.052**	-0.058**	-0.060***
	(-2.654)	(-2.555)	(-2.355)	(-1.948)	(-2.041)	(-2.620)	(-2.840)	(-2.298)	(-2.561)	(-2.658)
Intercept	96.542***	96.391***	95.857***	95.090***	93.716***	96.449***	98.100***	95.949***	97.358***	96.060***
	(28.516)	(28.533)	(28.405)	(28.097)	(27.977)	(28.475)	(26.919)	(28.512)	(28.716)	(28.505)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,118	1,118	1,118	1,118	1,118	1,118	1,118	1,118	1,118	1,118
Adj R^2	0.119	0.121	0.126	0.129	0.150	0.119	0.120	0.129	0.124	0.126

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and regions during the period from 2009 to 2016. Colum 1 (2 to 10) West Midlands (Wales, South West, South East, North West, North East, Greater London, East of England, East Midlands and Yorkshire and The Humber, respectively) equals 1 if the trust is located in West Midlands (other regions), 0 otherwise. RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients, Out-Patients= the total number of out-patients divided by the total number of all patients. t-statistics of coefficients are in parentheses. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

Table 3. Results of OLS Regression Test of RCI Relations with Trust Type from 2009 to 2016

Variable	(1)	(2)	(3)	(4)
Acute	-2.700***			
	(-2.908)			
Community		2.466*		
		(1.898)		
Mental Health			-4.683***	
			(-3.637)	
Specialist				6.139***
				(5.290)
West Midlands	-3.820**	-3.355**	-3.590**	-4.680***
	(-2.550)	(-2.212)	(-2.400)	(-3.131)
Wales	-7.838***	-7.231***	-7.266***	-8.607***
	(-3.096)	(-2.835)	(-2.873)	(-3.423)
South West	-6.192***	-5.921***	-5.908***	-6.485***
	(-4.283)	(-4.048)	(-4.085)	(-4.526)
South East	-6.188***	-5.615***	-5.492***	-6.722***
	(-4.301)	(-3.863)	(-3.812)	(-4.696)
North West	-1.580	-1.091	-1.249	-2.372*
	(-1.124)	(-0.766)	(-0.890)	(-1.691)
North East	-3.440**	-3.160**	-3.586**	-4.324***
	(-2.293)	(-2.087)	(-2.395)	(-2.892)
Greater London	-4.074***	-3.811***	-4.546***	-5.317***
	(-2.832)	(-2.592)	(-3.175)	(-3.712)
East of England	-6.365***	-6.070***	-6.251***	-6.938***
	(-4.316)	(-4.065)	(-4.245)	(-4.739)
East Midlands	-1.922	-1.505	-1.670	-2.655*
	(-1.299)	(-1.016)	(-1.134)	(-1.800)
Foundation Trusts	-2.592***	-2.237***	-1.998***	-2.713***
	(-6.479)	(-5.464)	(-4.845)	(-6.846)
Size	1.276	0.476	0.900	2.882***
	(1.510)	(0.616)	(1.156)	(3.179)
Male Patients	0.256***	0.263***	0.250***	0.230***
	(5.654)	(5.795)	(5.514)	(5.083)
In-Patients	-0.143**	-0.214***	-0.410***	-0.306***
	(-2.264)	(-3.879)	(-5.915)	(-5.735)
Out-Patients	0.050**	0.035*	-0.009	0.011
	(2.474)	(1.800)	(-0.395)	(0.542)
Intercept	91.178***	92.200***	98.045***	91.200***
	(26.141)	(26.305)	(28.265)	(27.292)
Year FE	Yes	Yes	Yes	Yes
N	1,118	1118	1118	1118
Adj R^2	0.151	0.147	0.154	0.165

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and types during the period from 2009 to 2016. Colum 1 (2 to 4) Acute (Community, Mental Health and Specialist, respectively) equals 1 if the trust is Acute (other types), 0 otherwise. RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients, Out-Patients= the total number of out-patients divided by the total number of all patients. t-statistics of coefficients are in parentheses. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

Table 4. Results of OLS Regression Test of RCI Relations with Foundation Status and Size from 2009 to 2016

Variable	Coefficient	t-Statistic
Foundation Trusts	-2.183***	-5.293
Size	4.153***	4.354
West Midlands	-4.154***	-2.780
Wales	-7.739***	-3.088
South West	-5.740***	-3.997
South East	-5.979***	-4.175
North West	-1.823	-1.300
North East	-4.100***	-2.746
Greater London	-4.854***	-3.333
East of England	-6.330***	-4.317
East Midlands	-2.607*	-1.780
Acute	-6.837***	-5.731
Community	-3.950**	-2.455
Mental Health	-10.535***	-6.037
Male Patients	0.221***	4.902
In-Patients	-0.407***	-5.255
Out-Patients	-0.026	-1.120
Intercept	98.194***	25.966
Year FE	Yes	
N	1,118	
Adj R^2	0.178	

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and foundation status and size during the period from 2009 to 2016. RCI=reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

6. Discussion

In healthcare both location and provision of specialised services are expected to affect costs according to Palmer (2005). The results set out in Table 2 indicate that there are differences in RCI between trusts, in terms of region. This is in line with the findings of Busse et al. (2008) which suggested that factors such as region or wage levels may play a larger part than the similarity of treatment patterns in cost differences for each care episode. The existence of regional differences supports the view of scholars who argued that taking average costs for the whole of England cannot work due to regional cost discrepancies (e.g., Allen, 2009). In the current study, the results did not show Greater London and the South East to have higher costs than other regions, as had been suggested by Northcott and Llewellyn (2003) and Daidone and Street (2013), who noted that costs remained higher for Greater London despite regional adjustment. This

discrepancy between the results of these two studies and those of the current research can be explained by a number of factors. In the case of Northcott and Llewellyn (2003), the study pre-dated the introduction of HRG4 and the MFF has improved since then. Furthermore, the study was qualitative. Daidone and Street (2013) only used 19 HRGs in their study, so did not cover the full range of activities, and focused on a single year.

The results bear out **H2,** in line with the work of Palmer (2005), demonstrating that specialist trusts have higher costs than other trust types. This may reflect the greater complexity of the service they provide (Daidone and D'Amico, 2009) and the need to account for the treatment of more costly patients (Bojke et al., 2018), despite the idea of specialist trusts providing a "focused factory" (Skinner, 1974). Robinson (2005) suggested that specialist trusts' success (at least in the US) may be due to their ability to choose their markets and the services they provide. One potential solution to the higher costs of providing specialist care is to make a surcharge, similar to the MFF regional adjustment, which is extra to the prospective price if specialist care is found to be more costly compared to other patients within the same payment category (Daidone and Street, 2013). Furthermore, since it is possible that traditional accounting methods under-cost specialist services, the adoption of the ABC technique and PLICS could provide more accurate cost data which might help to address the problem, as discussed by Llewellyn et al. (2016) and Ellwood et al. (2016).

FTs were, as expected in **H3,** found to have lower RCIs than Non-FTs. FTs' greater economic freedom allow them to treat private patients and use any tools and equipment purchased for their benefit on publicly funded patients. This might lead to the situation highlighted by Kessler (2007) and Bai (2016) in California, where trusts reduce their public patient numbers

because they can charge more for private patients[18].

H4 investigated the potential impact of size of trusts on costs and the results bear out the significance of the size issue, suggesting that the larger the trust the higher its RCI. These results are in line with many other studies which have suggested size to be an important factor to explain trusts' costs. However, results of other studies vary as to whether larger or smaller trusts are more efficient. The current study is consistent with the findings of Asmild et al. (2013), who found larger size to be a problematic, possibly due to congestion problems in larger institutions, where high numbers may lead to bottlenecks in certain treatment areas. In this vein, Giancotti et al. (2017) found that economies of scale are beneficial to efficiency, but only if trusts have between 200 and 300 beds. Additionally, Czypionka et al. (2014) found that small to medium trusts (200-400 beds) were more scale efficient than larger ones, especially those with over 1,000 beds.

6.1 Theoretical Contribution

The findings of Study 2 overall are supported by contingency theory which recognises that cost management practices of organisations are affected by factors such as location, size, type and structure. As a result, no single accounting system to standardise costing can work for all trusts regardless of their circumstances (e.g., Otley, 1980; Haldma and Lääts, 2002; Gerdin and Greve, 2004). The control systems which are applied must be appropriate to the organisation (Islam and Hu, 2012). The results have illustrated that a trust's location, its type, size and foundation status are all associated with its RCI. HRG4+ and the MFF may have gone some way towards addressing this issue. Although this study only examines associations between trust characteristics and RCIs, the results might suggest that work remains to be done to tackle discrepancies, to avoid issues of

[18] Although these studies relate to the differences between private and public trusts in California, the system of governance is comparable to foundation and non-foundation status respectively as discussed in the literature section on page 65.

unfairness arising for the management of certain trusts. If the current system continues to be used without further refinements, some trusts might continue to have above average RCIs because of their characteristics.

As discussed earlier, contingency theory suggests that there is no one ideal way to standardize costing systems which works for all types of organisation. This study makes an important contribution to our understanding of contingency theory because by applying it to healthcare data, I have illustrated and reinforced how variations between organisations mean that "one size fits all" costing systems are problematic, The results show that different types of NHS trusts vary in their capacity to work within the efficiency requirements of the Reference Cost system. Furthermore, trusts in different regions, and with different organisational status vary as to their RCIs and how well they can keep within the necessary cost restrictions. This is in line with contingency theory, but a further issue is that some overarching system is necessary to curb spiraling costs in a healthcare system, even if the structures and needs of different types of trusts make this challenging to achieve. This study has therefore contributed to the theoretical work by highlighting the need to find a system for ensuring efficiency which also takes into account the diversity of organisations. This study does not provide any clear answers to this issue, although it does indicate that the Reference Cost system may be working towards success in this area, despite its limitations. More work is needed to discover how such a system could be further improved, bearing in mind what we learn from contingency theory.

7. Conclusion

The Reference Cost system has been providing cost efficiency data for the NHS since 1997. This study has examined the differences in trust characteristics and RCIs, over the period from 2009 to 2016. It has taken contingency as its theoretical framework, as it suggests that no one costing standardisation process can be applied regardless of an organisation's characteristics.

This theory has underpinned the development of the hypotheses tested in the study. The four hypotheses focused on the characteristics of trusts and the differences in their RCI. The data was drawn from National Archives of the Department of Health, NHS Reference Cost Collections, NHS Digital and England NHS websites and analysed using OLS regression. **H1**, that predicted that RCIs differ for trusts in different regions, was supported. Results showed that the East of England was the most efficient region. The results for Greater London suggest that the MFF adjustment for regional differences appear to be working in the region. **H2** was that the RCIs differ for trusts of different types. This hypothesis was supported by the results, which indicated that mental health was the most efficient type of trust and specialist the least efficient. As expected in **H3**, FTs have lower RCIs than Non-FTs and **H4** predicted that trusts of different sizes differ as to their RCI. The results supported **H4**, since the larger the trust, the higher its RCI. The results are in line with contingency theory, which underpinsthis study, demonstrating that variations between trusts are important and that, although the last version of HRG (HRG4+) has been associated with improvements in the RCI system, a greater adjustment may be needed to take into account other variations in trusts.

The results contribute to contingency theory by illustrating that in the healthcare sector there is no one ideal costing standardisation system which is appropriate for all organisations. and that this needs to be taken into account when assessing the cost-effectiveness of trusts with varied remits, of different sizes and structures and in different areas of the country. The Reference Cost system may have gone some way towards addressing this but there are still adjustments to be made to improve it yet further.

One limitation of this study is that it does not take into account the quality of care provided. However, this will be addressed in the next chapter, which will consider this variable in addition to those investigated in the current chapter.

Chapter 4: Reference Cost Index Reduction and Care Quality of National Health Service Healthcare

Reference Cost Index Reduction and Care Quality of National Health Service Healthcare

Context: NHS in England introduced PbR in 2002, to enhance the cost efficiency nationally and at individual trusts.

Objective: To examine the relationship between RCI reduction and the quality of trust services provided, using seven quality measures (i.e., mortality rates, SDD, infection rates, LOS, emergency and in-patient and out-patient waiting times).

Data Sources: Data for years between 2010 and 2016 were extracted from two NHS websites. Data for RCIs and foundation status were obtained from the NHS Reference Costs Collection website. Data for the dependent and other control variables were gathered from the National Archives of the Department of Health and the NHS Digital websites.

Study Design: Panel fixed effect regression.

Main Findings: RCI reduction is positively associated with care quality indicators, which are, the trust infection rate and the mean waiting time for in-patients. In terms of PbR trusts with RCIs lower than the national average are more financially efficient without compromising healthcare quality.

Conclusion: The results indicate that there is no negative association between RCI reduction and the healthcare quality measures used in this study. However, a significant limitation of this study is that it only considers acute trusts.

Key Words: NHS, RCI, Payment by results, Cost efficiency, Quality.

1. Introduction

In Chapters 2 and 3 of this thesis, I have discussed healthcare worldwide and examined specifically healthcare costs in the NHS in England and Wales. I have also discussed the financial system introduced in 1997, which was the Reference Cost system and PbR, which followed in 2002. The latter is also known as a fixed-price payment system and is applied in many countries worldwide. In England and Wales, the system is based on the NRCI, which is the total of the averages of the costs of treating patients in specific diagnostic categories (for more details, please see Chapters 1 and 2). Additionally, the relationship between NHS trust characteristics and cost was examined. An underlying assumption in these previous chapters was that there has been a move towards standardisation of RCIs which could be financially beneficial to the healthcare system. However, I did not examine the relationship between RCI reduction and quality in healthcare after the introduction of the Reference Cost system and PbR. These systems were introduced to improve both efficiency and the quality of healthcare in England and Wales. This chapter examines the reduction of RCIs and their relationship with healthcare quality. The study will discuss whether RCI reduction is related to lower healthcare quality.

This chapter contributes to the knowledge in the field of accounting, costing and healthcare quality by investigating the relationship between cost and the quality of services provided. To the researcher's knowledge, this is the first study that has used trust infection rates as a measure of quality both in accounting related studies and healthcare studies investigating the relationship between cost and quality. It is also the first to evaluate quality while making a distinction between those trusts that have lower RCIs than the national average and those which have higher RCIs. Data analysis relies on the panel fixed effect regression with region and year fixed effect. Seven dependent variables are used to measure healthcare quality. Those are mortality rates, the number of patients who were discharged on the same day,

infection rate, mean LOS, and the percentage of emergency patients waiting fewer than four hours for treatment, mean in-patient waiting time and mean out-patient waiting time. The independent variable is cost, measured according to the RCI. Data from the period 2010-2016 were obtained from the NHS Digital website.

The following section provides the background. Section three provides quality definition and measures. Section four provides a review of previous research in this field and discusses the various studies which have assessed healthcare quality. Section five explains and justifies the data and the methodology of the current study. Section six displays the results. Section seven presents the discussion, and the final section provides conclusions and suggestions for future research.

2. Background

The healthcare industry is a rapidly growing sector that accounts for a large proportion of the Gross Domestic Product (GDP) of nations worldwide (Hod, 2016). Governments have therefore tried to introduce measures to curb costs (Figueroa et al., 2016; Kaya Samut and Cafri, 2016), particularly since the global financial crisis which occurred in 2008, adversely affecting different economies and industries all over the world, with the healthcare sector suffering particularly badly (Cantor and Poh, 2018). Countries within the Organisation for Economic Co-operation and Development (OECD) found it necessary to implement various measures to reduce health expenditure to safeguard the sector's future. These strategies included reducing the prices of medical products, cutting healthcare workers' wages, and setting limits on publicly funded healthcare budgets. The effect of the global economic crisis has spurred research into new methods for scrutinizing efficiency and effectiveness in how public money is spent and ensuring control of resource usage (Rondeau and Wagar, 2003).

It is self-evident that healthcare organisations not only need to treat patients but to do so to a high standard. However, there is evidence of considerable variations in the quality of care provided by different trusts and variations in patient experience (Chen et al., 2005; Coelli et al., 2005; Chen, 2006). Treatment quality can be included as an output measure. Thus, a healthcare organisation providing its patients with a superior quality of care can be considered to have produced a higher level of output than one delivering lower quality of care (Castelli et al., 2015a). Public healthcare service aims to optimise its use of resources inpursuit of the nation's health (Hollingsworth, 2008).

It is necessary for healthcare organisations to maximise efficiency and effectiveness, and to lower costs while simultaneously providing quality health services (Kounetas and Papathanassopoulos, 2013). Research has shown that it is often the question of cost which predominates despite efforts to introduce governance systems that are more quality-oriented. For instance, Cardinaels and Soderstrom (2013) have shown that, while patient groups try to put pressure on trusts to include quality, such initiatives are consistently overridden by economic considerations.

The accounting literature has examined the problems and tensions which have arisen, particularly when it has been suggested that accounting practices have effectively altered healthcare's social objectives because the control systems they establish fail to categorise patients appropriately (Miller and O'Leary, 1987; Hayes, 1995; Llewellyn and Northcott, 2005; Kurunmaki and Miller, 2006; Scarparo, 2011). Balancing cost and quality is still problematic (Cardinaels and Soderstrom, 2013; Hassabelnaby, 2014), but despite this, healthcare systems worldwide are introducing quality initiatives. For example, the state of Maryland in the US recently introduced the integration of a quality aspect into its system for pricing and budgeting (Patel et al., 2015; Malmmose and Fouladi, 2019). In Norway, quality

indicators have also been implemented (Østergren, 2009), while in the US customer surveys have been conducted (Pflueger, 2016). Meanwhile, in Iran, an accreditation model has been introduced for their health care providers (Agrizzi et al., 2016).

Dillard et al. (2004) demonstrated that when the continued existence of a public institution requires them to fulfil financial targets, they have no choice but to safeguard their organisation. For trusts this means a concentration on the basic financial issues which are imposed on them by law. The core practice of a healthcare organisation is usually thought to be the care of its patients, but in this case, the organisation is failing to protect this, prioritizing instead the accounting measures of costs and the pursuit of efficiency. The implication of this case is that organisations no longer regard patient treatment as their core service, and the difference between core practices and those which are supportive lacks clarity (Malmmose and Kure, 2020).

In 2008, the Darcy Report set out a number of strategies for the improvement of the NHS's quality of care. This included the drafting of an NHS constitution, and ensuring that any changes were patient-centred, locally-led, and based on clinical needs. Change was also required to address the challenges facing the NHS and the need to improve care quality to provide better value for money for taxpayers. The need to increase patient influence over NHS resources was also recognised. The PbR system meant that resource allocation for trusts was already influenced by patient choices but this was to be enhanced via the payment mechanism's recognition of quality and by strengthening individual control. Greater clarity about what was meant by quality and how it was measured was also recommended, as was the publication of quality data and rewarding of quality practices. From 2010, Quality Accounts were to be presented, taking into account safety, experiences and outcomes. The NHS Choices website was to provide comparative information while The Care Quality Commission (CQC) undertook

independent validation of the performance of service providers using nationally-agreed quality indicators (Department of Health, 2008). From April 2009 the system of payment for NHS service providers aimed to reflect clinical practice, while recognising complexity of care and to encourage innovation. In 2010, the Best Practice Tariffs (BPT) programme was introduced, based on clear evidence of what constituted best practice and to ensure that the setting of tariffs focused on best clinical practice not average cost (Department of Health, 2012).

Commissioning for Quality and Innovation (CQUIN) allowed for extra quality payments to be made as appropriate, according to the NHS Standard Contract. Calculation of a CQUIN scheme's full year financial value was as a percentage of the value for the whole year, taking into account all the healthcare services which were commissioned via the NHS Standard Contract. Payment was conditional upon achievement of the agreed CQUIN goals. Commissioners were required to state what proportion of payment referred to each CQUIN indicator and to be clear about the basis for payments. The CQUIN system encouraged care providers to improve both quality and innovation over and above the Standard Contract's baseline requirements. CQUIN schemes were to be realistic but challenging and it was expected that providers would earn a large percentage of the CQUIN annually. Providers who did not participate in an appropriate national CQUIN scheme did not receive payment (NHS Cambridgeshire Community Services, 2022).

3. Quality Definition and Measures

Issues of characterising quality in healthcare services have received much attention from providers (Sewell, 1997; Alotaibi et al., 2015). However, finding one clear and satisfactory definition of quality, particularly for the healthcare sector, is challenging, due to the range of people involved in the development and delivery of this type of service (Rocha et al., 2013; Rezaee and Karimdadi, 2015), with different levels of community and numerous stakeholders

being involved, from medical and administrative staff (Alotaibi et al., 2020), to taxpayers and regulators (Chang et al., 2002; Smith, 2002; Devlin and Sussex, 2011). There are different perspectives, levels of awareness and expectations, so contradictions can arise (Alotaibi et al., 2020). Furthermore, the professional autonomy of clinicians can make controlling and reviewing their activities difficult (Aidemark, 2001; Zelman et al., 2003; Llewellyn and Northcott, 2005). In addition, trusts are focused on long-term outcomes (Zelman et al., 2003), and financial performance is a means to service provision, not an end. Thus, the numerous healthcare objectives make an evaluation of quality a complex issue (Dixit, 2002; Besley and Ghatak, 2003; Zelman et al, 2003; Llewellyn and Northcott, 2005), and various performance dimensions must be taken into account (Eddy, 1998; McIntyre et al., 2001). These may be contradictory, thus, performing well in one dimension may be to the detriment of performance in another, so it is challenging to establish common, explicit valuations covering each performance dimension (Gutacker and Street, 2018). In order to enhance their performance and optimise outcomes for their patients, healthcare institutions need to investigate the best ways of quantifying performance and how those determinants which are part of the function of health provision can be identified (Cantor and Poh, 2018).

Previous studies have produced controversial results, and this could have arisen due to the lack of generally acceptable tools to measure healthcare performance. Kaplan and Porter (2011) argue that the main problem with healthcare is that the wrong things are evaluated in the wrong ways. Some studies have included quality as a measure of healthcare performance, but others have only used indicators that are cost-oriented and used to highlight financial success. Precise performance evaluation is also hindered by the inconsistent application of inputs and outputs when estimating healthcare performance (Cylus and Dickensheets, 2007). According to Choi et al. (2017), if the evaluation of performance is to be precise, both quality of care and cost indicators should be taken into account in any evaluation.

Three main methods have been used to evaluate the quality of care (Romano and Mutter, 2004). The first uses structural variables which illustrate the circumstances in which care provision is given. This includes both material and human resources, as well as the characteristics of the organisation (Romano and Mutter, 2004). Some researchers have tried to apply structural measures as quality variables, such as teaching status (Taylor et al., 1999; Romano and Mutter, 2004; Rosko and Mutter, 2008) or system-membership status (Rosko, 2001; Bernet et al., 2008). Such organisational characteristics as numbers of medical staff in each department (Chen, 2006), and in-patient numbers have also been used (Linna and Häkkinen, 2006). However, modification of structural measures is challenging, and they do not explain much about the variability which can be noted in processes and outcomes (Mitchell and Shortell, 1997). Neither do they encompass the complex and dynamic characteristics which make up quality care (Romano and Mutter, 2004).

Quality evaluation may also take into consideration those process measures which encompass healthcare content and cover all the activities of healthcare providers (Romano and Mutter, 2004). There are two main categories into which these process measures can be placed, explicit measures and implicit measures. Explicit measures are usually gathered by monitoring whether patients who require specific evidence-based care are being given the necessary treatment. This is usually done by asking patients several yes-or-no questions following their treatment. One example of the development of quality indicators comes from the Centers for Medicare and Medicaid Services (CMS)'s the Health Care Quality Improvement Program, which commenced in 1992 in the United States. The program aimed to help managers of healthcare institutions to identify areas in which the quality of care could be improved (Nayar and Ozcan, 2008). Implicit measures are concerned with the comprehensive assessment of quality by means of experienced professionals conducting a semi-structured review of medical records. Using process measures raises certain practical issues, although the measure can help

explain the enigmatic nature of the treatment process. Process measures are more costly to gather than either structural measures or outcome measures. In addition, explicit measures are frequently lacking in predictive validity. On the other hand, implicit measures often lack reliability or suffer from bias arising from the perspective of the reviewers (Romano and Mutter, 2004).

Outcome measures have also been used as quality variables. Such measures explain changes that can be ascribed to healthcare and usually focus on mortality or morbidity as an ultimate outcome measure, which is a matter of great concern to patients (Romano and Mutter, 2004; Rosko and Mutter, 2008). Outcome measures reveal both actions taken for patients and how well these were conducted. Thus, measuring quality is crucial to maintaining healthcare standards in the face of pressures on costs, but research to date has used a variety of metrics for this purpose. This study takes mortality rates, SDD, trust infection rates, LOS, and waiting times as its quality measures. These are fully elucidated in the methodology section below, which also discusses the data used for the analysis.

4. Literature Review

A healthcare provider's performance will probably be affected by its patient profile (Laudicella et al., 2013; Barnett et al., 2015; Greysen et al., 2015). In particular, those providers which have high numbers of patients from low-income groups or many state-funded patients may perform poorly. Earlier work has demonstrated that there is a connection between the socioeconomic status of patients and the outcomes of service use, including readmission (Weissman et al., 1994; Joynt and Jha, 2011; Hu et al., 2014). Prior studies have highlighted the importance of appropriate patient education, and a number of other interventions, which can reduce readmissions (Benbassat and Taragin, 2000). Furthermore, over 50% of the variation in trust readmissions can be attributed to community factors (Herrin et al., 2015).

Much research has considered the relationship between the performance of healthcare institutions and the number of patients with a particular diagnosis or requiring the same procedure. It has been shown that the severity of illness (Andersen and Newman, 2005), as assessed by a weighted severity HRG, may impact negatively on performance (Conway et al., 2015).

Research has elucidated the connections between patient volume and some of the ways in which operational performance improvement has been evaluated, for example, reduction in expenditure and low mortality rates. Links of this type have been explained as "practice makes perfect" (Luft et al., 1987; Theokary and Ren, 2011). Theokary and Ren (2011) have likened this to the economies-of-scale effect and the learning effect. The healthcare industry now generally acknowledges economies of scale, and a vast body of research now indicates that larger-volume trusts perform better financially than those which are smaller (Preyra and Pink, 2006). Learning-by-doing comes from cumulative experience and often drives improved performance. Porter and Teisberg (2004) have shown that the learning effect may account for the superior financial performances of healthcare institutions with larger volumes over those with smaller volumes, arguing that doctors with more experience produce better outcomes and reduce costs at the same time. Within the healthcare sector, there are contradictory opinions about the volume effect (Choi et al., 2017). Theokary and Ren (2011) considered both the positive and negative aspects and discovered that the link between volume and process quality formed an inverted U-shape. While an increase in volume has benefits due to the effect of "practice make perfect", if patient volume is increased beyond a certain level, it may prove detrimental to care quality within the trust. However, Nayar et al. (2013)'s results indicate that, in the United States, small trusts were more efficient and offered higher quality than large trusts.

In order to improve quality, European countries have improved the range of private provision available in their healthcare systems, since the privatisation of healthcare services has been put forward as a way of increasing both quality and efficiency (Kruse et al., 2018). In England and Wales, the government has actively encouraged a policy of NHS trust mergers, as a means of enhancing patients' treatment and experience (Gaynor et al., 2012).

The question of healthcare provider ownership is a major issue, especially the effect on quality (Leys and Toft, 2015). Private trusts might be driven to improve quality to attract more patients, although if demand does not depend on quality, private trusts might not prioritise it (Sloan, 2000; Glaeser and Shleifer, 2001; Brekke et al., 2014). Staff attracted to work in public trusts may be more altruistic workers and focused on quality (Lakdawalla and Philipson, 2006). Evidence from a range of European countries indicates that public healthcare institutions have as good if not better levels of efficiency than private ones. It is difficult to reach a definite conclusion because there are inconsistencies in the quality-of-care evidence which is currently available. It appears that, in Europe, the increase in private healthcare provision is not connected to performance improvement. Mixed evidence was also cited by Eggleston et al. (2008) in their analysis of variations in the quality of care. An overview of systematic reviews concerning quality in public, NFP and FP service providers were produced by Herrera et al. (2014). One of their conclusions was that mortality rates are higher for FP providers. The evidence concerning technical efficiency indicates that no clear conclusion can be reached regarding the cost and/or technical efficiency of FP and NFP and public healthcare institutions. However, public healthcare institutions appear to be equally if not more efficient than private institutions (Berta et al., 2010; Kruse et al., 2018).

Trusts' mortality rates in Germany were examined by (Tiemann and Schreyögg, 2009). Their results indicated that, when controls were in place to account for casemix differences,

the mortality rates in FP and NFP trusts were better than those in the public sector. In France, studies showed that the private sector performed worse in terms of quality outcomes. Variations were discovered in the mortality rates depending on the type of healthcare institution. The mortality rates in public (non-teaching) trusts were lower than those of FP trusts (Gobillon and Milcent, 2016). In Italy, higher levels of funding for public provision of healthcare services were associated with a reduction in levels of avoidablemortality (Quercioli et al., 2013).

In the UK, there is little or no difference in LOS, for most diagnostic groups, between private Independent Sector Treatment Centers (ISTCs) and public NHS trusts (Kruse et al., 2018). However, it was shown that, on average, ISTCs had a better level of performance for all dimensions (Gutacker and Street, 2018). These results concur with other research which has shown that ISTCs produce health outcomes that are superior to those of NHS trusts (Browne et al., 2008; Chard et al., 2011), and that patients are discharged sooner (Street et al., 2010; Siciliani et al., 2013). UK patient experiences were the subject of work by Owusu-Frimpong et al. (2010) and Pérotin et al. (2013). Owusu-Frimpong et al. (2010) found that satisfaction rates for patients in ISTCs were higher than for those in publicinstitutions, for example, when trying to attract the attention of doctors. However, no significant difference was discovered by Pérotin et al. (2013) between public and private providers in terms of overall experiences reported by patients. Where variations occurred, these appeared to be associated with other variables, for example, patient characteristics (Pérotin et al., 2013). Furthermore, Fenton et al. (2012); Shoemaker (2012) and Stanowski et al. (2015) have all linked patient satisfaction with cost and found that better patient satisfaction is associated with higher costs.

The effect of mergers on a wide range of outcomes, such as financial performance, productivity, clinical quality and waiting times, was analysed. The evidence did not suggest any gains from mergers except a reduction in activity (Gaynor et al., 2012). Mergers may not

be the best way of tackling the problem of trusts which under-perform because of the resulting reduction in the potential for competition between trusts (Gaynor et al., 2012). Mergers lead to a reduction in the scale of trusts, overall activity and total staffing levels. Apart from this capacity reduction, the evidence does not suggest that mergers enhance performance. Financial performance often declines after a merger, while patient waiting times lengthen. Furthermore, clinical quality appears not to improve. The results by Gaynoret al. (2012) concur with those which have considered the effects of many healthcare institution mergers in the 1990s, in the US (e.g., Ho and Hamilton, 2000; Krishnan, 2001; Town et al., 2006; Dafhy, 2009) finding scant benefit from consolidation and merger.

There is evidence within the literature that under certain circumstances, such as price regulation and observable quality, it is possible for competition to positively impact quality (Gaynor and Town, 2011). Quality does seem to have been improved in UK NHS trusts as a result of reforms that favour competition (Cooper et al., 2011), and it has been demonstrated that competition leads to improved NHS trust management, and hence to improvements in other outcomes (Bloom et al., 2015). Gaynor et al. (2012) found that there have been indications that quality of care has fallen. LOS is not affected by merger. Four years after merger, mean waiting time increased as well the share of patients waiting for an elective treatment for over 180 days.

PbR is a strategy that has been applied to many healthcare systems globally to increase cost efficiency, provide fair treatment payment and ensure high-quality service and good outcomes for patients (Busse, 2012; Grašič et al., 2015; Bojke et al., 2017; Longo et al., 2017). The issue of ensuring fairness was pioneered in 1983 by the US Medicare system's use of DRG (Jackson, 2001), the British version of this being HRGs, which worked towards fairness in the payment system as discussed by (Grašič et al., 2015; Bojke et al., 2017; Longo et al.,

2017), taking into account variations in clinical and running costs (Northcott and Llewellyn, 2002). Thus, payment adjustments of this kind allow additional payments to be made when specialised care is provided. Adjustments to the payments also take into account variations in capital and staffing costs across the country and help to ensure fairness in the reimbursement system, rewarding trusts for care provision rather than their circumstances. Comparable systems are used in numerous other countries around the world (see Lowe and Doolin, 1999; Roeder et al., 2002; Lungen and Lapsley, 2003; Grašič et al., 2015; Holzhacker et al., 2015; Longo et al., 2017). Details of PbR and HRGs were discussed fully in Chapters 1 and 2 of this thesis.

In England and Wales, PbR was introduced in 2002, in line with the "Reforming NHS Financial Flows" policy, which aimed to change decision making and behaviours, improve quality and volume and incentivise cost efficiency. Concerns have been raised about the risks of compromising care quality when fixed-price payment systems require cost reduction measures (Farrar et al., 2009), which may lead to undesirable behaviours when unit costs are used as targets (Dawson and Street, 1998; Appleby and Thomas, 2000). Providers might decrease resources allocated for patient care, negatively impacting quality, or select only patients whose care requirements are less resource-intensive, although the system intends to reduce unit costs by increasing efficiency. Farrar et al. (2009) did not find evidence that quality of care changed following the introduction of PbR. However, in the long term (two years) it was noted that in NHS FTs the quality of care improved, in terms of reduced mortality rates. Evidence that care quality can be adversely affected by fixed-price payment systems has been found in the US, where researchers suggest that quality may have reduced when providers decrease spending to meet average cost targets (Propper et al., 2005). Smith (2002) asserts that the healthcare system in the UK has become one of low cost and poor quality due to the pressure to perform efficiently. The arguments surrounding whether low cost, low quality, or high cost,

high quality is best, have been discussed more fully by Culyer (2006), indicating that the best solutions will only be found when both efficiency and quality are taken into consideration.

Appleby et al. (2012) have pointed to the need to evaluate PbR systems alongside other policy instruments, since PbR is only one measure among many in healthcare policy. One payment system is not appropriate to all services, so the system needs to cover a flexible compromise of different approaches and adjustments made according to their impact. They also point to the inevitable trade-offs between objectives, in particular the conflict between cost, quality and supply maintenance. If tariffs are reduced to too low a level, it becomes impossible even for efficient providers to sustain the high quality of their services. PbR may, for example incentivise compromising quality or discharging patients prematurely (Bevan et al., 2014). The loading of increasing numbers of objectives onto the payment system may give rise to unpredictable conflicts and make evaluation difficult (Appleby et al., 2012) and it is problematic to distinguish the impact of PbR from other reforms introduced at the time (Jacobs, 2014). High-quality data and analysis are needed to support the PbR system to avoid lack of compliance or undesired side effects. As Glasziou et al. (2012) have noted, it is possible for financial incentives to enhance clinical quality, but there is also a risk of them becoming a costly diversion. Assessing the impact of PbR in England, Farrar (2010) drew the comparison with Scotland where PbR had not be implemented. However, although LOS in England had reduced rapidly, other factors, such as increased availability of resources in England made it impossible to ascertain PbR's impact on volume of activity. While the Audit Commission (2008) claimed that the introduction of PbR had fostered better financial planning and financial and performance management, Appleby et al. (2012) highlight the lack of quantitative evidence to support this viewpoint or to assess the impact of PbR on quality. The Audit Commission (2008) noted an increase in readmissions but this could not be linked to PbR.

The Health Mandate (2012) noted that trusts had not made full use of the potential for extra payments through CQUIN, which implies a limited beneficial impact for this scheme (Appleby et al., 2012), while Monitor (2012) found both under and over-payments within the system. Petersen et al. (2006) posited that the evidence is challenging to assess due to differences in approach and that rigorous assessment of the impact of PbR on quality is lacking. However, quality itself is not incentivised by PbR because the policy makers assumed that pressure to improve quality would arise from patient and commissioner choices (Appleby et al., 2012). However, Dixon et al. (2010) found choice to be a weak driver of quality. Furthermore, conflict may arise between standards set by the CQC and the National Institute for Health and Clinical Excellence (NICE) and budget constraints on services, which may result in limited access. However, no direct evidence suggests that concentrating on cost reduction has been detrimental to quality (Jacobs, 2014).

Costing, productivity, and the impact of HRG on healthcare have been the subject of much critical discussion. Nevertheless, they remain in use as benchmarking tools. This indicates that more studies are required which address issues of agendas that concentrate on productivity, HRGs, and the influence this has on how well alternative projects manage and whether they succeed or fail. If the maximum number of patients are to receive quality but cost-efficient treatment, in a timely fashion, it is essential to balance cost and quality (Malmmose and Kure, 2020). This study will therefore examine the relationship between RCIs and healthcare quality and answer the question as to whether RCI reduction is associated with lower levels of healthcare quality.

Mortality rates, LOS, waiting times and other variables have been shown to be important in this context, so these will be examined in this study, alongside other variables. Mortality rate is taken as an indicator of differences in care quality in health centre provision (Ferrier and

Valdmanis, 1996; Marathe et al., 2007) and the links between healthcare costs and mortality have been a focus of earlier research (see Hussey et al., 2013). Mortality rates are an important factor when analysing technical efficiency (Giuffrida et al., 1999; Amado and Santos, 2009). In addition, this particular variable forms a useful proxy for variability in the quality of care provided (Ferrier and Valdmanis, 1996).

LOS has often been analysed as a factor that may impact trust efficiency (Allen, 2009). It is generally agreed that increasing the LOS negatively affects efficiency (Coulam and Gaumer, 1992; Staat, 2006). However, the only researchers to show a positive effect between these variables are Burgess and Wilson (1998). Some researchers have suggested that pressurising healthcare institutions to reduce LOS could adversely affect the quality of care. The argument, known as "quicker and sicker", suggests that premature discharge means more risk of readmission to trust. For example, Kosecoff et al. (1990) discovered that, after PbR was introduced into the US Medicare system, there was evidence supporting the "quicker and sicker" argument. However, some studies have found no relationship between LOS and readmission rates (Baker et al., 2004; Kaboli et al., 2012); others found that LOS is associated with an increase in readmissions (Bueno et al., 2010), while others suggested that there is an association between longer LOS and higher readmission (Westert et al., 2002). Waiting times, health-related quality of life for patients and access to services are also important dimensions when measuring quality, but these have received scant attention in the literature (Gutacker and Street, 2018).

Rosko and Mutter (2008) expected that improved cost efficiency would result from high-quality care as leadership engagement is a key to the delivery of high-quality care. Leaders must be committed to implementing strategies to improve care, monitor their progress and constantly strive to implement initiatives to improve care in their trusts. If leaders are

committed in this way to improving care quality, better cost efficiency may also be attained. There is, thus, a positive association between quality of care and healthcare institutions efficiency (Choi et al., 2017).

Following the discussion above, I investigate the following research question:

Research question: Is lower RCI associated with lower levels of healthcare quality among NHS acute trusts?

5. Data and Methodology

Secondary quantitative data was used for this study. It was extracted from two NHS websites. Data for MFF adjusted RCIs and foundation status were obtained from the NHS Reference Costs Collection website[19]. Data for the dependent and other control variables were gathered from the NHS Digital website[20]. The number of observations was 846 and these were all drawn from acute trusts.

In order to measure the quality of healthcare service provided by NHS acute trusts, seven variables were examined. Mortality rates, SDD, infection rate, mean LOS, and the percentage of emergency patients waiting fewer than four hours for treatment, mean in-patient waiting time and mean out-patient waiting time.

Mortality rates are measured by the actual number of deaths divided by the expected number, which is calculated based on patient characteristics, including patients who die in the NHS trusts or within 30 days of discharge. The second variable used was SDD. The number of SDD represents how many patients had surgery and returned home the same day. The third

[19] This data is available at: https://www.gov.uk/government/collections/nhs-reference-costs
[20] This data is available at: https://digital.nhs.uk/

variable, infection rate, is calculated by dividing the number of patients with trust acquired infections by the number of the population. In 2014 the NHS calculation method was changed to the number of infected patients divided by the number of beds. However, in this study the number of patients infected in trust was divided by the number of in-patient episodes, to standardise the method across the full period of the research. Infection rate[21] figures were taken from the National Archives of the Department of Health website[22], which provides six monthly updates. In this document, there are figures for different types of infection incidents and different categories of harm (i.e., no harm, low harm, moderate harm, severe harm and death). However, for the current study, the annual figures were required, so the figures were matched by organisation code and added together. It would not have been helpful to separate the different types and categories of harm, so the overall figure for all types and level of infection were used.

LOS represents the number of nights patients remain in the trust. Emergency waiting time was measured by the percentage of patients who were treated withinless than four hours (i.e., the number of patients treated within the four hours divided by the total of a number of emergency cases). In-patient waiting time was measured by the number of months patients waited for treatment. Out-patient waiting time was measured in the number of weeks patients waited for treatment. The natural log was used for SDD and total number of episodes to standardise the data.

Quality was taken as the dependent variable and cost as the independent variable. According to a systematic review carried out by Hussey et al. (2013), evidence for the direction

[21] Trust-acquired infections
22 This data is available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20171030124143/http:/www.nrls.npsa.nhs.uk/resources/

of the relationship between healthcare costs and quality is not consistent. For example, Rosko and Mutter (2008) and Choi et al. (2017), have indicated that improved cost efficiency will result from high-quality care. However, Romley et al. (2011) and Romley etal. (2014) used cost as the independent variable. In this study, it has been demonstrated that striving to be cost-efficient can itself improve care quality. It can be argued, given that the focus of the PbR strategy was specifically a financial initiative to cut healthcare costs, that it is the drive towards more cost-efficient healthcare which has led to the influence on quality. Furthermore, lagged cost data was used because trusts make decisions about how to allocate their resources according to their future plans and intentions. There is therefore a time lag between financial outgoings and the outcome of resource allocation. This is consistent with the methodology employed by Rogers et al. (2017).

Cost was captured by two variables. First, cost was measured by the RCI, not the actual amount of money spent. Second, cost was measured as a dummy variable; the sample was divided into two halves. Those in the group at the high end of the RCI scale were given 1; those at the lower end of the scale were given 0. This second measure of cost make it possible to distinguish between those trusts whose RCIs exceed the national average costs and those which maintain their RCIs below the average, to examine whether PbR, which aims to encourage trusts to reduce costs, is negatively associated with quality. This study compared quality data from one year with financial data from the previous year.

Panel fixed effect regression was run for all the data, using SPSS 25, to test the relationship between cost and healthcare quality, one of the advantages of using this technique is that it controls for all time invariant omitted variables such as the age of trust buildings and equipment. following the formula below:

$$Y_t = \beta_0 + \alpha_i + \beta_1 Cost_{it-1} + \beta_2\, Foundation_{it} + \beta_3\, Total\ Episodes_{it} + \beta_4\, InPatients_{it} + \beta_5\, OutPatients_{it} + \beta_6\, Male\ Patients_{it} + Year\ FE_t + \epsilon_{it}$$

Where Y is the dependent variable (i.e., mortality rate, the log of SDD, infection rate, mean LOS, emergency waiting time, in-patient waiting time and out-patient waiting time). α_i is the term capturing all individual fixed effects. *Cost* is the lagged RCI, in the first model. In the second model it is a dummy variable *(Cost_dummy)*. *Foundation* is a dummy variable equals 1 if the trust is foundation and 0 if it is not. *Size* is the natural log of the number of available bed days. *Total Episodes* is the natural log of number of episodes a trust carries out. *In-Patients* is the number of in- patient episodes divided by the total number of episodes. *Out-Patients* is the number of out-patient episodes divided by the total number of episodes. *Male Patients* is the number of male patients divided by the total number of patients and Year FE is years fixed effect.

6. Results

Tables 1 and 2 present a description of the sample. Table 1, Panel A shows the number of acute trusts in each region from the period from 2010 to 2016, with their percentages in brackets. Table 1 Panel B shows the numbers of acute FTs and the cost_dummy which is the number of acute trusts with RCIs above the national average, with the FT percentages, also in brackets, across the overall period examined.

The number of trusts did not change much in each region during the period except for Greater London which lost 25% of its observations (i.e., from 24 trusts in 2010 to 18 trusts in 2016). The highest was North West and the lowest were Wales and Yorkshire and The Humber with 1 and 2 respectively. No trusts were excluded, but the data only showed 1 acute trust for Wales. The total number of observations decreased during the time period by just 4% (i.e., from 123 trusts in 2010 to 118 trusts in 2016). The percentage of FTs increased to 64% of all

trusts by 2016.

Table 1. Panel A. Number of National Health Service Acute Trusts in Each Region Included in this Study from 2010 to 2016

Regions	2010	2011	2012	2013	2014	2015	2016
West Midlands	10 (8)	10 (8)	10 (8)	10 (8)	10 (8)	10 (8)	10 (8)
Wales	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
South West	14 (11)	14 (12)	15 (12)	15 (12)	15 (13)	15 (13)	15 (13)
South East	15 (12)	15 (13)	15 (12)	15 (12)	14 (12)	14 (12)	13 (11)
North West	24 (20)	24 (20)	24 (20)	24 (20)	24 (20)	24 (20)	24 (20)
North East	12 (10)	11 (9)	11 (9)	11 (9)	11 (9)	11 (9)	11 (9)
Greater London	24 (20)	22 (18)	21 (17)	21 (17)	18 (15)	18 (14)	18 (15)
East of England	12 (10)	13 (11)	13 (11)	13 (11)	13 (11)	13 (11)	13 (11)
East Midlands	9 (7)	9 (8)	11 (9)	11 (9)	11 (9)	11 (9)	11 (9)
Yorkshire and The Humber	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
Total	123	121	123	123	119	119	118

Note: Percentages of number of acute trusts in each region are in parentheses.

Table 1. Panel B. Number of National Health Service Acute Trusts Included in this Study from 2010 to 2016 by Foundation Status and Cost_dummy

	2010	2011	2012	2013	2014	2015	2016
Foundation Trusts	56 (46)	69 (58)	73 (59)	74 (60)	73 (61)	73 (61)	75 (64)
Cost_dummy	56	51	55	63	69	62	61

Note: Cost_dummy= number of acute trusts that there RCI is above 100. Percentages of number of foundation trusts (number of foundation trusts divided by total number of trusts) are in parentheses.

Table 2. Descriptive Statistics of the Continuous Variables Used in this Study from 2010 to 2016

	Mean	Minimum	Maximum	Standard deviation
Cost	0.98	0.78	1.25	0.06
Total Episodes	719,537	209,520	2,099,395	329,570
In-Patients	16.96	8.05	26.85	2.97
Out-Patients	66.39	37.79	81.18	5.52
Male Patients	43.15	32.36	48.27	2.29
Mortality Rate	1.00	0.54	1.25	0.10
Same Day Discharge	40,816	5	122,892	20,594
Infection Rate	0.01	0.00	0.09	0.01
Mean Length of Stay	4.23	2.90	7.60	0.58
Emergency Waiting Time	0.91	0.00	0.99	0.07
In-Patient Waiting Time	49.89	0.00	139.03	11.10
Out-Patient Waiting Time	39.46	12.10	90.50	10.68

Note: Cost= lagged reference cost index; Total episodes= the natural log of the number of episodes a trust carries out; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients; Male Patients= the total number of male patients divided by the total number of patients; Mortality rate= the actual number of deaths divided by the expected number; Same day discharge= The natural log of the number of patients who had surgery and returned home the same day; Infection rate= the number of patients infected divided by the number of in-patient episodes; Mean length of stay= the mean number of nights patients remain within the trust; Emergency waiting times= the percentage of emergency patients who were treated within 4 hours divided by the total number of emergency cases; In-patient waiting time= the number of months in-patients waited for treatment; Out-patients waiting time= the number of weeks out-patients waited for treatment.

Table 2 depicts the descriptive statistics of the continuous variable of the model showing the mean, minimum, maximum and standard deviation for each variable during the period 2010 to 2016. Standard deviation for total episodes and SDD are very high due to the large range between the minimum and the maximum. Therefore, the natural log was used for these two variables in the model. The mean for mortality rates is 100%, indicating that the number of people who died in trusts or after 30 days of their discharge was as expected, with a maximum of 25% higher than expected. There are some trusts with no patients treated in less than four hours in emergencies, although some trusts almost achieved the target of treating all their patients (i.e., 99% of emergency patients) within the four-hour time limit.

Table 3 presents the correlation between the variables used in this study. It shows that mortality rates are negatively correlated with the total number of episodes and out-patients and positively with inpatients and male patients. SDD patients is positively associated with foundation status, total number of episodes and male patients but negatively associated with cost. In terms of infection rate, there is a positive correlation with cost and out-patients. Infection rate is negatively correlated with total number of episodes and in-patients. Mean LOS is also positively associated with cost, out-patients and male patients but negatively associated with foundation status and in-patients. All waiting times are negatively associated with foundation status and all positively associated with total number of episodes.

Table 4 explains the results of the study. The left-hand side of the table shows independent and control variables. Columns 1 to 7 show the dependent variables used, mortality rates, SDD, infection rates, mean LOS, emergency waiting times, in- patient waiting times and out-patient waiting times respectively. Also, Table 4 shows the relationship between cost and healthcare quality. There is a positive relationship between cost and infection rate ($\beta = 0.013$ p-value ≤ 0.1) and between cost and in-patient waiting time ($\beta = 18.906$ p-value $\leq$

0.05). The table also shows that cost had no significant relationship with the other five quality measures. NHS acute trusts which reduce their costs, the percentage of patients acquiring infections is lower, and the number of months patients waited for in-patient treatment is lower. In general, results indicate that there is no negative relationship between reducing cost and the quality of treatment provided.

Table A in Appendix 4 replicates the estimation regression in Table 4. As a robustness test, the system General Method of Moments (GMM) was conducted. This study follows the estimation strategy proposed by Roodman (2009). The results show that there was no negative relationship between trusts with lower RCIs and the quality measures used in this study. The results show that the RCIs are associated negatively with mortality rate and positively with the SDD which indicate that there no negative relationship between reducing cost and the quality of treatment provided as suggested in the main test, indicating that the findings are robust. Overall, my results on the association between RCI reduction and healthcare quality are robust.

In the first model, the relationship between RCI reduction and healthcare quality was examined. This reduction does not necessarily correspond to national averages. Those which reduce costs could be either above or below the national average. However, in the second model, costs were measured as a dummy variable to distinguish between trusts that have lower RCIs than the national average and those whose RCIs exceed the national average. Trusts that are financially efficient (i.e., their RCI is at the lower end of the scale) have lower in-patient waiting times ($\beta = 1.752$, p-value ≤ 0.05) (see Table 5). Another test was run, in which the trusts were divided into thirds rather than halves and the middle third deleted, to allow a clearer examination of those trusts which were at either end of the scale. The results concurred with those of the earlier test and showed only one positive relationship, that being between costs and

in-patient waiting times (see Table B in Appendix 4).

Table 3. Results of Correlations between the Variables used in the Regressions from 2010 to 2016

	Cost	Foundation Trusts	Total Episodes	In-Patients	Out-Patients	Male Patients	Mortality Rate	SDD	Infection Rate	Mean LOS	Emergency Waiting Time	In-Patients Waiting Time	Out-Patients Waiting Time
Cost	1	-0.159**	0.123**	-0.132**	0.044	0.052	-0.061	-0.141**	0.113**	0.185**	-0.060	0.015	0.048
Foundation Trusts		1	-0.110**	0.203**	0.020	0.162**	0.032	0.111**	0.008	-0.140**	0.090**	-0.076*	-0.119**
Total Episodes			1	-0.164**	0.351**	0.144**	-0.173**	0.146**	-0.049	0.014	-0.100**	0.096**	0.115**
In-Patients				1	-0.536**	0.215**	0.206**	0.051	-0.218**	-0.164**	0.021	-0.123**	-0.103**
Out-Patients					1	0.117**	-0.102**	0.021	0.124**	0.124**	-0.058	0.156**	0.176**
Male Patients						1	0.164**	0.124**	-0.034	0.249**	0.043	0.055	-0.015
Mortality Rate							1	-0.145**	-0.001	0.132**	-0.021	0.002	-0.060
SDD								1	0.028	0.039	-0.021	0.078*	0.047
Infection Rate									1	0.228**	-0.052	0.048	0.108**
Mean LOS										1	-0.062	-0.029	0.019
Emergency Waiting Time											1	-0.100**	-0.181**
In-Patients Waiting Time												1	0.172**
Out-Patients Waiting Time													1

Note: This table presents the Pearson correlations between the variables used in the regressions. Cost= lagged reference cost index of acute trusts; Total episodes= the natural log of the number of episodes a trust carries out; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients; Male Patients= the total number of male patients divided by the total number of patients; Mortality rate= the actual number of deaths divided by the expected number; Same day discharge= The natural log of the number of patients who had surgery and returned home the same day; Infection rate= the number of patients infected divided by the number of in-patient episodes; Mean length of stay= the mean number of nights patients remain within the trust; Emergency waiting times= the percentage of emergency patients who were treated within 4 hours divided by the total number of emergency cases; In-patient waiting time= the number of months in-patients waited for treatment; Out-patients waiting time= the number of weeks out-patients waited for treatment. * and **, correlation is significant at the 0.05 and 0.01 level, respectively.

Table 4. Results of Panel Fixed Effect Regression of Cost Relations with Healthcare Quality from 2010 to 2016

Variable	Mortality Rate	SDD	Infection Rate	Mean LOS	Emergency Waiting Time	In-Patients Waiting Time	Out-Patients Waiting Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Cost_{t-1}$	-0.038	0.068	0.013*	0.014	0.011	18.906**	3.527
	(-0.048)	(0.106)	(0.007)	(0.279)	(0.064)	(7.801)	(7.342)
Foundation Trusts	0.019	-0.022	0.007*	-0.074	0.015	1.299	-0.321
	(0.015)	(-0.029)	(0.004)	(-0.075)	(0.013)	(3.875)	(-2.096)
Total Episodes	-0.019	0.032	0.007**	0.090	-0.025	4.792	3.709
	(-0.039)	(0.081)	(0.003)	(0.197)	(-0.019)	(5.316)	(4.506)
In-Patients	-0.002	0.005	-0.000*	-0.055***	-0.002	-0.076	0.151
	(-0.002)	(0.005)	(-0.000)	(-0.014)	(-0.002)	(-0.510)	(0.346)
Out-Patients	0.000	-0.001	-0.000	-0.001	-0.002**	0.059	-0.031
	(0.001)	(-0.003)	(-0.000)	(-0.008)	(-0.001)	(0.237)	(-0.135)
Male Patients	-0.000	0.000	0.000	0.036**	0.001	0.157	0.160
	(-0.002)	(0.005)	(0.000)	(0.018)	(0.002)	(0.431)	(0.438)
Intercept	1.152***	4.256***	-0.043	3.218*	1.220***	-8.902	4.937
	(0.341)	(0.723)	(-0.026)	(1.889)	(0.196)	(-60.255)	(41.400)
Trust FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	846	846	846	846	846	846	846
R-within	0.010	0.008	0.047	0.085	0.268	0.043	0.259
R-between	0.001	0.000	0.002	0.110	0.053	0.000	0.000
R-overall	0.007	0.003	0.000	0.085	0.199	0.016	0.068
Rho	0.801	0.959	0.433	0.839	0.303	0.397	0.716

Note: Columns 1 to 7 are the dependent variables (i.e., mortality rate, number of same-day discharge patients, infection rate, mean length of stay, percentage of emergency patient waited less than four hours, mean in-patient waiting time and mean out- patient waiting time, respectively). Cost= lagged reference cost index of acute trusts; Total episodes= the natural log of the number of episodes a trust carries out; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients; Male Patients= the total number of male patients divided by the total number of patients; Mortality rate= the actual number of deaths divided by the expected number; Same day discharge= The natural log of the number of patients who had surgery and returned home the same day; Infection rate= the number of patients infected divided by the number of in-patient episodes; Mean length of stay= the mean number of nights patients remain within the trust; Emergency waiting times= the percentage of emergency patients who were treated within 4 hours divided by the total number of emergency cases; In-patient waiting time= the number of months in-patients waited for treatment; Out-patients waiting time= the number of weeks out-patients waited for treatment. t-statistics of coefficients are in parentheses. *, ** and *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

Table 5. Results of Panel Fixed Effect Regression of Cost_dummy Relations with Healthcare Quality from 2010 to 2016

Variable	Mortality Rate	SDD	Infection Rate	Mean LOS	Emergency Waiting Time	In-Patients Waiting Time	Out-Patients Waiting Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cost_dummy $_{t-1}$	-0.005	0.012	0.001	0.013	0.006	1.752**	0.184
	(0.005)	(0.011)	(0.001)	(0.027)	(0.007)	(0.693)	(0.730)
Foundation Trusts	0.019	-0.022	0.007*	-0.072	0.016	0.866	-0.427
	(0.015)	(0.029)	(0.004)	(0.074)	(0.013)	(4.020)	(2.104)
Total Episodes	-0.019	0.03	0.007**	0.086	-0.026	4.957	3.79
	(0.039)	(0.080)	(0.003)	(0.200)	(0.018)	(5.368)	(4.537)
In-Patients	-0.002	0.005	-0.000*	-0.055***	-0.002	-0.093	0.151
	(0.002)	0.005	(0.000)	(0.014)	(0.002)	(0.502)	(0.348)
Out-Patients	0.001	-0.001	-0.000	-0.001	-0.002**	0.045	-0.031
	(0.001)	(0.003)	(0.000)	(0.008)	(0.001)	(0.231)	(0.135)
Male Patients	-0.000	-0.000	0.000	0.035**	0.000	0.161	0.165
	(0.002)	(0.005)	(0.000)	(0.018)	(0.002)	(0.422)	(0.440)
Intercept	1.108***	4.346***	-0.032	3.282*	1.252***	9.202	7.704
	(0.334)	(0.708)	(0.026)	(1.904)	(0.185)	(57.437)	(41.800)
Trust FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	846	846	846	846	846	846	846
R-within	0.011	0.009	0.044	0.086	0.269	0.042	0.259
R-between	0.000	0.000	0.003	0.113	0.041	0.001	0.000
R-overall	0.006	0.003	0.000	0.087	0.193	0.020	0.068
Rho	0.801	0.959	0.427	0.839	0.310	0.391	0.716

Note: Columns 1 to 7 are the dependent variables (i.e., mortality rate, number of same-day discharge patients, infection rate, mean length of stay, percentage of emergency patient waited less than four hours, mean in-patient waiting time and mean out- patient waiting time, respectively). Cost_dummy= lagged reference cost index of acute trusts with reference cost index higher than the average; Total episodes= the natural log of the number of episodes a trust carries out; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients; Male Patients= the total number of male patients divided by the total number of patients; Mortality rate= the actual number of deaths divided by the expected number; Same day discharge= The natural log of the number of patients who had surgery and returned home the same day; Infection rate= the number of patients infected divided by the number of in-patient episodes; Mean length of stay= the mean number of nights patients remain within the trust; Emergency waiting times= the percentage of emergency patients who were treated within 4 hours divided by the total number of emergency cases; In-patient waiting time= the number of months in-patients waited for treatment; Out-patients waiting time= the number of weeks out-patients waited for treatment. t-statistics of coefficients are in parentheses. *, ** and *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

7. Discussion

The results of the study support the arguments of researchers who claim it is possible to maintain the quality of healthcare, even when costs are reduced. A key factor is the quality measures selected. Previous research has given little attention to the issue of waiting times, which is an important dimension because they affect the quality of life for patients (Gutacker and Street, 2018). Therefore, this study took waiting times as one of its dimensions and found that in-patient waiting times were significantly associated with cost, alongside other quality measure, which were mortality rates, SDD, infection rates and mean LOS.

In this study, the results have indicated that accounting practices and the drive to reduce costs and improve efficiency are not negatively associated with the quality of healthcare given to patients. This concurs with a number of researchers, such as Farrar et al. (2009), who found no evidence that the introduction of PbR affected the quality of care provided and Jacobs (2014) who found no evidence to suggest that a focus on cost reduction compromises quality. Likewise, the current results support the argument made by Rosko and Mutter (2008) that, cost efficiency and high quality care are linked due to the key role of leaders who are committed to applying strategies and initiatives which drive up care quality and achieve greater cost efficiency. This leads to the development of a positive relationship between healthcare efficiency and care quality (Choi et al., 2017). Furthermore, the competition between NHS trusts has been found to foster better quality in terms of patient treatment speeds (Cooper et al., 2011), and the current study supports this viewpoint and that of Gaynor and Town (2011) that competition may positively impact quality. The results also support the findings of Cooper et al. (2011) who demonstrated that there have been quality improvements in UK NHS trusts resulting from measures which favour competition, and that competition has improved NHS trust management, and other outcomes (Bloom et al., 2015).

The study findings contrasts with those of several studies, for example, Dillard et al. (2004), which have expressed concern that the imposition of accounting measures alters the focus of healthcare organisations from patient care as a core service to the pursuit of efficiency as the major goal. Neither do the result support Kosecoff et al. (1990)'s faster sicker findings, for RCIs as used in England and Wales. Thus, the concerns of Malmmose and Kure (2020) that organisations may fail to prioritise their core service of patient care over accounting measures and the pursuit of efficiency are not borne out by the results of the current study.

The results of this study provide a marked contrast with those raising concerns about fixed price payment systems compromising care quality. The views expressed by Dawson and Street (1998) and Appleby and Thomas (2000) that PbR systems requiring cost reduction, could encourage providers to reduce resource allocation for patient care, and hence lower quality were also repudiated by the study results, as were those of Smith (2002) who posited that efficiency performance pressure in the UK healthcare system had created a low cost and poor-quality system. Bevan et al. (2014) suggested that reducing tariffs to too low a level may prevent even efficient providers from maintaining high quality of care provision and that PbR may, for example incentivise compromising quality or discharging patients prematurely, although the current study did not specifically test for earlier discharges. However, the results suggest that this is not the case and that efficiency and care quality are complementary. Although this study did not specifically examine satisfaction, it could be assumed that at least some aspects of patient satisfaction would be covered by the quality dimensions used in this study. Therefore, this study does not support the results of prior researchers who suggest that patient satisfaction is linked to higher costs (e.g., Fenton et al., 2012; Shoemaker, 2012; Stanowski et al., 2015).

PbR is an important strategy to enhance cost efficiency in healthcare systems worldwide, to ensure fairness in payments for treatment alongside a high-quality service and favourable patient outcomes (Grašič et al., 2015; Bojke et al., 2017; Longo et al., 2017). The results of the second model study suggest that, in England and Wales, when a distinction is made between those trusts whose RCIs are at the higher end of the scale and those whose RCIs are at the lower end, it can be seen that this goal has been accomplished and that healthcare is now more cost-efficient while maintaining and even improving some aspects of quality of care.

8. Conclusion

In view of the spiraling costs of healthcare globally and the need for greater cost efficiency in health service provision, this study has examined the relationship between RCI and the quality of care provided in the NHS in England and Wales. The seven dependent variables used to represent quality were mortality rates, number of patients who were discharged on the same day, infection rates, mean LOS, and the percentage of emergency patients waiting fewer than four hours for treatment, mean in-patient waiting time and mean out-patient waiting time. Panel fixed effect regression was used and the data, for NHS acute trusts, was taken from the NHS Reference Cost Collection and the NHS Digital website for the period 2010-2016. Having reviewed the literature in this field, the study examined whether reducing costs measured by RCI is negatively associated with the quality of healthcare services provided.

The study concurs with the findings of various previous researchers (e.g., Rosko and Mutter, 2008; Farrar et al., 2009; Jacobs, 2014) who found no evidence that care quality is adversely affected by the introduction of PbR and suggests a positive relationship between healthcare efficiency and care quality (Choi et al., 2017). Thus, the study results go some way to allaying the concerns of (Malmmose and Kure, 2020) that PbR may alter the priorities of

organisations such that accounting measures take precedence over their core service of patient care.

It can be therefore concluded that the introduction of the Reference Cost system and PbR in England and Wales has provided a useful strategy to enhance cost efficiency without compromising healthcare quality and that healthcare is now more cost-efficient and has maintained and even improved some aspects of quality of care.

Some limitations must be noted so that they can be addressed in subsequent research. First, this study only examines data from acute NHS trusts. Generalization of the findings of this study to other contexts might be problematic and should be done with caution. Second, this study does not account for readmission rates. Although some data regarding certain specific diagnoses, such as hip or knee replacements, are available, lack of availability of data regarding general readmission rates did not allow this variable to be considered. Thirdly, this study does not take into account clinical negligence costs as one of the quality variables used, since the data is not readily available for all NHS Trusts for all the years required for the sample. Covering this aspect of costs would be a lengthy project in itself, and it would require many months to collect this data by hand. This issue would be best addressed by a further, dedicated research project. Furthermore, the study focused exclusively on quantitative data. Future research could use the methodology employed here to examine the effect of cost reduction on healthcare quality in other types of trust, such as community, mental health, specialist and ambulance trusts.

Chapter 5: Conclusion

Conclusion

The rationale behind this PhD thesis was to contribute to the knowledge within the field of healthcare accounting, costing and quality in healthcare system. It used NHS trusts in England and Wales as a test bed as it provided one of the largest cost accounting databases for public healthcare in the world. The NHS healthcare budget is large and financed by taxpayers' money. Striving for greater efficiency is therefore of the utmost importance. Furthermore, inefficiency within the healthcare system may result in problems that cause human suffering. This thesis therefore makes an important contribution to the knowledge which can underpin efficiency improvements by considering the trends and patterns produced by costing approaches over a twenty-year period, and by examining the relationships between performance measurement, RCI and healthcare quality. The thesis also contributes to development of contingency theory by applying it to RCI data, since this is the first time, to the author's knowledge, that the theory has been applied to this type of data. Contingency theory suggests that there is no "one size fits all" solution to accounting practices within different organisations, yet the Reference Cost system is based on the assumption that there is a degree of homogeneity between healthcare trusts. Using contingency theory to underpin the investigation in Study 2 has shown that, even in the healthcare sector, there are differences between institutions which need to be taken into account, thus illustrating the usefulness of the theory in this context.

The first study focused on the Reference Cost system, which has been in use in the NHS in England since 1997. The aim of introducing the system was to gather data about treatment costs, to enable comparisons to be made between trusts, efficiency to be improved and any variation in treatment costs to be reduced in line with national average costs. Study 1 sought to describe trends and patterns in cost variations between trusts over the twenty-year period since the introduction of RCIs. The study also examined whether and how RCIs varied across

regions, types and foundation status. Trends were identified by means of descriptive statistics. The National Archives of the Department of Health and the NHS Reference Cost Collections websites were used as a data source and analysis was conducted by means of ANOVA and one-sample t-test. The findings of the study showed that, during those two decades, overall variations between trusts have been reduced. This indicates that since the Reference Cost system was introduced costs between trusts have been standardized. However, amongst the characteristics tested, which were region, type and foundation status, there were found to be significant differences. However, the study did not establish the relationship between organisational characteristics and RCIs, because that would have required further statistical tests to be run on the data. This was to be the focus of the second study in the thesis.

In Study 2, which was rooted in contingency theory, four hypotheses were tested to focus on the relationship of trust characteristics on their RCI**. H1** RCIs differ between regions. **H2** RCIs differ between trust types. **H3** FTs have lower RCIs than Non-FTs. **H4** RCIs vary according to trust size. The data source was The National Archives of the Department of Health and the NHS Reference Cost Collections websites and OLS regression was used for the analysis. The findings confirmed **H1,** indicating that the most efficient region was the East of England. In the case of Greater London, the results suggest that the MFF adjustment to take into account regional differences, appear to be working successfully, despite claims that the specific circumstances of this region have not been fully taken into account. The results of the analysis also support **H2**, showing that the most efficient trust type was mental health and the least efficient was specialist. As posited by **H3,** FTs have lower RCIs than Non-FTs. The results also support **H4,** showing that the larger the trust, the greater the average costs. The findings concur with contingency theory, showing that differences between trusts are an important factor, although the introduction of the last version of HRG (HRG4+) into the RCI system has

made a partial improvement. However, the results of this study indicate that further adjustments are required to take into consideration other differences between trusts.

Study 2 makes an important contribution to contingency theory by illustrating that,even within the public healthcare sector, account must be taken of variations between trusts because there is no perfect "one size fits all" structure suitable for all organisations within the sector. Assessment of cost-effectiveness must consider such factors as trust size and location as well as their different remits. The MFF system has made some progress in addressing this but further adjustments could improve the system.

A limitation of Study 2 was that it did not address issues of the quality of care provided in the NHS. Therefore, Study 3 examines whether reducing RCIs, as required by PbR, is negatively associated with the quality of healthcare services provided. This issue was investigated using seven dependent variables to represent quality: mortality rates, number of patients who were discharged on the same day, infection rates, mean LOS, and the percentage of emergency patients waiting fewer than four hours for treatment, mean in-patient waiting time and mean out-patient waiting time. The focus of the third study was acute trusts and the data were collected from the NHS Reference Cost Collections and NHS Digital websites covering the period 2010-2016. The data were analysed using panel fixed effect regression.

The results of Study 3 demonstrate that cost reduction may be achieved without compromising quality and that a concern with finance and accounting does not relegate patient care to a secondary concern. This finding concurs with earlier researchers who have shown that a focus on efficiency may help to maintain or improve healthcare quality. The results show that limiting costs as required by the PbR system is positively associated with some quality

measures, such as speed of treatment and infection rate, which suggests that PbR is to encouraging efficiency without adversely affecting care quality. The study helps to allay those fears expressed by researchers who have suggested that a focus on efficiency risks reducing the core service of patient care to a secondary consideration.

Some limitations to this research have been identified. Only data from acute NHS trusts was used, so it would be difficult to generalise these results to other contexts. Neither does this study take into consideration readmission rates, due to a lack of availability of data which made it impossible to analyse this variable. Furthermore, the study is exclusively quantitative. Future research might utilise the methodology of Study 3 and apply it to other trust types, such as community, mental health, specialist and ambulance trusts, to assess the association between RCI reduction and healthcare quality in those areas. Other variables might be considered, such as the associations between RCIs and clinical negligence payments or being a Private Finance Initiative (PFI) trust. It would also be useful to find a method of controlling for the effect of other systems, for example best practice tariffs, to help identify the relationship between PbR and trust behaviour. Conducting a cluster analysis, for example comparing teaching and non-teaching trusts or those which provide children's or elderly persons' services with those who do not, would also provide further useful information. Future qualitative research could consider in depth the differences between a trust with an above average RCI and one with a lower than average RCI. It would also be useful to conduct qualitative research on how well clinical staff understand the importance of balancing professionalism and ethics with the need to be cost efficient. This is essential to safeguard the future survival of individual trusts and the NHS system as a whole.

Overall, this thesis has shown that trusts' healthcare costs in England and Wales are

becoming increasingly standardised. However, work still needs to be done in order to make trusts more efficient, taking into account the several uncontrollable variables investigated in this thesis in the form of trust characteristics. It is important to ensure that the drive towards cost reduction and standardisation does not come at the expense of healthcare quality.

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Appendix 1

Table A. The Development of Reference Cost Index from 1998 to 2016

Year	Change
1998	- To eliminate some of the cost differences found in the 1998 publication, the NHS Executive introduced a new Costing Manual as the basis for costing the 1998/99 submissions. The more prescriptive approach adopted assisted in eliminating the variations caused by different costing methodologies. This process was continued to ensure that any opportunities to shift costs between services were removed. - In addition, a reconciliation of the reference cost financial statements was undertaken with the final accounts for each NHS trust included in reference costs, to ensure that all relevant costs were included in this database. - The first publication concentrated on providing information on over 5000 surgical procedures covering almost 5 million episodes of acute care in 1997/98. That financial year saw this rise to almost 20 million inpatient and outpatient episodes.
1999	- This publication covered 69.4 million inpatient, outpatient and Accident and Emergency episodes and an increased range of surgical and medical treatments. This was an increase of 250% over the previous financial year. The document introduced information on Accident and Emergency services and a significant range of outpatient services for the first time. Small elements of community-based services, were taken into account because most community services were excluded from the Index as only small areas of their total expenditure were included and this would not have been consistent or comparable across all providers.
2000	- Service coverage was further extended to include more detail about acute services and a wider range of community services. - £21 billion of NHS expenditure was covered, representing 83% of expenditure on hospital and community health services.
2001	- A further extended range of services was included, covering £25 billion of NHS expenditure representing almost 89% of expenditure on hospital and community health services.
2002	- 'Payment by Results' was introduced. - Payment, at a predetermined national tariff, was required for 15 specific procedures (HRGs) where activity exceeded the level of the previous year. Prior to this, prices were negotiated locally. 6 clinical specialties were to be contracted using national case-mix adjustments, to facilitate comparisons of relative workload, taking into account not just patient numbers but the severity of their conditions. - The publication covered NHS expenditure details for in excess of £30 billion, increasing the scope of the Reference Cost system by £5 billion from the previous year**.** - This was the occasion on which a spell, covering a patient's entire stay from admission to discharge, rather than a finished consultant episode (FCE) was used as the basis for the tariff.

2003	- This publication covered £33 billion of NHS expenditure, increasing by £3 billion the Reference Costs coverage year**.** This means that more treatments were added. - The HRG version from 1997 was HRG v3. In 2003 the new version was HRG v3.5.
2004	- Between 2003 and 2004 changes were made to the way the increases in pensions indexation was treated.
2005	- This year was the first in which some trusts were granted foundation status.
2006	- Major changes were made to data gathering, usage and Reference Costs Indices calculation. £41 billion of NHS expenditure was covered for 2006/07, including cost data from more than 400 NHS providers. - For the first time, the Healthcare Resource Group version 4 (HRG4) was used. The HRG4 currency supported the policy of Payment by Results (PbR) and revised the system to account for complex cases and expand the groupings used previously. - The design of HRG4 included: • Increased Clinical Coverage, including Chemotherapy, Radiotherapy, Specialist Palliative Care, Diagnostic Imaging, Rehabilitation and Critical Care. • Improved accounting for severity and case complexity by using Complications and Co-morbidities. • Enhancing HRGs' representation of costs by separating activities to account for expensive drugs and other costly aspects of treatments. This also allowed HRGs to be independent of setting to facilitate healthcare funding. - Adult Critical Care data was not included because this was the first year it was the 'number of organs supported' was used as the basis for calculation instead of 'levels of critical care'.
2010	- Best Practice Tariffs was introduced.
2012	- For the first time, the Healthcare Resource Group version 4+ (HRG v4+) was used

Note: This table shows the main changes to the Reference Cost Index system between 1998 and 2016 as documented by the National Health Service websites.

Appendix 2

Table A. Descriptive Statistics of RCIs of all Trusts from 1997 to 2016

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	162	186	154	212	199	173	147	153	153	158	162	148	157	134	167	353	149	141	136	133
95 Percentile	119	127	117	141	127	125	123	118	120	119	115	117	115	115	123	117	115	114	114	115
Median	99	100	96	98	100	100	99	99	100	101	99	99	99	98	99	100	101	100	100	100
5 Percentile	82	84	81	80	82	83	84	84	87	85	87	88	89	89	88	88	87	89	89	88
MIN	67	67	71	54	46	28	42	51	50	69	81	75	80	81	74	63	71	75	80	72
STD	14	16	12	21	17	15	12	12	12	12	11	9	9	8	11	19	9	9	8	9
Average	100	103	98	102	102	101	101	100	101	101	100	100	100	100	102	102	101	101	100	101
Number of Trusts	196	216	221	313	284	273	268	267	265	240	238	239	236	243	248	244	244	239	237	234
Number of Trusts within 99-101	10	11	14	18	21	27	13	28	26	14	16	30	31	28	23	26	31	23	31	20
%	5	5	6	6	7	10	5	10	10	6	7	13	13	12	9	11	13	10	13	9
Number of Trusts below 101	113	114	151	188	154	153	146	155	143	120	135	145	145	152	137	138	131	128	136	124
%	57	53	68	60	54	56	54	58	54	50	57	61	61	63	55	57	54	54	57	53
Number of new Trusts	197	20	11	112	31	57	7	0	1	18	2	1	2	8	9	3	1	1	0	0
Number of disappeared Trusts	0	1	6	20	60	68	12	1	3	43	4	0	5	1	4	7	1	6	2	3

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year.

Table B. Descriptive Statistics of RCIs of all Trusts in West Midlands from 1997 to 2016

West Midlands	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	141	134	154	176	166	156	147	133	134	128	116	118	139	118	133	118	117	114	115	119
95 Percentile	135	121	115	138	128	130	119	115	121	116	113	115	116	115	127	115	113	111	112	113
Median	100	97	99	102	105	99	99	100	98	99	100	100	101	101	102	103	102	102	101	99
5 Percentile	87	89	93	85	86	86	81	80	87	86	87	90	93	92	94	91	93	91	91	90
MIN	87	87	84	82	77	78	72	69	57	81	81	88	92	88	92	78	91	82	91	84
STD	15	11	13	20	16	16	13	13	14	10	8	8	9	8	11	9	7	7	6	8
Average	103	100	102	107	105	102	100	98	99	100	100	100	103	102	106	103	102	101	101	100
Number of Trusts	22	22	23	37	35	32	29	29	29	28	26	27	27	28	28	28	28	27	27	26
Number of Trusts within 99-101	1	1	2	0	2	3	2	4	3	2	2	4	3	5	2	4	2	4	4	1
%	5	5	9	0	0	9	7	14	10	7	8	15	11	18	7	14	7	15	15	4
Number of Trusts below 101	12	13	15	18	14	20	17	17	18	16	14	15	13	14	13	12	12	13	15	14
%	55	59	65	49	40	63	59	59	62	57	54	56	48	50	46	43	43	48	56	54
Number of new Trusts	22	0	1	17	2	5	2	0	0	2	0	1	0	1	1	0	0	0	0	0
Number of disappeared Trusts	0	0	0	3	4	8	5	0	0	3	2	0	0	0	1	0	0	1	0	1
Acute	17	17	18	19	18	16	16	16	16	16	15	15	15	15	15	15	15	14	14	14
Specialist	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Community	0	0	0	4	2	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2
Ambulance	0	0	0	0	0	4	4	4	4	2	1	1	1	1	1	1	1	1	1	1
Mental health	2	2	2	11	12	9	6	6	6	7	7	8	8	8	7	7	7	7	7	7
Foundation	0	0	0	0	0	0	0	0	2	5	10	10	12	13	13	14	14	13	13	13

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table C. Descriptive Statistics of RCIs of all Trusts in Wales from 1997 to 2016

Wales	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	123	118	122	114	116	107	125	120	119	141	129	116	108	105	113	111	111	109	108	109
95 Percentile	122	117	120	112	114	107	123	119	118	139	127	115	107	105	113	111	111	109	108	108
Median	111	109	106	97	97	103	107	105	106	116	108	107	104	102	106	109	109	108	106	108
5 Percentile	100	101	93	96	94	99	91	92	94	94	89	100	100	99	99	96	102	96	91	94
MIN	99	100	91	96	94	99	89	90	92	91	86	99	100	98	98	95	101	95	89	92
STD	17	13	21	10	12	6	26	21	19	35	30	12	5	5	7	9	5	8	10	9
Average	111	109	106	102	102	103	107	105	106	116	108	107	104	102	106	105	107	104	101	103
Number of Trusts	2	2	2	3	3	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Number of Trusts within 99-101	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
%	0	50	0	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0
Number of Trusts below 101	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
%	50	50	50	67	67	50	50	50	50	50	50	50	50	50	33	33	0	33	33	33
Number of new Trusts	2	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Number of disappeared Trusts	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Acute	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Specialist	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Community	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Ambulance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mental health	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table D. Descriptive Statistics of RCIs of all Trusts in South West from 1997 to 2016

South West	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	118	151	101	129	125	140	134	132	134	147	148	128	122	134	167	135	127	128	115	116
95 Percentile	110	116	101	112	115	126	129	119	127	112	123	118	117	129	131	125	124	118	114	113
Median	95	96	92	91	95	103	101	99	99	98	98	99	96	97	96	100	99	98	99	97
5 Percentile	75	81	82	74	87	82	86	87	88	84	87	91	90	89	86	89	90	90	88	90
MIN	68	70	77	70	84	76	81	85	85	69	85	85	84	86	79	85	86	90	86	85
STD	12	15	6	13	10	14	13	11	12	13	13	10	9	12	18	12	11	10	9	8
Average	95	98	93	93	98	102	102	100	101	98	101	101	99	102	102	101	102	102	100	99
Number of Trusts	23	24	25	30	28	31	31	31	31	28	28	28	28	28	27	27	28	27	26	26
Number of Trusts within 99-101	1	0	1	4	1	1	1	4	3	2	1	3	1	2	2	4	3	2	1	1
%	4	0	4	13	4	3	3	13	10	7	4	11	4	7	7	15	11	7	4	4
Number of Trusts below 101	15	18	23	24	18	13	15	19	18	17	17	17	18	18	18	17	16	17	14	16
%	65	75	92	80	64	42	48	61	58	61	61	61	64	64	67	63	57	63	54	62
Number of new Trusts	23	1	2	5	2	7	0	0	0	2	0	0	0	0	0	1	1	0	0	0
Number of disappeared Trusts	0	0	1	0	4	4	0	0	0	5	0	0	0	0	1	1	0	1	1	0
Acute	20	20	20	21	21	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18
Specialist	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Community	2	2	2	3	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	1
Ambulance	0	0	0	0	0	5	5	5	5	2	2	2	2	2	2	1	1	1	1	1
Mental health	1	1	2	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Foundation	0	0	0	0	0	0	0	0	4	11	16	16	17	18	18	18	18	17	17	18

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table E. Descriptive Statistics of RCIs of all Trusts in South East from 1997 to 2016

South East	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	148	150	117	149	140	122	123	119	132	138	133	123	123	117	127	113	104	106	107	113
95 Percentile	128	127	115	135	125	120	113	112	118	120	113	115	111	111	110	107	104	104	106	109
Median	100	103	99	101	102	99	98	98	97	99	97	98	98	98	98	96	98	97	99	98
5 Percentile	84	89	85	83	92	88	88	86	87	82	92	87	90	89	87	88	92	89	91	84
MIN	82	86	84	57	90	84	81	81	83	81	85	86	84	81	82	78	89	87	86	82
STD	16	14	9	18	11	11	9	8	10	13	9	9	8	7	9	8	5	5	5	8
Average	103	106	99	103	104	101	99	98	100	100	100	99	99	98	99	97	98	98	98	98
Number of Trusts	22	25	26	39	35	33	33	33	31	26	26	26	26	27	27	27	27	26	26	25
Number of Trusts within 99-101	1	1	3	2	4	1	2	1	3	2	2	2	3	4	4	2	2	1	4	2
%	5	4	12	5	11	3	6	3	10	8	8	8	12	15	15	7	7	4	15	8
Number of Trusts below 101	12	10	17	20	16	19	21	22	19	15	16	18	17	19	18	18	17	16	18	15
%	55	40	65	51	46	58	64	67	61	58	62	69	65	70	67	67	63	62	69	60
Number of new Trusts	22	4	1	15	2	9	0	0	0	4	0	0	1	1	1	1	0	0	0	0
Number of disappeared Trusts	0	1	0	2	6	11	0	0	2	9	0	0	1	0	1	1	0	1	0	1
Acute	17	19	20	20	20	17	17	17	17	16	16	16	16	16	16	17	17	16	16	15
Specialist	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
Community	1	3	3	9	4	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2
Ambulance	0	0	0	0	0	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1
Mental health	2	1	1	8	9	8	8	8	6	5	5	5	5	5	6	6	6	6	6	6
Foundation	0	0	0	0	0	0	0	0	2	6	9	10	12	12	14	14	15	14	14	16

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table F. Descriptive Statistics of RCIs of all Trusts in North West from 1997 to 2016

North West	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	162	133	146	212	137	173	135	153	150	138	128	122	123	117	131	112	113	122	119	115
95 Percentile	119	124	118	146	125	116	123	131	132	133	119	118	119	115	113	109	109	111	112	112
Median	95	100	98	98	100	101	102	102	102	103	99	99	99	100	99	100	100	102	100	102
5 Percentile	82	80	81	80	76	80	85	83	87	86	87	88	90	89	88	86	88	91	86	86
MIN	80	75	75	54	61	67	77	75	82	80	83	83	89	86	74	81	71	75	80	72
STD	15	13	13	24	15	15	12	15	15	14	11	9	8	8	10	7	8	8	8	9
Average	97	101	99	103	101	102	102	103	104	104	100	100	101	101	100	100	100	101	100	100
Number of Trusts	41	44	43	61	53	46	45	45	45	41	42	42	42	44	45	44	44	44	44	43
Number of Trusts within 99-101	1	4	2	5	5	4	2	3	5	0	3	3	4	6	3	4	8	3	5	4
%	2	9	5	8	9	9	4	7	11	0	7	7	10	14	7	9	18	7	11	9
Number of Trusts below 101	28	24	26	38	28	22	21	22	21	14	25	25	25	23	24	24	25	21	24	19
%	68	55	60	62	53	48	47	49	47	34	60	60	60	52	53	55	57	48	55	44
Number of new Trusts	41	3	0	20	7	13	2	0	0	1	1	0	0	2	1	0	0	0	0	0
Number of disappeared Trusts	0	0	1	2	15	20	3	0	0	5	0	0	0	0	0	1	0	0	0	1
Acute	26	27	27	27	28	27	26	26	26	26	26	26	26	26	26	25	25	25	25	25
Specialist	5	5	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Community	1	2	2	16	12	0	0	0	0	0	0	0	0	2	3	3	3	3	3	3
Ambulance	0	0	0	0	0	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1
Mental health	9	10	10	12	7	9	9	9	9	8	9	9	9	9	9	9	9	9	9	8
Foundation	0	0	0	0	0	0	0	0	5	13	25	25	28	30	30	30	30	30	30	34

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table G. Descriptive Statistics of RCIs of all Trusts in North East from 1997 to 2016

North East	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	155	118	113	127	152	157	139	113	116	123	127	118	111	111	135	129	141	130	130	127
95 Percentile	130	117	110	115	123	133	128	112	115	113	113	112	111	110	112	112	111	112	116	126
Median	105	103	96	98	98	101	102	100	103	107	102	102	102	100	102	98	100	99	98	98
5 Percentile	90	82	90	63	86	81	88	88	95	95	96	92	89	90	85	93	92	93	92	92
MIN	90	77	88	61	84	74	76	72	87	84	90	88	85	86	74	85	85	87	89	88
STD	16	12	7	16	15	17	13	9	7	8	7	7	6	7	12	9	11	9	9	10
Average	107	102	99	96	100	103	103	99	104	105	103	102	101	101	102	101	102	101	100	100
Number of Trusts	15	18	20	27	26	27	27	27	27	22	22	22	22	22	22	21	21	21	21	21
Number of Trusts within 99-101	0	2	2	0	1	6	1	3	1	2	2	4	5	6	1	2	2	2	3	2
%	0	11	10	0	4	22	4	11	4	9	9	18	23	27	5	10	10	10	14	10
Number of Trusts below 101	6	8	13	15	15	15	11	15	6	7	9	10	10	14	10	13	11	12	15	15
%	40	44	65	56	58	56	41	56	22	32	41	45	45	64	45	62	52	57	71	71
Number of new Trusts	15	3	2	9	2	9	0	0	0	4	0	0	0	0	1	0	0	0	0	0
Number of disappeared Trusts	0	0	0	2	3	8	0	0	0	9	0	0	0	0	1	1	0	0	0	0
Acute	10	12	14	14	14	15	15	15	15	14	14	14	14	14	14	13	13	13	13	13
Specialist	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Community	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Ambulance	0	0	0	0	0	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2
Mental health	2	3	3	10	10	8	8	8	8	6	6	6	6	6	5	5	5	5	5	5
Foundation	0	0	0	0	0	0	0	0	4	9	11	11	15	15	16	16	16	16	16	16

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table H. Descriptive Statistics of RCIs of all Trusts in Greater London from 1997 to 2016

Greater London	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	136	158	145	201	199	149	141	149	153	158	162	148	157	132	135	137	132	133	136	129
95 Percentile	119	151	124	164	152	122	118	114	114	113	110	117	116	119	115	116	117	124	116	120
Median	103	103	96	98	102	99	97	99	99	99	100	101	99	98	101	100	100	101	102	102
5 Percentile	91	87	76	79	80	81	84	86	89	85	86	84	87	89	90	86	83	87	88	89
MIN	67	67	71	54	46	28	42	51	50	78	82	75	80	88	88	63	77	81	83	85
STD	12	19	15	28	26	17	14	13	14	12	14	12	12	10	10	12	11	12	11	10
Average	105	106	100	108	106	99	98	99	100	100	101	100	101	101	101	100	101	102	102	103
Number of Trusts	29	36	37	57	54	50	50	50	50	47	46	46	45	46	47	45	44	42	41	41
Number of Trusts within 99-101	5	1	1	2	1	5	1	6	8	4	3	7	6	2	8	5	9	3	4	6
%	17	3	3	4	2	10	2	12	16	9	7	15	13	4	17	11	20	7	10	15
Number of Trusts below 101	12	17	23	33	24	33	34	30	33	28	24	26	28	29	26	25	25	21	20	19
%	40	47	62	58	44	66	68	60	66	60	52	57	62	63	55	56	57	50	49	46
Number of new Trusts	30	6	4	22	8	7	0	0	1	1	1	0	1	1	1	1	0	1	0	0
Number of disappeared Trusts	0	0	3	2	11	11	0	0	1	4	2	0	2	0	0	3	1	3	1	0
Acute	23	26	28	30	29	28	28	28	28	28	28	28	27	27	27	25	24	22	21	21
Specialist	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Community	1	1	1	9	5	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2
Ambulance	0	0	0	0	0	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2
Mental health	3	4	3	13	15	12	12	12	12	12	11	11	11	11	11	11	11	11	11	11
Foundation	0	0	0	1	0	0	0	0	5	11	14	14	16	18	20	21	22	22	22	23

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table I. Descriptive Statistics of RCIs of all Trusts in East of England from 1997 to 2016

East of England	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	115	174	117	159	150	150	128	123	119	115	109	117	119	123	116	122	114	114	111	116
95 Percentile	113	130	111	134	138	115	119	118	113	114	107	110	112	108	113	112	111	110	105	113
Median	95	97	95	98	96	98	97	97	96	98	96	96	98	96	98	96	97	99	99	101
5 Percentile	84	83	81	83	85	83	85	81	87	85	88	84	85	87	87	88	87	88	88	87
MIN	82	78	81	79	74	81	83	76	80	81	81	82	80	82	80	78	85	87	85	86
STD	10	21	9	18	17	14	11	11	9	9	7	8	8	8	9	10	8	7	7	9
Average	96	101	96	101	100	98	98	98	98	99	97	97	98	97	98	98	98	98	98	99
Number of Trusts	17	18	18	25	23	26	25	24	24	22	22	22	21	22	22	22	22	22	22	22
Number of Trusts within 99-101	0	0	1	2	2	4	2	1	0	1	1	2	2	0	2	2	2	5	5	2
%	0	0	6	8	9	15	8	4	0	5	5	9	10	0	9	9	9	23	23	9
Number of Trusts below 101	13	11	14	16	17	17	17	15	15	13	16	17	16	18	15	16	15	15	15	12
%	76	61	78	64	74	65	68	63	63	59	73	77	76	82	68	73	68	68	68	55
Number of new Trusts	17	1	0	10	3	4	1	0	0	1	0	0	0	2	0	0	0	0	0	0
Number of disappeared Trusts	0	0	0	3	5	1	2	1	0	3	0	0	1	1	0	0	0	0	0	0
Acute	14	14	14	16	16	15	14	14	14	14	14	14	13	13	13	13	13	13	13	13
Specialist	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Community	1	2	2	4	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
Ambulance	0	0	0	0	0	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Mental health	1	1	1	4	6	8	8	7	7	6	6	6	6	5	5	5	5	5	5	5
Foundation	0	0	0	0	0	0	0	0	3	9	13	13	13	13	14	14	14	14	14	14

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table J. Descriptive Statistics of RCIs of all Trusts in East Midlands from 1997 to 2016

East Midlands	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	116	186	131	118	113	139	123	114	120	117	115	115	107	109	129	353	149	141	131	133
95 Percentile	112	114	123	114	107	120	114	114	112	115	113	115	105	107	125	135	124	114	113	128
Median	99	104	98	99	99	101	103	101	102	104	101	99	99	99	102	102	101	102	100	101
5 Percentile	87	89	84	89	86	92	96	93	94	95	91	94	94	94	93	93	91	91	93	92
MIN	87	87	76	86	74	89	94	91	93	91	91	91	92	88	92	87	86	90	92	90
STD	9	20	12	8	8	11	7	7	7	7	7	6	4	5	12	53	13	10	9	11
Average	100	107	99	100	97	104	105	103	102	103	101	100	99	100	105	114	105	103	102	103
Number of Trusts	19	21	22	29	22	22	22	22	22	20	20	20	20	20	23	23	23	23	23	23
Number of Trusts within 99-101	0	1	2	2	5	3	2	6	2	1	2	4	6	3	0	2	3	2	4	1
%	0	5	9	7	23	14	9	27	9	5	10	20	30	15	0	9	13	9	17	4
Number of Trusts below 101	10	7	14	18	16	10	6	11	10	7	10	14	15	13	10	11	9	11	12	11
%	53	33	64	62	73	45	27	50	45	35	50	70	75	65	43	48	39	48	52	48
Number of new Trusts	19	2	1	12	5	3	1	0	0	3	0	0	0	0	3	0	0	0	0	0
Number of disappeared Trusts	0	0	0	5	12	3	1	0	0	5	0	0	0	0	0	0	0	0	0	0
Acute	13	14	14	14	15	14	14	14	14	12	12	12	12	12	12	12	12	12	12	12
Specialist	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Community	1	2	2	6	3	1	0	0	0	0	0	0	0	0	3	3	3	3	3	3
Ambulance	0	0	0	0	0	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Mental health	4	4	5	8	3	4	5	5	5	6	6	6	6	6	6	6	6	6	6	6
Foundation	0	0	0	0	0	0	0	0	6	11	12	12	13	14	14	14	14	14	14	16

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table K. Descriptive Statistics of RCIs of all Trusts in Yorkshire and The Humber from 1997 to 2016

Yorkshire and The Humber	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	110	134	97	103	112	103	103	106	105	112	108	105	107	106	106	125	109	114	109	110
95 Percentile	108	124	97	103	108	102	102	104	104	110	107	105	106	105	106	122	109	112	108	109
Median	100	93	90	92	92	93	92	90	101	96	97	99	98	96	102	105	106	105	103	101
5 Percentile	82	84	80	84	72	87	83	88	92	89	87	91	95	92	97	100	99	101	92	97
MIN	77	84	79	83	69	86	82	88	90	88	86	90	95	91	96	100	98	100	90	97
STD	11	18	8	9	16	7	9	9	6	11	9	7	6	7	5	11	5	6	8	6
Average	97	97	89	93	90	94	92	93	99	98	97	98	100	97	102	109	105	106	101	102
Number of Trusts	6	6	5	5	5	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4
Number of Trusts within 99-101	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1	1
%	17	0	0	20	0	0	0	0	25	0	0	0	0	0	25	25	0	25	25	25
Number of Trusts below 101	4	5	5	4	4	3	3	3	2	2	3	2	2	3	2	1	1	1	2	2
%	67	83	100	80	80	75	75	75	50	50	75	50	67	75	50	25	25	25	50	50
Number of new Trusts	6	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Number of disappeared Trusts	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Acute	6	6	5	5	5	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3
Specialist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Community	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
Ambulance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mental health	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2	2	2	2	2

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; Acute= number of acute trusts; Specialist= number of specialist trusts; Community= number of community trusts; Ambulance= number of ambulance trusts; Mental health= number of mental health trusts; Foundation= number of foundation trusts.

Table L. Descriptive Statistics of RCIs of all Acute Trusts from 1997 to 2016

Acute	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	155	134	146	139	141	127	118	115	119	138	116	119	114	117	118	125	114	116	117	115
95 Percentile	117	117	110	116	114	111	110	111	111	112	109	110	110	110	109	112	109	109	110	110
Median	97	98	96	96	98	99	99	99	100	99	98	99	98	98	98	99	100	99	99	99
5 Percentile	83	84	82	79	86	87	87	87	88	86	86	88	90	89	90	90	89	90	89	89
MIN	74	75	75	54	69	82	79	72	83	69	81	79	80	86	87	78	83	88	85	83
STD	11	10	9	12	10	8	7	8	7	9	7	6	6	6	6	7	6	6	6	6
Average	99	99	96	96	98	99	99	99	100	99	98	99	99	99	99	99	99	99	99	99
Number of Trusts	147	156	161	167	167	156	154	154	154	150	149	149	146	146	145	142	141	137	136	135
Number of Trusts within 99-101	9	8	9	12	16	19	10	20	17	12	8	25	26	22	19	19	25	15	21	15
%	6	5	6	7	10	12	6	13	11	8	5	17	18	15	13	13	18	11	15	11
Number of Trusts below 101	91	92	124	121	105	101	91	96	90	87	94	102	105	105	98	91	90	83	89	80
%	62	59	77	72	63	65	59	62	58	58	63	68	72	72	68	64	64	61	65	59
Number of new Trusts	147	9	8	18	10	10	3	0	0	1	1	0	2	0	0	2	0	1	0	0
Number of disappeared Trusts	0	0	3	12	10	21	5	0	0	5	2	0	5	0	1	5	1	5	1	1
West Midlands	17	17	18	19	18	16	16	16	16	16	15	15	15	15	15	15	15	14	14	14
Wales	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
South West	20	20	20	21	21	19	19	19	19	19	19	19	19	19	18	18	18	18	18	18
South East	17	19	20	20	20	17	17	17	17	16	16	16	16	16	16	17	17	16	16	15
North West	26	27	27	27	28	27	26	26	26	26	26	26	26	26	26	25	25	25	25	25
North East	10	12	14	14	14	15	15	15	15	14	14	14	14	14	14	13	13	13	13	13
Greater London	23	26	28	30	29	28	28	28	28	28	28	28	27	27	27	25	24	22	21	21
East of England	14	14	14	16	16	15	14	14	14	14	14	14	13	13	13	13	13	13	13	13
East Midlands	13	14	14	14	15	14	14	14	14	12	12	12	12	12	12	12	12	12	12	12
Yorkshire and The Humber	6	6	5	5	5	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3
Foundation	0	0	0	0	0	0	0	0	26	50	69	70	73	77	80	81	83	81	81	83

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; West Midland, Wales, South West, South East, North West, North East, Greater London, East of England, East Midland and Yorkshire and The Humber= number of trusts in those regions; Foundation= number of foundation trusts.

Table M. Descriptive Statistics of RCIs of all Ambulance Trusts from 2002 to 2016

Ambulance	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	173	135	138	150	113	109	118	112	112	112	112	111	110	106	113
95 Percentile	145	134	132	132	111	109	116	112	112	112	110	109	107	106	109
Median	100	97	100	102	101	104	107	102	103	107	100	101	102	102	102
5 Percentile	75	77	80	82	83	90	88	88	92	88	89	90	89	90	89
MIN	67	72	69	57	81	90	88	85	90	85	85	85	87	89	88
STD	25	18	17	18	11	7	11	9	8	9	8	7	7	6	8
Average	105	102	102	103	98	101	102	101	102	102	100	100	100	100	100
Number of Trusts	30	30	30	30	12	11	11	11	11	11	10	10	10	10	10
Number of Trusts within 99-101	2	0	2	1	1	0	0	1	0	0	2	1	0	0	0
%	7	0	7	3	8	0	0	9	0	0	20	10	0	0	0
Number of Trusts below 101	16	16	17	15	6	4	5	5	5	5	6	5	4	3	3
%	53	53	57	50	50	36	45	45	45	45	60	50	40	30	30
Number of new Trusts	30	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Number of disappeared Trusts	0	0	0	0	28	1	0	0	0	0	1	0	0	0	0
West Midlands	4	4	4	4	2	1	1	1	1	1	1	1	1	1	1
Wales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South West	5	5	5	5	2	2	2	2	2	2	1	1	1	1	1
South East	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1
North West	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1
North East	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2
Greater London	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2
East of England	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
East Midlands	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Yorkshire and The Humber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	2	4	5	5	5	5	5

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; West Midland, Wales, South West, South East, North West, North East, Greater London, East of England, East Midland and Yorkshire and The Humber= number of trusts in those regions; Foundation= number of foundation trusts.

Table N. Descriptive Statistics of RCIs of all Community Trusts from 1997 to 2016

Community	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	119	186	124	212	199	122	105	109	119	115	115	116	109	118	125	138	120	110	113	133
95 Percentile	115	179	120	183	186	121	104	109	118	115	115	115	108	113	116	120	118	109	111	116
Median	99	108	103	108	109	118	101	103	106	113	110	112	107	101	105	103	105	103	97	102
5 Percentile	82	88	88	81	75	105	98	98	94	111	106	109	106	86	86	87	92	93	88	88
MIN	79	85	88	79	61	103	98	98	93	111	105	109	106	81	82	85	87	88	87	87
STD	13	33	12	32	33	10	5	8	19	3	7	5	2	10	11	12	8	6	8	11
Average	98	126	104	116	115	114	101	103	106	113	110	112	107	100	103	103	104	101	98	101
Number of Trusts	8	13	13	52	27	3	2	2	2	2	2	2	2	10	18	18	19	19	18	18
Number of Trusts within 99-101	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0
%	0	8	8	2	0	0	0	0	0	0	0	0	0	0	6	6	0	11	0	0
Number of Trusts below 101	4	3	6	20	9	0	1	1	1	0	0	0	0	5	7	8	5	9	10	8
%	50	23	46	38	33	0	50	50	50	0	0	0	0	50	39	44	26	47	56	44
Number of new Trusts	8	5	1	42	0	0	0	0	0	1	0	0	0	8	8	1	1	0	0	0
Number of disappeared Trusts	0	0	1	3	25	24	1	0	0	1	0	0	0	0	0	1	0	0	1	0
West Midlands	0	0	0	4	2	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2
Wales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
South West	2	2	2	3	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	1
South East	1	3	3	9	4	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2
North West	1	2	2	16	12	0	0	0	0	0	0	0	0	2	3	3	3	3	3	3
North East	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Greater London	1	1	1	9	5	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2
East of England	1	2	2	4	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
East Midlands	1	2	2	6	3	1	0	0	0	0	0	0	0	0	3	3	3	3	3	3
Yorkshire and The Humber	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
Foundation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; West Midland, Wales, South West, South East, North West, North East, Greater London, East of England, East Midland and Yorkshire and The Humber= number of trusts in those regions; Foundation= number of foundation trusts.

Table O. Descriptive Statistics of RCIs of all Mental Health Trusts from 1997 to 2016

Mental health	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	121	150	124	176	152	157	139	153	148	119	148	128	122	134	167	353	149	141	136	130
95 Percentile	118	124	117	135	126	120	121	114	115	114	113	117	115	114	132	131	125	128	122	123
Median	99	99	96	100	100	101	99	99	101	102	100	99	100	99	104	100	101	100	100	99
5 Percentile	80	71	81	79	78	80	83	81	87	84	88	85	88	88	78	80	85	85	86	83
MIN	68	67	77	54	46	28	42	51	50	78	82	75	80	82	74	63	71	75	80	72
STD	13	18	12	20	17	17	14	13	13	9	10	9	9	9	17	37	14	13	11	12
Average	99	101	98	104	102	101	100	99	100	101	100	100	100	101	105	105	102	102	102	101
Number of Trusts	24	26	27	72	69	64	62	61	59	56	56	57	57	56	55	55	55	55	55	54
Number of Trusts within 99-101	1	2	1	3	4	6	3	6	6	1	7	5	3	6	2	4	4	6	10	3
%	4	8	4	4	6	9	5	10	10	2	13	9	5	11	4	7	7	11	18	6
Number of Trusts below 101	15	15	16	39	36	32	34	36	30	24	32	35	30	32	23	29	27	29	31	29
%	63	58	59	54	52	50	55	59	51	43	57	61	53	57	42	53	49	53	56	54
Number of new Trusts	24	3	2	50	21	17	4	0	1	6	1	1	0	0	1	0	0	0	0	0
Number of disappeared Trusts	0	1	1	5	24	22	6	1	3	9	1	0	0	1	2	0	0	0	0	1
West Midlands	2	2	2	11	12	9	6	6	6	7	7	8	8	8	7	7	7	7	7	7
Wales	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South West	1	1	2	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
South East	2	1	1	8	9	8	8	8	6	5	5	5	5	5	6	6	6	6	6	6
North West	9	10	10	12	7	9	9	9	9	8	9	9	9	9	9	9	9	9	9	8
North East	2	3	3	10	10	8	8	8	8	6	6	6	6	6	5	5	5	5	5	5
Greater London	3	4	3	13	15	12	12	12	12	12	11	11	11	11	11	11	11	11	11	11
East of England	1	1	1	4	6	8	8	7	7	6	6	6	6	5	5	5	5	5	5	5
East Midlands	4	4	5	8	3	4	5	5	5	6	6	6	6	6	6	6	6	6	6	6
Yorkshire and The Humber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	1	0	0	0	0	0	15	29	29	38	40	40	40	40	40	40	43

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; West Midland, Wales, South West, South East, North West, North East, Greater London, East of England, East Midland and Yorkshire and The Humber= number of trusts in those regions; Foundation= number of foundation trusts.

Table P. Descriptive Statistics of RCIs of all Specialist Health Trusts from 1997 to 2016

Specialist	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	162	154	154	173	166	156	147	149	153	158	162	148	157	132	135	137	132	133	134	129
95 Percentile	150	134	145	154	147	150	141	133	135	148	156	124	140	131	135	123	124	124	119	121
Median	111	116	110	108	113	111	114	112	112	116	113	115	111	112	113	110	108	110	108	109
5 Percentile	91	90	81	83	83	86	87	84	91	93	88	88	89	90	96	93	92	94	93	92
MIN	67	88	71	79	80	82	86	75	87	86	87	83	88	90	90	93	88	92	86	86
STD	22	16	19	23	20	20	17	18	18	19	21	14	16	13	12	10	11	10	10	10
Average	116	114	112	112	115	114	115	111	113	118	115	111	112	110	111	109	109	109	108	108
Number of Trusts	17	21	20	22	21	20	20	20	20	20	20	20	20	20	19	19	19	18	18	17
Number of Trusts within 99-101	0	0	3	2	1	0	0	0	2	0	1	0	1	0	1	0	1	0	0	2
%	0	0	15	9	5	0	0	0	10	0	5	0	5	0	5	0	5	0	0	12
Number of Trusts below 101	3	4	5	8	4	4	4	5	7	3	5	3	5	5	4	4	4	3	3	4
%	17	19	25	36	19	20	20	25	35	15	25	15	25	25	21	21	21	17	17	24
Number of new Trusts	30	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of disappeared Trusts	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1
West Midlands	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Wales	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
South West	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
South East	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
North West	5	5	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
North East	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater London	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
East of England	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
East Midlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Yorkshire and The Humber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	6	11	13	13	16	16	18	18	18	17	17	16

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year; West Midland, Wales, South West, South East, North West, North East, Greater London, East of England, East Midland and Yorkshire and The Humber= number of trusts in those regions; Foundation= number of foundation trusts.

Table Q. Descriptive Statistics of RCIs of all Non-Foundation Trusts from 2005 to 2016

Non-Foundation	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	153	158	162	148	157	132	135	138	132	133	134	133
95 Percentile	120	119	115	116	112	115	122	115	110	110	112	113
Median	101	101	102	100	100	100	101	101	101	101	101	102
5 Percentile	87	85	86	88	90	90	90	88	87	89	89	89
MIN	50	80	81	79	84	81	74	78	86	82	86	82
STD	12	12	11	9	9	8	10	10	8	8	8	9
Average	101	102	102	101	101	101	101	101	101	101	101	102
Number of Trusts	233	164	127	127	109	108	106	100	98	96	94	81
Number of Trusts within 99-101	24	12	10	19	19	17	10	12	14	9	13	7
%	10	7	8	15	17	16	9	12	14	9	14	9
Number of Trusts below 101	123	80	60	71	62	61	55	54	48	49	50	37
%	53	49	47	56	57	56	52	54	49	51	53	46
Number of new Trusts	1	17	1	1	2	8	9	3	1	1	0	0
Number of disappeared Trusts	35	86	38	1	20	9	11	9	3	3	2	13

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year.

Table R. Descriptive Statistics of RCIs of all Foundation Trusts from 2005 to 2016

Foundation	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
MAX	125	147	148	128	139	134	167	353	149	141	136	130
95 Percentile	115	115	113	117	119	115	125	117	117	116	114	116
Median	98	99	97	98	98	98	99	99	100	100	99	99
5 Percentile	90	84	87	88	89	88	88	87	87	89	89	87
MIN	88	69	81	75	80	82	74	63	71	75	80	72
STD	9	12	9	9	9	9	12	23	10	9	9	9
Average	100	100	99	99	100	100	102	102	101	101	100	100
Number of Trusts	32	76	111	112	127	135	142	144	146	143	143	153
Number of Trusts within 99-101	2	2	6	11	12	11	13	14	17	14	18	13
%	6	3	5	10	9	8	9	10	12	10	13	8
Number of Trusts below 101	20	40	75	74	83	91	82	84	83	79	86	87
%	63	53	68	66	65	67	58	58	57	55	60	57
Number of new Trusts	32	44	35	1	15	8	7	2	2	0	0	12
Number of disappeared Trusts	0	0	0	0	0	0	0	0	0	3	0	2

Note: RCI= reference cost index; MAX= the highest RCI in a given year; MIN= the lowest RCI in a given year; STD= standard deviation; Number of trusts= number of trusts that their RCI was published; Number of trusts within 99-101= number of trust that their RCI was between 99% and 101%; %= the percentage of the number above it; Number of trusts below 101= number of trust that their RCI was below 101%; Number of new trusts= number of trust that their data did not exist in the previous year; Number of disappeared trusts= number of trust that their data did not exist in the given year.

Table S: Results of One Sample t Test of the Mean RCI of each Region on the National Average

Variable	2002-2016				2005-2016			
	N	Mean	t	Mean Difference	N	Mean	t	Mean Difference
West Midlands	419	101.182	2.339	1.182*	329	101.460	2.914	1.460**
Wales	36	105.332	2.655	5.332*	30	105.383	2.540	5.383*
South West	425	100.904	1.587	0.904	332	100.777	1.229	0.777
South East	419	98.944	-2.524	-1.055*	320	98.781	-2.621	-1.219**
North West	656	101.219	2.901	1.219**	520	100.946	2.225	0.946*
North East	345	101.798	3.430	1.798**	264	101.798	3.453	1.798**
Greater London	690	100.493	1.052	0.493	540	100.907	1.834	0.907
East of England	340	98.019	-4.033	-1.980**	265	97.931	-4.107	-2.068**
East Midlands	326	103.397	3.728	3.397**	260	103.240	2.911	3.240**
Yorkshire and The Humber	59	99.530	-0.443	-0.469	47	101.165	1.062	1.164

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table T: Results of One Sample t Test of the Mean RCI of each Type on the National Average

Variable	1997-2016				2005-2016			
	N	Mean	t	Mean Difference	N	Mean	t	Mean Difference
Acute	2992	98.603	-9.456	-1.396**	1730	99.006	-6.152	-0.993**
Ambulance					147	101.010	1.117	1.010
Community	250	107.789	5.562	7.789**	130	102.209	2.614	2.209*
Mental Health	1075	101.295	2.705	1.294**	670	101.492	2.499	1.492*
Specialist	392	112.240	14.726	12.240**	230	111.302	11.995	11.302**

Note: RCI= reference cost index. * P-value is ≤ 0.05, ** P-value is ≤ 0.01

Table U. Descriptive Statistics for ANOVA Test

Variable	1997-2016		2002-2016		2005-2016	
	N	Mean	N	Mean	N	Mean
West Midlands	558	101.847	419	101.182	329	101.460
Wales	48	105.396	36	105.332	30	105.383
South West	555	99.590	425	100.905	332	100.778
South East	566	100	419	98.944	320	98.781
North West	898	101.083	656	101.221	520	100.946
North East	451	101.433	345	101.798	264	101.798
Greater London	904	101.517	690	100.494	540	100.908
East of England	440	98.243	340	98.019	265	97.932
East Midlands	439	102.640	326	103.398	260	103.240
Yorkshire and The Humber	87	97.871	59	99.530	47	101.165
Total	4946	100.860	3715	100.753	2907	100.797
Acute	2992	98.603	2194	98.929	1730	99.006
Ambulance	237	101.651	237	101.651	147	101.010
Community	250	107.790	137	102.480	130	102.209
Mental health	1075	101.204	857	101.187	670	101.493
Specialist	392	112.241	290	111.719	230	111.303
Total	4946	100.860	3715	100.753	2907	100.797
Non-foundation	1465	100.284	1464	100.352	1464	100.352
Foundation Trusts	3481	101.102	2251	101.014	1443	101.248
Total	4946	100.693	3715	100.683	2907	100.800

Table V: ANOVA test to compare between the means of RCIs of regions from 2002 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7688.101	9	854.233	6.709	0.000
Within Groups	471748.910	3705	127.328		
Total	479437.011	3714			

Note: RCI= reference cost index.

Table W: Welch and Brown-Forsythe tests for regions from 2002 to 2016

	Statistic	df 1	df 2	Sig.
Welch	7.40073	9	555.095	0.000
Brown-Forsythe	6.87617	9	1258.370	0.000

Table X: ANOVA test to compare between the means of RCIs of regions from 2005 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6093.660	9	677.073	5.773	0.000
Within Groups	339797.087	2897	117.293		
Total	345890.748	2906			

Note: RCI= reference cost index.

Table Y: Welch and Brown-Forsythe tests for regions from 2005 to 2016

	Statistic	df 1	df 2	Sig.
Welch	6.94414	9	447.46	0.000
Brown-Forsythe	5.82549	9	954.877	0.000

Table Z: ANOVA test to compare between the means of RCIs of types from 1997 to 2016

Types	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	78288.147	4	19572.037	128.766	0.000
Within Groups	751018.678	4941	151.997		
Total	829306.826	4945			

Note: RCI= reference cost index.

Table AA: Welch and Brown-Forsythe tests for types from 1997 to 2016

	Statistic	df 1	df 2	Sig.
Welch	80.3701	4	712.665	0.000
Brown-Forsythe	67.7722	4	1057.660	0.000

Table AB: ANOVA test to compare between the means of RCIs of types from 2005 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31525.445	4	7881.361	72.755	0.000
Within Groups	314365.303	2902	108.327		
Total	345890.748	2906			

Note: RCI= reference cost index.

Table AC: Welch and Brown-Forsythe tests for types from 2005 to 2016

	Statistic	df 1	df 2	Sig.
Welch	47.2070	4	415.940	0.000
Brown-Forsythe	53.1367	4	989.853	0.000

Table AD: ANOVA test to compare between the means of RCIs of regions Excluding Wales from 1997 to 2016

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7612.970	8	951.621	5.715	0.000
Within Groups	814066.070	4889	166.510		
Total	821679.041	4897			

Note: RCI= reference cost index.

Table AE: Welch and Brown-Forsythe tests for regions Excluding Wales from 1997 to 2016

	Statistic	df 1	df 2	Sig.
Welch	6.604	8	1198.931	0.000
Brown-Forsythe	6.211	8	3557.647	0.000

Appendix 3

Table A. Results of OLS Regression Test of RCI Relations with Regions from 2012 to 2016

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
West Midlands	-0.115									
	(-0.133)									
Wales		-5.102*								
		(-1.837)								
South West			-1.402*							
			(-1.897)							
South East				-2.398***						
				(-3.463)						
North West					3.712***					
					(6.255)					
North East						-1.337				
						(-1.497)				
Greater London							-1.186			
							(-1.607)			
East of England								-2.383***		
								(-2.995)		
East Midlands									2.541***	
									(3.121)	
Yorkshire and The Humber										6.157***
										(3.528)
Acute	-4.719***	-4.724***	-4.105**	-4.828***	-3.915 ***	-4.770***	-4.659 ***	-4.270***	-3.982***	-5.024***
	(-3.121)	(-3.138)	(-2.669)	(-3.226)	(-2.657)	(-3.165)	(-3.093)	(-2.834)	(-2.626)	(-3.353)

Community	-2.780	-2.779	-2.296	-2.469	-2.285	-2.818	-3.651*	-2.576	-3.520*	-3.906**
	(-1.431)	(-1.435)	(-1.176)	(-1.282)	(-1.209)	(-1.454)	(-1.813)	(-1.335)	(-1.812)	(-2.002)
Mental Health	-9.338***	-9.207***	-8.560***	-8.126 ***	-9.335***	-9.651***	-10.168***	-8.930***	-8.740***	-9.724***
	(-4.634)	(-4.584)	(-4.181)	(-4.013)	(-4.769)	(-4.775)	(-4.897)	(-4.456)	(-4.354)	(-4.868)
Foundation Trusts	-1.728***	-1.829***	-1.667 ***	-1.868 ***	-1.947***	-1.589 ***	-1.763 ***	-1.733***	-1.804***	-1.840***
	(-3.263)	(-3.497)	(-3.207)	(-3.606)	(-3.835)	(-3.017)	(-3.388)	(-3.350)	(-3.484)	(-3.559)
Size	2.862**	2.854**	2.317 **	2.862 **	3.051***	3.181***	3.034***	2.625**	2.302**	3.166***
	(2.532)	(2.531)	(1.992)	(2.554)	(2.774)	(2.770)	(2.678)	(2.331)	(2.025)	(2.818)
Male Patients	0.135**	0.133**	0.152***	0.151***	0.181***	0.134**	0.110*	0.138**	0.119**	0.144***
	(2.374)	(2.366)	(2.658)	(2.676)	(3.266)	(2.372)	(1.890)	(2.446)	(2.103)	(2.568)
In-Patients	-0.423**	-0.415***	-0.403***	-0.403***	-0.508***	-0.437***	-0.494***	-0.408***	-0.447***	-0.445***
	(-4.746)	(-4.655)	(-4.489)	(-4.549)	(-5.782)	(-4.881)	(-4.978)	(-4.599)	(-5.031)	(-5.022)
Out-Patients	-0.061**	-0.059**	-0.058**	-0.043	-0.047*	-0.064**	-0.072***	-0.055**	-0.061**	-0.063**
	(-2.351)	(-2.294)	(-2.271)	(-1.644)	(-1.886)	(-2.4713)	(-2.710)	(-2.136)	(-2.382)	(-2.451)
Intercept	101.468***	101.398***	101.290***	99.753***	98.109***	101.121***	104.172***	101.189***	103.265***	100.961***
	(24.029)	(24.102)	(24.074)	(23.689)	(23.713)	(23.976)	(23.015)	(24.140)	(24.438)	(24.141)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	703	703	703	703	703	703	703	703	703	703
Adj R^2	0.09	0.10	0.10	0.11	0.14	0.10	0.10	0.10	0.11	0.11

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and regions during the period from 2012 to 2016. RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients, Out-Patients= the total number of out-patients divided by the total number of all patients. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively. Colum 1 (2 to 10) West Midlands (Wales, South West, South East, North West, North East, Greater London, East of England, East Midlands and Yorkshire and The Humber, respectively) equals 1 if the trust is located in West Midlands (other regions), 0 otherwise. t-statistics of coefficients are in parentheses.

Table B. Results of OLS Regression Test of RCI Relations with Trust Type from 2012 to 2016

Variable	(1)	(2)	(3)	(4)
Acute	0.565			
	(0.478)			
Community		0.192		
		(0.124)		
Mental Health			-4.550***	
			(-3.135)	
Specialist				3.345**
				(2.355)
West Midlands	-6.297***	-6.272 ***	-6.083***	-6.833***
	(-3.444)	(-3.389)	(-3.348)	(-3.725)
Wales	-11.721***	-11.710***	-11.110***	-12.212 ***
	(-3.759)	(-3.733)	(-3.581)	(-3.925)
South West	-7.716***	-7.651***	-7.996***	-7.790***
	(-4.394)	(-4.306)	(-4.159)	(-4.455)
South East	-8.587***	-8.586***	-7.996***	-9.031***
	(-4.903)	(-4.835)	(-4.572)	(-5.156)
North West	-3.049*	-3.033*	-2.742	-3.559**
	(-1.784)	(-1.750)	(-1.613)	(-2.075)
North East	-6.725***	-6.680***	-6.810***	-7.190***
	(-3.657)	(-3.603)	(-3.729)	(-3.902)
Greater London	-6.665***	-6.545***	-6.738***	-7.135***
	(-3.802)	(-3.654)	(-3.883)	(-4.065)
East of England	-8.448***	-8.385***	-8.151***	-8.684***
	(-4.702)	(-4.609)	(-4.565)	(-4.845)
East Midlands	-3.340*	-3.385*	-3.387*	-3.932**
	(-1.861)	(-1.887)	(-1.904)	(-2.186)
Foundation Trusts	-2.576***	-2.597***	-2.138***	-2.775***
	(-5.185)	(-5.107)	(-4.191)	(-5.623)
Size	0.374	0.627	1.379	2.019*
	(0.371)	(0.684)	(1.504)	(1.885)
Male Patients	0.209***	0.209***	0.194***	0.193***
	(3.669)	(3.670)	(3.429)	(3.391)
In-Patients	-0.342***	-0.316***	-0.489***	-0.348***
	(-4.379)	(-4.936)	(-6.010)	(-5.623)
Out-Patients	0.018	0.021	-0.020	0.008
	(0.803)	(1.001)	(-0.821)	(0.392)
Intercept	100.085***	99.209***	103.015***	97.815***
	(24.100)	(23.812)	(25.536)	(24.860)
Year FE	Yes	Yes	Yes	Yes
n	703	703	703	703
Adj R^2	0.17	0.17	0.19	0.18

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and types during the period from 2012 to 2016. RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients, Out-Patients= the total number of out-patients divided by the total number of all patients. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively. Colum 1 (2 to 10) West Midlands (Wales, South West, South East, North West, North East, Greater London, East of England, East Midlands and Yorkshire and The Humber, respectively) equals 1 if the trust is located in West Midlands (other regions), 0 otherwise. t-statistics of coefficients are in parentheses.

Table C. Results of OLS Regression Test of RCI Relations with Foundation Status and Size from 2012 to 2016

Variable	Coefficient	t-Statistic
Foundation Trusts	-2.342***	-4.540
Size	2.528**	2.218
West Midlands	-6.792***	-3.694
Wales	-11.755***	-3.783
South West	-7.567***	-4.303
South East	-8.557***	-4.856
North West	-3.403**	-1.978
North East	-7.474***	-4.049
Greater London	-7.616***	-4.246
East of England	-8.623***	-4.786
East Midlands	-3.949**	-2.209
Acute	-2.957**	-1.992
Community	-4.444**	-2.266
Mental Health	-8.151***	-3.982
Male Patients	0.177***	3.106
In-Patients	-0.559***	-5.842
Out-Patients	-0.038	-1.457
Intercept	106.515***	23.081
Year FE	Yes	
n	703	
Adj R^2	0.19	

Note: This table presents the results of OLS regression examining the association between RCI of all trusts and foundation status and size during the period from 2012 to 2016. RCI= reference cost index; Size= the natural log of number of beds available overnight; Male Patients= the total number of male patients divided by the total number of patients; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients. *, **, *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.

Appendix 4

Table A. Results of Dynamic Panel Data Estimation

Variable	Mortality Rate (1)	SDD (2)	Infection Rate (3)	Mean LOS (4)	Emergency Waiting Time (5)	In-Patient Waiting Time (6)	Out-Patient Waiting Time (7)
Mortality Rate$_{t-1}$	0.413***						
	(0.072)						
SDD $_{t-1}$		0.325***					
		(0.083)					
Infection Rate $_{t-1}$			0.075				
			(0.090)				
Mean LOS $_{t-1}$				0.664***			
				(0.116)			
Emergency Waiting Time $_{t-1}$					-0.005		
					(0.058)		
In-Patient Waiting Time $_{t-1}$						0.402	
						(0.250)	
Out-Patient Waiting Time $_{t-1}$							0.475***
							(0.124)
Cost $_{t-1}$	-0.177*	0.466**	0.027	-0.357	-0.173	20.760	-12.070
	(-0.096)	(0.231)	(0.018)	(-0.481)	(-0.207)	(15.683)	(-11.733)
Foundation Trusts	0.021	-0.128	0.016	0.302	-0.224	17.872	13.774
	(0.067)	(-0.193)	(0.014)	(0.545)	(-0.148)	(20.705)	(13.695)
Total Episodes	0.005	-0.079	0.009	0.412	0.083	-7.598	0.523
	(0.051)	(-0.103)	(0.011)	(0.259)	(0.083)	(-13.919)	(5.649)
In-Patient	0.005	-0.014	-0.002**	-0.045	0.003	-1.381	0.499
	(0.006)	(-0.012)	(-0.001)	(-0.032)	(0.010)	(-1.049)	(0.807)
Out-Patient	0.002	-0.008	-0.000	0.025	-0.004	-0.723	-0.047
	(0.003)	(-0.007)	(-0.000)	(0.021)	(-0.004)	(-0.685)	(-0.348)
Male Patient	-0.005	0.014	0.000	0.043	-0.018	-0.140	-0.326

	(-0.006)	(0.015)	(0.001)	(0.048)	(-0.019)	(-1.225)	(-0.890)
AR (2)	-1.35	-1.25	-0.83	1.24	-1.21	-0.47	-1.41
	(-0.18)	(-0.21)	(-0.41)	(0.22)	(-0.23)	(-0.64)	(-0.16)
Hansen	32.67	32.89	32.25	30.99	33.29	35.89	32.24
	(0.53)	(0.52)	(0.55)	(0.62)	(0.50)	(0.38)	(0.55)
N	596	596	596	596	596	596	596

Note: This table presents the results of system GMM regression for healthcare cost. Column 1 to 7 present the dependent variables which are mortality rate, number of same-day discharge patients, infection rate, mean length of stay, percentage of emergency patient waited less than four hours, mean in-patient waiting time and mean out- patient waiting time respectively. instruments dated t–1 was used in this estimation. The sample period runs from 2010 till 2016. Time dummy variables were included in each model. AR 2 is a test for second-order serial autocorrelation in the residuals. Hansen test is for over-identifying restrictions and it is distributed as chi-square under the null hypothesis of instrument validity. *, ** and *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively. t-statistics of coefficients are in parentheses.

Table B. Results of Panel Fixed Effect Regression of Cost_dummy Relations with Healthcare Quality from 2010 to 2016

Variable	Mortality Rate (1)	SDD (2)	Infection Rate (3)	Mean LOS (4)	Emergency Waiting Time (5)	In-Patients Waiting Time (6)	Out-Patients Waiting Time (7)
$Cost\_dummy_{t-1}$	-0.000	-0.003	0.001	-0.019	0.011	3.234**	0.705
	(-0.009)	(-0.022)	(0.001)	(-0.052)	(0.011)	(1.408)	(0.959)
Foundation Trusts	0.041*	-0.066*	0.003*	-0.123**	0.026	-1.200	-0.035
	(0.022)	(-0.038)	(0.002)	(-0.049)	(0.023)	(-2.603)	(-3.503)
Total Episodes	-0.079***	0.163***	0.006***	-0.003	-0.010	-0.397	-0.860
	(-0.026)	(0.056)	(0.002)	(-0.093)	(-0.015)	(-2.857)	(-1.306)
In-Patients	-0.003	0.006	-0.000	-0.053***	-0.001	-0.446	-0.063
	(-0.003)	(0.006)	(-0.000)	(-0.016)	(-0.002)	(-0.409)	(-0.325)
Out-Patients	-0.001	0.003	-0.000	-0.007	-0.002**	-0.296	-0.189
	(-0.001)	(0.003)	(-0.000)	(-0.007)	(-0.001)	(-0.180)	(-0.120)
Male Patients	-0.003	0.006	0.000	0.030	0.002	0.174	0.144
	(-0.002)	(0.004)	(0.000)	(0.019)	(0.002)	(0.386)	(0.472)
Intercept	1.713***	3.041***	-0.016	4.456***	1.025***	69.870**	49.846*
	(0.281)	(0.617)	(0.026)	(1.461)	(0.169)	(31.935)	(26.236)
Trust FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	558	558	558	558	558	558	558
R-within	0.039	0.032	0.056	0.087	0.267	0.040	0.229
R-between	0.004	0.001	0.000	0.135	0.185	0.005	0.054
R-overall	0.001	0.001	0.002	0.093	0.203	0.013	0.062
Rho	0.836	0.966	0.392	0.851	0.443	0.451	0.733

Note: Columns 1 to 7 are the dependent variables (i.e., mortality rate, number of same-day discharge patients, infection rate, mean length of stay, percentage of emergency patient waited less than four hours, mean in-patient waiting time and mean out- patient waiting time, respectively). Cost_dummy= lagged reference cost index of acute trusts with reference cost index higher than the average; Total episodes= the natural log of the number of episodes a trust carries out; In-Patient= the total number of in-patients divided by the total number of all patients; Out-Patients= the total number of out-patients divided by the total number of all patients; Male Patients= the total number of male patients divided by the total number of patients; Mortality rate= the actual number of deaths divided by the expected number; Same day discharge= The natural log of the number of patients who had surgery and returned home the same day; Infection rate= the number of patients infected divided by the number of in-patient episodes; Mean length of stay= the mean number of nights patients remain within the trust; Emergency waiting times= the percentage of emergency patients who were treated within 4 hours divided by the total number of emergency cases; In-patient waiting time= the number of months in-patients waited for treatment; Out-patients waiting time= the number of weeks out-patients waited for treatment. t-statistics of coefficients are in parentheses. *, ** and *** Indicate statistical significance at the p-value ≤ 0.10, ≤ 0.05 and ≤ 0.01 levels, respectively.