Returns on public capital investment – procurement, whole life cost and value in English schools and hospitals from 1997 – 2012

by

Alex Murray

A

THESIS SUBMITTED IN FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSPHY

in

THE BARTLETT SCHOOL OF CONSTRUCTION AND PROJECT MANAGEMENT

UNIVERSITY COLLEGE LONDON

March 2018

'I, Alex Murray, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

Abstract

The UK government has for many decades assumed the role of provider for a range of public services (and the assets that underpin them) considered essential to the functioning of society. Education and healthcare in England have remained almost entirely publicly funded under the administration and management of central government departments and local authorities. The need to maintain and invest in the public service assets (PSAs) that support delivery remains, regardless of whether their ownership is public or private. The business cases for investment involve social cost benefit analysis assessed against the budgetary constraints of fiscal affordability. This thesis attempts to identify the information used, and ideally required, to make decisions to invest in building schools and hospitals. The role of procurement method is considered alongside the forms of capital work (refurbishment / new build) in recent capital programmes for schools and hospitals. Theoretical frameworks for analysis of the efficacy of capital investment are drawn from the whole life cost (WLC) literature and discourses on decision making under uncertainty, contract theory and transaction cost economics. New methodological contributions on the valuation of whole life cost returns, including those from improved outcomes in the form of educational attainment in schools, are presented in later analysis chapters. Key findings include: 1) the estimated whole life cost ratio of 1 (construction) to 0.5 (operation) to 5 (staffing) for schools over a 60 year life discounted at 3.5% and, 2) a lack of association in improved educational attainment following capital investment. Further, findings suggest that given the durable nature of PSAs, along with the long time periods over which benefits accrue, there is considerable difficulty in appraising the returns to (and value of) capital investment in PSAs. Recommendations focus on the need for better co-ordination of government data on capital programmes and projects, on-going costs of operation and the outcomes of PSA users to better inform investment appraisal and programme design.

Key words: Capital investment, public service assets, social infrastructure, whole life cost and value, procurement.

Table of contents

LIST OF TABLES

List of Figures

List of Abbreviations

BE – Built environment

B&MT – Benchmarking and Market Testing

BSF – Building Schools for the Future

CAPEX – Capital expenditure

CFR – Consistent Financial Reporting

D&B – Design and Build

DBFM – Design Build Finance and Maintain

DBFO – Design Build Finance and Operate

DBOM – Design Build Operate Maintain

DECs – Display Energy Certificates

DfE – Department for Education

DfEE – Department for Education and Employment

DfES – Department for Education and Skills

DoH – Department of Health

EA – Educational Attainment

ERIC – Estates Return Information Collection

FC – Financial Close

FE – Further education

FOI – Freedom of Information

GDP – Gross Domestic Product

GCSE – General Certificate of Secondary Education

GFC – Global Financial Crisis

GIFA – Gross Internal Floor Area

HE – Higher education

HMT – Her Majesty's Treasury

IRR – Internal Rate of Return

LA – Local Authorities

LEP – Local Enterprise Partnership

MRSA – Methicillin-Resistant Staphylococcus Aureus

NAO – National Audit Office

NHS – National Health Service

NPSA – National Patient Safety Agency

NPV – Net Present Value

NQF – National Qualification Framework

OBC – Outline Business Case

OJEU – Official Journal of the European Union

OPEX – Operational expenditure

P21 – Procure 21

PB – Preferred Bidder

PDSP – Priority Data Survey Programme

PEAT – Patient Environment Action Teams

PFI – Private Finance Initiative

PPP – Public Private Partnerships

PfS – Partnerships for Schools

PSA – Public Service Asset

PSC – Public Sector Comparator

PSBP – Priority Schools Building Programme

PV – Present Value

R&M – Repair and Maintenance

SBS – School Building Survey

SPV – Special Purpose Vehicle

STPR – Social Time Preference Rate

TCE – Transaction Cost Economics

TUFA – Total Usable Floor Area

VfM – Value for Money

WACC – Weighted Average Cost of Capital

WLC – Whole Life Cost

WLV – Whole Life Value

List of Appendices

List of specialist terminology

Construction cost (or CAPEX): This includes the resource cost expenditures on building the facility, as the cost incurred for labour, materials, plant, equipment etc. It is not necessarily the sums used to finance the construction, which may have to be somewhat higher to pay for additional on costs.

Construction performance: construction performance is commonly measured against the delivery of finished building against anticipated timescales.

Funding: this term refers to the cash flow required to honour the financial liabilities incurred from investment in the facilities. For public investments, the funding source comes from future tax revenues. For private investments, the funding source sometimes comes from user charges, such as toll revenues for concession road projects. However, it should be noted that in the case of school and hospital PFIs, they remain fundamentally publicly funded, as eventual payment falls liable on the public purse.

Infrastructure**:** a definition of 'infrastructure' in this investigation aligns with that of (Fourie, 2006), where a distinction is made within infrastructure, between assets delivering public goods - excludable asset based services, where there is true non-rivalry and non-excludability – and other forms of infrastructure. Infrastructure can be conceived as a sub-set of the wider built environment (BE) that sub-divide into networks (transport, utilities) and buildings (schools, hospitals, prisons), for which the latter are the forms to be considered here. Hirschman (1958) also adds to the concept highlighting that infrastructure is characterised by its fixed capital nature. Furthermore, one can breakdown the general term infrastructure into two subsets:

- ***Social*****:** those infrastructures which promote the "health, education and cultural standards" (Fourie, 2006) of society and broadly include schools, hospitals, courts, prisons and forms of cultural capital such as museums.
- ***Economic*****:** those infrastructures which promote economic activity in terms of facilitating market transactions and related undertakings, including roads, rail, air and

sea ports, electricity generation, transmission and distribution networks, telecommunications and water.

- ***Built assets not classed as infrastructure:*** these include those that are property in the sense they can be transacted via markets, with low asset specificity and multiple alternate users.

Merit good: A form of service that is commonly considered by society to be worthy of public provision via public financing and tax funding. Education and healthcare are examples of such services as providing positive effects to society as a whole.

Operation cost (or OPEX)**:** this refers to the phase of the contract following construction when the public service asset is in use and for which use, in the case of PFI or outsourced providers, the special purpose vehicle (or contractor) is in receipt of contractual revenues.

Operational performance: performance during operations is a multifaceted concept incorporating aspect such as thermal performance of the built fabric as well as the quality of FM services (not including pedagogical clinical standards in PSA setting). An alternative to direct measures of service quality includes the contribution of operational FM to preventing asset deterioration and reducing accumulated backlog maintenance.

Output specification: an output specification is a set of required levels of service provision that are intended to specify what the client requires from the provider. They represent a shift in the basis for procurement as more formalised mechanisms for evaluating performance than earlier service level agreements.

Privately financed**:** to cover the expenses of construction resource costs, recourse has been made to capital raised through private borrowing, as opposed to recourse to public finance through the raising of gilts.

Private Finance Initiative (PFI)**:** the primary model of Public Private Partnership (PPP) used in the UK since 1992 involving the integration of design, construction, finance and long-term operation of PSAs into one contract. A special purpose vehicle (SPV) is used for their delivery as a form of project financing. The public sector contracts with the SPV. The SPV contracts

with construction and operation contractors and obtains project finance mainly from private debt providers as well as shareholders. The shareholders in the SPV typically comprise of the parent companies that are proposing to take the construction and operation contracts, plus sometimes other 3rd party investment funds. Because no one shareholding corporation owns more than 50% of share in an SPV, this allows off-balance sheet classification of accounting liabilities, with limited recourse of creditors of the SPV to the shareholder's corporate assets for the honouring of debt liabilities.

Public service assets (PSA): in this thesis, these are considered as tangible fixed asset facilities that support the on-going delivery of core public services, definable as the capital element of the factors of production applied in delivery of services. The non-capital elements include the current liabilities incurred from both:

- Employment of staff that work within the facility, be they *front line* staff in the form of doctors, nurses and teachers (staffing) in hospitals and schools respectively, or the *support staff* who clean, cater, maintain the physical facility.
- Other non-fixed forms of factors of production, in the main constituting use of utilities, and non-labour services required on an on-going basis such as materials and other current assets.

A useful classification of factors of production in economics is that of KLEMS (Capital (K), labour, Energy, Materials and Services). PSAs are proposed as the main form of K, with ongoing operational cost of various forms of the other items within this classification.

***Publicly financed*:** to cover the expenses of construction resource costs, recourse has been made to capital raised through public borrowing on capital markets, to be eventually (or possibly immediately, depending on fiscal position) publicly funded by tax receipts.

***Unitary charge payments (UCPs)*:** the contractual revenues payable to the SPV for provision of the asset in adherence to the output specification within the contract with the public client. They typically divide into a payment for making the PSA available for use, and a payment for provision of on-going facility management services.

***Whole life cost (WLC) and whole life value (WLV)*:** An approach to assessing the relative costs and benefits (value) of alternative means of provision over the life of an asset. In this case, concerning the whole life cost of PSAs including benefits over asset life and the capital resources expended on construction, as well as operational, maintenance and decommissioning costs. In practice, given the difficulty in measuring benefits, what is often done is to consider costs (WLC) at all times against a set level of service provision.

Acknowledgements

The production of the following thesis has been a challenging and very rewarding process. It would not have happened without the support and guidance of a number of individuals and organisations.

I would first like to thank the Technology Strategy Board and KPMG for funding the Knowledge Transfer Partnership that allowed me to enter this field of study. My time at KPMG under the enlightening guidance of Dr. Kai Rintala was an eye opening exposure to corporate finance practice and operational research.

The Major Project Association's financial and member engagement support was particularly valuable in providing a conduit to discuss and disseminate my emerging findings with practitioners. I am particularly grateful to Manon Bradley for her encouragement in pursuing MPA member discussions both on and off campus.

Prof. Andrew Edkins has provided continual support and always showed enthusiasm for the next stage of the research, for which I am appreciative. Other colleagues who have provided invaluable guidance include Dr. Aris Pantelias, Dr. Chen-yu Chang, Prof. Hedley Smyth, Dr. Grant Mills and Prof. Peter Morris.

There are a number of students whose research has helped advance my understanding of PFI, public procurement and capital investment programmes over the years, with their dedicated pursuit of dissertation research under my supervision. These include Habib Naderi, Amir Mohammadi, Monica Ordonez and Sam Albiston and Michael Lee – thank you for your efforts and keenness.

A number of civil servants have been instrumental in providing access to particular datasets that made much of proceeding investigation possible. To those collaborators, I am very grateful. I hope that your willingness to improve transparency and instill cooperation becomes the norm across the public sector.

My brothers have always been able to provide essential distraction from scholarly pursuits. For those I thank them. To my dear late father, my deepest gratitude for passing on an appreciation of worldly issues beyond ones own concern. To my darling wife Olivia, I am deeply grateful for your patience and understanding during the final stretch of the production of this thesis.

Finally, my eternal thanks go to my primary supervisor and academic mentor Mr. Graham Ive. Your refreshing willingness to admit an absence of knowledge contrasts with your expansive awareness of what is. Your creative imagination towards what can be will continue to inspire me for many years to come.

Chapter 1 Introduction

1.1 Capital investment in social infrastructure

The UK government has for many decades assumed the role of provider for a range of public services (and the assets that underpin them) considered essential to the functioning of society. While the provision of many public utilities such as telecoms, energy and some transport services were relatively recently transferred to market forms of provision (with commercial revenues providing the cash flows to meet private financial liabilities), education and healthcare have remained majorly publicly funded under the administration and management of central government departments and local authorities. The need to maintain and invest in the public service assets (PSA) that support delivery (including facilities such as schools and hospitals) remains, regardless of whether their ownership is public or private. The justifications used in business cases for investing in renewing existing, and in constructing new PSAs, can be sensitive to the forms of investment funding and financing. The criteria for public investment involve social cost benefit ratios and the soft budget constraint of public affordability. The key criteria for private investment concerns the possible internalised net cash flows. Whereas a private investor understandably focuses on the commercial cash flows generated by investment in assets, public authorities rightfully consider on-going fiscal and wider societal implications.

This thesis identifies the information used, and ideally required, to make efficient decisions concerning capital investment in schools and hospitals. The decision to investigate both schools and hospitals is based on a number of strategic justifications:

1. The fundamental interest of the research concerns returns from capital investment in publicly funded PSAs. The investigation of 2 types of PSAs allows the research of both common issues, as well as those that highlight the differences between schools and hospitals. These included WLC factors, such as normalised cost and their determinants, as well as the valuation of outcomes in educational and healthcare settings.
2. The investment programmes in schools and hospitals have been the most active in recent years when compared to other types of PSAs. This includes investments that have applied new forms of procurement, principally the Private Finance Initiative

(PFI), providing sufficient opportunity to observe and collate data on investments that have applied alternative procurement methods.

3. These recent investment programmes include both new building of facilities, as well as refurbishment of existing PSAs. This provides an alternative breakdown for analysis other than by procurement, so that some accommodation is made to account for, and insight drawn from, this aspect of investments. This is relevant as theory and practice suggest that new build and refurbishment investments will involve different normalised construction costs, and may be associated with different value and WLC profiles throughout asset lives.

Once the primary decision to invest has been made, the role of procurement method applied becomes pertinent in assessing the efficacy of achieving stated investment aims at pre-determined budgets. The procurement method is a secondary decision, with additional decisions nested within it, including particularly the choice of contract and specific risk allocations. This thesis develops a framework for evaluating whole life pay offs by projection from the observed early year outcomes following recent programmes of capital investment in schools. Results compare the incidence of improvements, or otherwise, in cost and performance of PSAs delivered using alternative procurement methods, including forms of privately financed investment. The theoretical framework and discussion of potential implications of alternative procurement methods is included in the literature review in sections on contracts (2.2), ownership rights (2.3), transaction cost economics (2.4) and the hold up problem (2.5). The methodology for comparisons is described in Chapter 3 and applied in later analysis chapters. Empirical analyses on the associated cost and performance of PFI and non-PFI forms of procurement can be found in Chapter 4 on construction cost, Chapter 5 on operations and Chapter 7 on outcomes. The limitations of these approaches are discussed in Chapter 8 with regards to uncertainty, and in Chapter 9 in terms of application to policy development and decision-making.

PFI involves the use of private finance for investment in PSAs and has provided an alternative procurement method in the UK since the early 1990s. As a defining feature of recent programmes of investment, much of the following work is dedicated to considering its features and role in publicly funded investment, drawing on appraisal and evaluation methods detailed in Her Majesty's Treasury Green Book (HM Treasury, 2011). The thesis also compares pay offs of different forms of capital investment between rebuild and refurbishment.

1.2 Research aims and objectives

1) **First**, establish what can be said about the ex post return on investment in PSAs.

The principal aim of this thesis is improve the evidence base of the on-going WLC of PSAs, as well contribute to the understanding and valuation of their benefits. The value of education and healthcare as public goods no doubt justify their cost of provison in aggregate, while austere times bring challenges to the efficient allocation of capital investment and on-going maintenance of the infrastructure that underpins them. At the margin, decisions about expenditure on their provision are made with imperfect knowledge of the consequences. Improving the evidence base on the results of recent capital investments will serve to inform future decisions.

2) **Second**, how choice of procurement effects WLC and the value of investment in PSAs.

There have been a small number of studies comparing construction cost and construction performance (in the main regarding timeliness of completion) of private finance forms of procurement beside conventionally procured assets (Blanc-Brude et al., 2006; National Audit Office, 2003, 2009a). However, there is limited work on comparative operational cost and performance. A key intention of this work is to develop methods for comparing the operations of privately and publicly financed PSAs. These empirical comparisons will serve to test the assertion that procurement method is a significant determinant of both construction and operational cost and performance.

3) **Third**, how choice of form of investment expenditure (new build or refurbishment) effects WLC and return on investment.

The form of capital works contracted for by public clients for build or remediation of PSAs varies considerably between complete new build on green field site, to light refurbishment of existing buildings. Where data permits, comparisons between sets of facilities that have undergone different forms of capital works are made to assess whether this aspect bears upon PSAs operational cost and performance.

For clarity on scope, it should be stated that this thesis is not primarily concerned with policies of the employment and management of the *front line* staff delivering public services. However, commentary will consider how the design, construction, management and maintenance of their work environments may impact upon their productivity in providing service outputs and outcomes. It is important to point out that the employment of frontline

staff across the regimes of management of PSAs remains, in the main, in-house as public authorities typically employ the teachers, doctors and nurses directly. These include local education authorities, schools, healthcare trusts and other decentralised bodies in the case of social infrastructure.

A key intention of the thesis, apart from collating available operational data, is to identify where data gaps still exist for improved ex post economic evaluation of investment programmes, leading to propositions of how closing those gaps may ultimately inform future ex ante appraisals. The key beneficiaries are intended to include PSA commissioners, UK government (specifically the Treasury), the National Audit Office (NAO), commercial investors in and operators of such PSAs (for means of their own benchmarking) as well as the academic community interested in furthering research into publicly funded capital investment programmes.

1.3 Methodological approach

To achieve the above research aims, two approaches are pertinent. The first is based on collection of primary data via observation and measurement of the unit of analysis (that of PSAs as discrete facilities), entailing live observation, surveying and questionnaires of those involved in these investments. The second approach is founded on a secondary data approach, requiring the collation of already existing data on the units of analysis. The latter is preferred and applied in this study for two principal reasons:

- Commercial confidentiality: this greatly restricts access to direct observation of PFI operated assets, as does the difficulty of accessing many PSAs specific cost and value metrics.
- Coverage: A primary data collection method may limit the coverage any study may achieve, regardless of the previous point, due to limits on research resources and the willingness of respondents to provide data.

The research method developed around what data was publicly accessible, and semi-publicly available, via freedom of information requests and collaboration with public authorities. The goal was to develop good methods for comparisons of operating cost and performance incorporating appropriate economic approaches given the data that was accessible on large samples of PSAs.

On amassing data concerning project finance projects, Debande (2002) noted then that data had yet to be amassed, as there had not been sufficient PFI contracts in the operational phase for data to be available. That is no longer the case, and this research has sought to commence amassing the relevant data to begin to answer the research questions proposed above, with a specific focus on the role of procurement on the on-going WLC and performance of PSAs.

1.4 Pay-offs from capital investment

Regardless of the form of financing for investment in PSAs, from a rudimentary economic point of view, the benefits of investment in assets can be considered as either:

- 'cost savings', resulting from negative effects on-going cost of operations of the asset (lower input facility / staffing costs) for a similar level of provision
- positive effects on the quality and / or quantity of outcomes (revenues in a commercial sense or social outcome improvements from a social perspective);

These pay offs provide the logical basis of the case for capital investment in PSAs, regardless of how they are proposed to be financed or procured. The ability to appraise these anticipated benefits of investment ex ante is subject to considerable uncertainty. This is especially so concerning the achievement of outcomes given the greater complexity of causal determination of such social goals as educational attainment in schools or patient outcomes in hospitals, when compared to commercially assessed investment, where cash flows are more calculable, if still somewhat uncertain.

At this early point, it should be stated that whilst the financing of capital investment concerns who pays at the beginning, the funding of investment, which concerns who pays in the end, can only come from two sources:

- User charges – the commercial revenue stream of purely private ventures to pay off private finance
- Tax funding – the fiscal revenue stream to government from taxes, either directly to pay costs as they arise or pay off public debt finance or private finance

1.4.1 Business cases for investment

The business cases for investments where there is are market prices for the outputs, are typically quite different from those in social infrastructure. In the former, the focus for calculation of future net revenue flows (determining the return on investment) is on two key components:

- Price: the predicted future market price for the homogenous unit of output (e.g. mega / gigawatts in the case of energy generation);
- Quantity: the capacity of the facility to produce units of output (in the main, a predictable function of the technological solution applied).

Investment often seeks to achieve a combination of benefits from increased output and lower operating cost. It is nevertheless useful to divide investment into that which adds to capacity, and that which replaces existing assets. Compare a power generation facility example to the prospects of investing in schools or hospitals, where neither the price or quantity have easily discernable meanings, let alone monetary values to attribute to them. This results, in part, from the lack of any commercial user revenues. Rather, these facilities are funded, at least in the UK, via a 'free at the point of need' fiscal arrangement. This creates difficulties in estimating purely financial business cases for investment in social infrastructure.

Guidance on the creation of business cases is provided by HM Treasury, with a recent development in their specification coming from the 5 cases model (HM Treasury, 2014). The 5 stages include: *strategic* case as the basis for change, the *economic* case as supporting the VfM of the proposal, the *commercial* case assessing viability, the financial case relating to affordability and the management case considering successful delivery. Business case development is not intended to be a single stage effort, with continual assessment to assess fitness.

> "There should be an iterative process with the department in order to develop satisfactory proposals but it is also permitted to reject a Business Case that you believe represents a poor strategic option, is unaffordable or represents poor value for money."
>
> HM Treasury, 2014, p. 1.

1.4.2 Particularities of investment in social infrastructure

The challenges of appraising and evaluating capital investment in PSAs are compounded by a number of particularities specific to their context:

1.4.2.1 Cost savings

Beside the effects of investment on outputs and revenues, there are also implications for on-going costs of PSA operation and management. The size of operating costs relative to capital investment sums will vary by type of facility in the first instance (see table 2.1), and then by specifics of operational regime in the second. Regardless, they can represent the majority of the WLC of depending on the asset type (Goh and Sun, 2016), hence why much of the claimed benefits of investment in assets comprises of reduction in these on-going costs. It is these perceived benefits in reducing WLC upon which much of the case for PFI procurement methods lie, hence their consideration within this work. While the real present value of operating cost after discounting will be significantly lower (depending in part on their profile over the life of the asset and the discount rate applied), their recurrent and risky nature are important factors on the net present value of PSA investments.

Within WLC frameworks, operational costs can be broken down into those that relate to the management and maintenance of the PSA (F – facility), and those that are attributable to the delivery of front line services in such PSAs (S – Staffing), S, normally being greater than F over the life of the asset.

First costs are another set of costs to be acknowledged when considering capital investment. *First costs*, include all those costs required to deliver the capital investment such as certain design costs and other forms transaction cost incurred by parties on both sides before any capital investment (or construction resources costs) are expended. Given the prevalence of relatively bespoke investments (more so in hospital facilities than schools) total first costs should be considered in order to provide a fuller appraisal of return for the public sector in delivering capital investments.

1.4.2.2 Temporal dimension of social outcomes

Whereas a commercial venture would expect to start generating revenues very soon after completion of the asset, the prospects for any return resulting from investments in PSAs are

more distant and hence uncertain. While it may be possible predict the nominal value of a graduate's benefit from a better education or a patient receiving better healthcare, the real present value depends heavily on when that person is able to apply the non financial benefit resulting from consumption of the service, with the associated fiscal pay offs. Even if a power plant and a school had the same asset life, the returns from the use of a school would cover a longer period and for this reason alone be more uncertain. This is because the benefits of the asset are realised over the sum of the asset life and the period over which benefits are accrued by the beneficiaries (users of PSAs). The case of a hospital is similar in that benefit of healthcare provision can be accrued for many years. A power plant's output is consumed in the present and the value is captured in those years' GDP.

1.4.2.3 Valuing externalities in absence of markets

A fundamental difference between the business case for commercial (private) and government (public) investments concerns the extent to which each are able to internalise the wide-ranging forms of pay offs. Commercial ventures have little regard for the additional benefits realised by consumers of their output above and beyond the price consumers pay for their use (consumer surplus), or for benefits to persons other than its consumers (such as property value increases and improved labour mobility from private investment in transport infrastructures). Conversely, much of the business case for public investment focuses on these wider externalities. The social benefits of healthier or better-educated populations will in part be captured by the *consumers* of public services in the form of higher lifetime incomes. This increment in incomes can, in principle, be measured and attributed as a private return to public investment in human capital. However, other parts of the social benefit comprise (a) benefits to those *consumers* not reflected in their income (including benefits to their well being) and (b) benefits to the *rest of society* from having a more productive workforce, such as marginal productivities in excess of the additional salaries or wages. The difficulty with assessing these externalities lies in the lack of timely market transactions as a basis for their valuation, other than labour markets, for the internalised benefits of improved human capital. As such, this research uses the enhanced incomes attributable to those with higher levels of education as the principal basis for assessing the value of improved outcomes from capital investment in school PSAs. This aligns with the Green Book's identification of improved human capital as the amenable outcome resulting from investment in education provision (HM Treasury, 2011).

1.5 Public sector gross investment

The figure below provides a useful context for first, considering historic publicly funded investment against GDP. As is clear, there is a striking reduction over time as a percentage of GDP in the level of aggregate public investment, although there has been some resurgence since the late 1990s trough. Secondly, as is also clear, despite PFI delivering billions of pounds of investment through the period leading up to 2010 (yellow line), as a proportion of all government investment it is relatively small. This should be borne in mind when considering the overall effect of PFI in the delivery of PSAs.

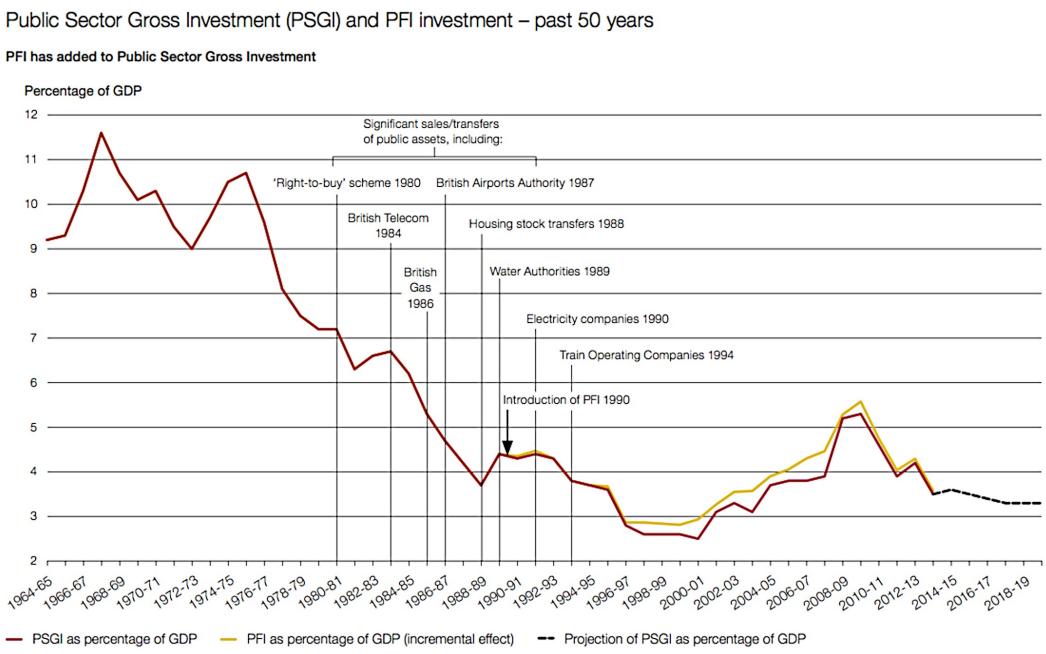


Figure 1-1: Public sector gross investment and PFI investment from 1964. Source: NAO, 2015, fig. 1.

1.6 Procurement

1.6.1 Strengths and weaknesses of different procurement methods

Using the degree of fragmentation as a basis for classifying the range of procurement methods, a summary of generally accepted strengths and weaknesses for this categorisation of procurement methods is presented below.

Table 1-1: The strengths and weaknesses of alternative procurement methods. Source: Adapted from Edkins, Ive and Murray., 2011a, p. 98.

Procurement	Strengths	Weaknesses
Fragmented: Separate procurement for design, build, and operation & maintenance contracts (D+B+O)	1) Choose separate tailored parties for each phase 2) Greater flexibility for client	1) Can take longer to deliver with opportunities for disagreement Opportunities for difference between bid prices and out-turn costs and delivery times *2) Cost of flexibility -* *3) Ambiguous responsibility for failure to perform*
Partially integrated: Single contract for design and build, separated from operation (D&B+O)	Reduced contracting so lower transaction costs Single point responsibility Incentives for communications between D & B to improve *buildability* Allows use of output specification	1) Reduced input from client in design process 2) *Buildability* may be achieved at cost of operational performance 3) May be harder to measure key outputs than to measure inputs
Fully integrated: Design, build and operation wrapped up together into one contract	1) Fully incentivised to devise WLC savings between D, B & O Risk transfer, client does not pay if agreed service / availability is not delivered	Inherently inflexible beyond contract close Risk transfer can be costly
Fully integrated <u>with</u> finance: Design, build, finance and operation e.g. PFI (DBFO)	As above but with incomplete contracting for post contract eventualities via residual control rights to the SPV Access to private capital for public infrastructure	Higher cost of private finance

PFI is a procurement method for the commissioning of serviced PSAs. It involves the private sector securing the initial finance required for the construction of fixed capital assets. A PFI contract sees a private sector Special Purpose Vehicle (SPV) take responsibility to design, build, finance and operate the facility under one single contract, hence PFI agreements are referred to as DBFO or *integrated* contracts. Responsibility for on-going facility maintenance (operations) is passed to the SPV under the long-term contract.

Procurement methods of different degrees of integration / fragmentation offer different and inconsistent benefits to the purchaser (Ive and Chang, 2007). The purchaser should consider what aspects they place the greatest importance on achieving before then deciding which procurement route will deliver them greatest value against their desired goals. Further, different procurement methods deal with different risks more effectively – the choice of procurement method should be aligned to the risks to which particular projects are most exposed. Three key aspects in this area concern:

1) Number of contracts
2) When the contracts are signed
3) Whether the contract is written on specification of inputs (material used), outputs (built asset capability) or performance (including operations e.g. availability for use)

Construction clients suffer both hold-up (Chang and Ive, 2007) and quality measurement problems (Ive and Chang, 2007). The essence of the hold up problem concerns the ex post power of the contractor, following contract signing, to extract prices in excess of cost for variations from client-induced changes. The extent of this power depends on the contractor's cash flow position, relative to that of the client, part way through the project. PFI reduces the contractor's power be eliminating interim payments by the client, as the client only commences payment on commissioning of the PSA.

On the quality measurement problem, by making the constructor (and project company, which it part owns in the case of PFI) bear the consequences of inferior quality (lower service payments on unavailability and / or higher maintenance and life cycle costs), PFI can claim to be superior at solving the problem that some construction contracts give the contractor a perverse incentive to *shade* construction quality.

The role of the NAO as the auditors of central government departments and public agencies places them at the heart of evaluating the use of PFI and value for money (VfM) or public procurement generally. With their unique ability to access otherwise sensitive data from those organizations who are majority tax funded, they have produced numerous reports that provide objective evidence as to the cost and benefits of PFI procurement. Their report on Performance of PFI Construction (2009a) report found PFI contracts were delivered on time more frequently and not subject to the additional costs associated with more traditionally procured projects. These additional costs for the client in non-PFI projects, in part a result of the hold-up power of a contractor in later stages of procurement and construction, were on average close to the average higher contract price of PFI construction (Blanc-Brude et al., 2006). This suggests the additional premium paid for PFI fixed price construction reflects the construction risks passed to the provider under a PFI, with the strong incentive to deliver to time and quality that such contracts exhibit compared to traditional procurement methods. The fact PFI contracts are structured such that payment for provision of serviced facilities is only made following completion and commissioning serve to explain why PFI projects tend to deliver construction on time more frequently than alternative procurement methods. This credible risk transfer in PFI construction is well evidenced (National Audit Office, 2003, 2009a), yet equivalent examinations of the operations of PFI and traditionally procured facilities have remained elusive. This is a key area where this thesis seeks to contribute.

However, PFI also makes the client particularly vulnerable to opportunistic pricing of pre-contract changes introduced by the client at the preferred bidder stage (Armstrong, 2005). This is the form the hold-up problem usually takes in conventionally procured construction projects following contract signing. It therefore will tend to be a good choice for the public client in cases where: there is little risk of requiring changes; where the quality giving attributes of an asset are capable of objective measurement and can be linked to contractual payments; and where facility operation costs do not depend on occupiers' behaviour, so that the contractor can take full operational cost risk. PFI will also tend to be a good choice where the constructor has strong reasons not to take advantage of client vulnerability post contract signature, because they are trying to build a reputation and thus be selected (out of many competitors) to bid for future PFI projects (Ive and Rintala, 2006). This is relevant where the public client has an active public programme (particularly the case in the UK leading up to 2010) and where the number of competitors is fairly high (arguably not the case over the period of PFI's early development).

The VfM achieved by the client on the contract in excess of alternative procurement options will depend on, amongst other things, the extent to which:

- investment in operations is pursued and achieved by the contractor delivering PSAs
- competition in the procurement process distributes these anticipated efficiency savings to the client via reduced UCPs
- the cost of capital used to deliver the project is higher than cost of public finance

In summary, the defining characteristics of PFI contracts are; their long duration, their scope (to integrate design, construction, operation and finance within one contract), their incentives (linking payment to measured availability and performance relation to output specifications), and their ring-fencing of funds intended for maintenance of the fixed asset element of these PSAs (NAO, 2003).

1.6.2 Contracting for operational cost and performance

PFI has arguably been the single most influential example of the public sector moving from contracting serviced assets by input to output specifications. This is to say, rather than specifying the labour or capital resources allocated to provision, they directly specify the level of service (and availability of built assets) contracted for. Towards the end of the 1980s service level agreements (SLAs) began to be used more widely by commercial sectors, as an early attempt to specify the level of service provided by private contractors. Their use spread to the public sector, and could be considered an early form of output-based specification in as much as they can be described as an agreement on service. While they can be legally binding, this was not common.

Output specifications are based around the clear definition of the level of service to be provided. They are descriptive of the key characteristics that clients consider drive quality in service, for example, how long is required to clean up a spillage on a hospital ward or what temperature and lighting conditions are required for a class room to be considered *available* and warrant the availability payment. They are not intended to be prescriptive of how the service is delivered, for example, they do not require routine inspections for minor incidents to become apparent or for heating systems to be turned on at a certain time to ensure adequate temperatures in class rooms.

The long-term nature of PPPs brings another complexity to this issue of better knowledge about delivering the required service at lowest cost. Bidders do not just rely on their own expertise in construction to select and price a construction solution, but also their knowledge of asset operational cost and performance to select a service provision solution to an output specification requirement. This is where many diversified facility construction and operation contractors will benefit from economies of scope within their own firm, in terms of providing similar services across many more markets that just government. These operations, and the information derived from them, provide significant informational advantages when bidding for long-term contracts. Many PFI SPVs have contractual interfaces through separate construct and operation contractors, in which case part of the final VfM of the project will depend on how well these parties are separately and jointly incentivised through the SPV.

1.6.3 UK government procurement processes

Appendix 1 provides a summary of the processes involved in the alternatives of public and private financing of capital investment. The prominence of the Treasury as the ultimate approver (or not) of capital allocations is notable. This makes clear that the alternative to PFI investment involves making use of the Debt Management Office and Public Works Loans Board (with it's lower associated public finance cost of capital), but only with approval from Central Departmental sign off, and even then, within the agreed 3-5 years budgets set as part of government fiscal management processes.

Appendix 2 provides a description of the alternative processes required for public versus private financing in the capital investment decision process. A stark contrast is observed between the restraints placed on public finance budget cycles, and the limits this will place on additional capital investment, and the more flexible (if less transparent) process to approve allocations for use of private finance. The need for ex ante appraisal of a project's performance if it were to use private finance is of great importance, however the lack of transparency of this process for approving PFI has been noted by numerous stakeholders, not least the NAO. It is true that 'is this a good investment' question still fails to be answered – what the local bodies were not realising, is that it was no longer a grant, rather permission to spend with on-going liabilities attached to it.

This level of centralisation was not always so. In the earlier part of the 20th century, much of the local authority administrations financed their own investments. In the decades following

WW2, along with the creation and growth of the NHS, the financing of investment in PSAs was brought towards the centre, with a tendency to ration the dedication of resources along policy lines. This created a system where applications from local authorities for capital allowances fought for central monies, rather than necessarily prioritising those projects which had the greatest benefit to cost ratio. The widening of the intended use of the Green Book in 2003 to local authorities cemented this trend of centralised control over capital allocations, while improving the advice local authorities received on how to appraise future capital projects. This guidance suggests there is a real potential rate of return on projects, and effort should focus on attempting to maximise this. If proposals can show evidence that they will pass some *hurdle* rate of return (however notional), they will attract capital funding. This rate of return likely differs significantly between departments (little comparison is undertaken between different sectors, but rather within them). In reality, publicly financed capital commitments remain essentially rationed by the centre. Deakin and Walsh (1996) suggest:

> "Policy is made at the top of the organization by the purchaser, and put into effect at the periphery by the provider, operating according to a contract, which includes a clear statement of standards. The approach is one of centralization and decentralisation at the same time."
>
> Deakin and Walsh, 1996, p. 36.

In calculating cost and benefit, assessors are required to make some estimation of the benefits offered by some procurement methods (including PFI) of the transfer of risk on capital and operational cost. This value of risk transfer has been the basis for much of the preference for PFI type procurement, while the value placed on this transfer has been 'curiously… almost exactly what was needed to tip the balance in favour of undertaking the PFI mechanism' (Shaoul, 2005).

1.6.4 Current PFI portfolio

At 2013, PFI was being used to deliver over 728 contracts for a wide range of PSAs. These have already delivered, or are due to deliver before the end of 2015, projects with a combined capital value around £54bn[1] (unindexed). Longer-term liabilities in present value terms for this

[1] PFI signed projects list, HM Treasury, 2013. There were very few additional contracts signed following the 2012 policy review up to 2018. These included 5 PF2 contracts (4 school contracts and 1 hospital contract) and are not included in these statistics.

portfolio of projects, as at 2013 is approximately £177bn liable on the public purse[2] (author's estimate). Appendix 3 provides some useful summary statistics on the use of PFI by department and type.

Using data from the HM Treasury PFI signed projects list, the following figures illustrate the historic capital investment in hospitals and schools respectively. The numbers presented are in nominal terms and show, beside the sectoral investment, total investment in all PFI projects to provide a sense of the proportions of all PFI that hospital and school projects make up.

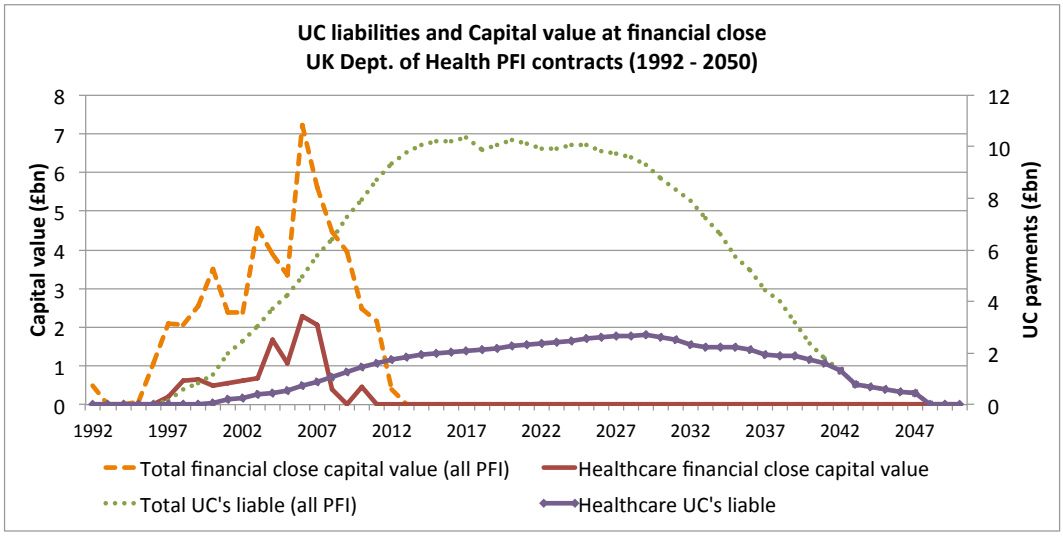


Figure 1-2: PFI capital investment and unitary charge contingent liabilities for Department for Health commissioned projects. Source: HM Treasury 2015, Author analysis

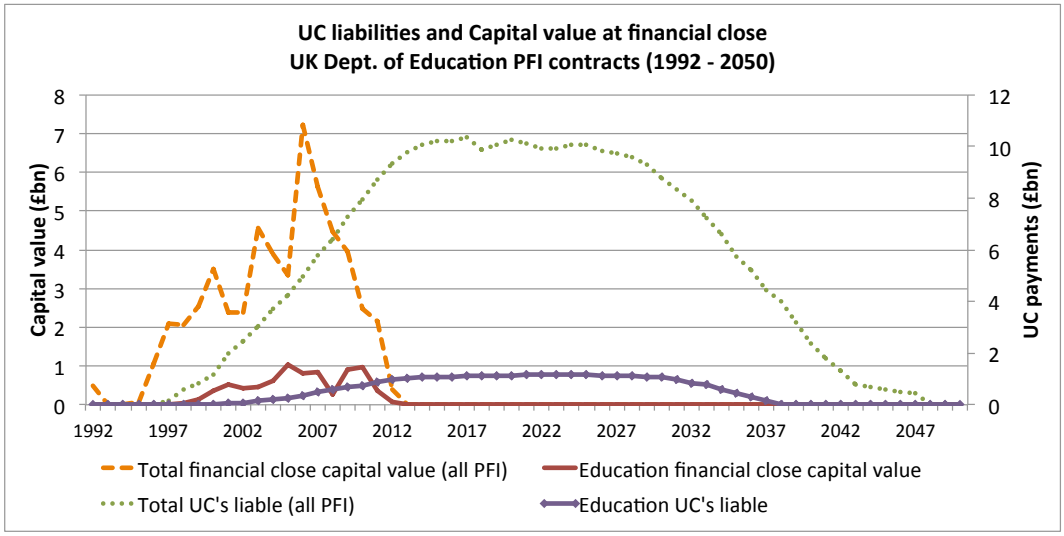


Figure 1-3: PFI capital investment and unitary charge payment contingent liabilities for Department of Education commissioned projects. Source: HM Treasury 2015, Author analysis

[2] Discounted (at 2.5% RPIX) cash flow of all liabilities under Unitary Charge payments

As can be seen, historic investment in healthcare projects via the PFI procurement method is greater than that witnessed in schools. What is also apparent from the above figures is the long-term liabilities the portfolio of PFI projects has amassed chargeable to the public purse. Notably, from 2041, all liabilities due on the current portfolio of PFI are for healthcare projects, whereas liabilities for education projects cease around 2038. This reflects longer contract periods in healthcare PFI contracts.

Contract periods typically range from around 25 to 35 years, with the weighted average contract length by capital value being around 27 years (HM Treasury, 2015a). The considerable length of the contracts provides credible potential for transfer of a range of operational risks, as well as the upfront construction / development risks. Despite the widespread use (with combined annual flow of public sector UCPs at approximately £9.7bn in 2013/14) and long term nature of PFI as a procurement method, there has been little empirical research concerning objective measurement of the on-going cost and performance of the these PSAs at the project level, and even less benchmarking of this against alternatives. This thesis seeks to contribute to filling this gap.

1.6.5 Transaction costs and price creep

Transaction costs during procurement are large, with evidence suggesting UK procurement practices lead to higher costs than international comparators (see table 1.2 below). These costs can perhaps be reduced by centralization of procurement. This should particularly be the case with centralised procurement units within the Ministry of Justice for prison projects and for Highways England for roads (Construction Industry Council, 2000). One constraint on reducing procurement costs for other types of projects, especially schools and hospitals, will have been the decentralised nature of these clients. The vast majority of NHS Trusts will have procured only one, at most two, PFI hospital projects. This limits the potential for learning and efficiency in future procurements and provides greater opportunity for price creep during the procurement process, and especially beyond preferred bidder stage (Armstrong, 2005).

Private sectors bid costs (as a % of capital value)	UK	Canada	Australia
Average project value	**US$150m**	**C$350m**	**A$250m**
Winning bidder	5-6%	0.5-1.5%	1-2%
Each failed bidder	2-3%	0.35-1.0%	0.8-1.2%

Table 1-2: Estimated bid costs for PPP procurements across UK, Canada and Australia. Source: KPMG, 2010a.

Transaction costs are in part a function of procurement period. In PFI, the procurement period is relatively long and procurement costs relatively high. In PFI, the whole period from OJEU to Commissioning is around 4.65 years. This breaks down into the period between OJEU to FC (2.9 years, 62%) and FC to commissioning (1.75 years, 38%). Time series analysis of procurement leads times is available in Appendix 4. It would seem the main impediment to more prompt delivery of these projects is the procurement period. Clients not having properly thought through project requirements before commencing procurement is cited as a major cause of delayed procurement (NAO, 2003).

1.7 Refurbishment versus rebuilding

The long economic lifespans of schools and hospital estates and their historic public provision of social PSAs means, when compared to other sectors, they have much larger legacy estates. The impact of this is such that a larger proportion of capital investment in social infrastructure is not applied in the provision of new facilities, where capacity is the often the primary benefit, but rather refurbishment / rebuilding of existing facilities, where modernisation of existing built assets becomes the primary goal in terms of improving fitness for purpose.

The story becomes more complex when one considers the form of investments being made. A useful extract from the recent NAO report summarises a major issue in the appraisal of government investments arising from the less than perfect accounting procedures applied.

> "When departments record capital expenditure there is no distinction between that used to build *new assets* and that to repair or renew *existing assets*. This means that it is difficult for the government to know how much capital expenditure departments require simply to maintain assets in their current condition for business-as-usual maintenance, or to observe how changes in capital expenditure affect different sectors. We estimate that under half of departmental capital spending is for constructing new assets. By contrast, *nearly all private finance investment* is used to construct new assets."
>
> NAO, 2015, p. 17.

This concern about the appropriate use of capital budgets as between R&M, renewal and new assets is something that PFI is supposed to deal with, by anticipating the need for capital

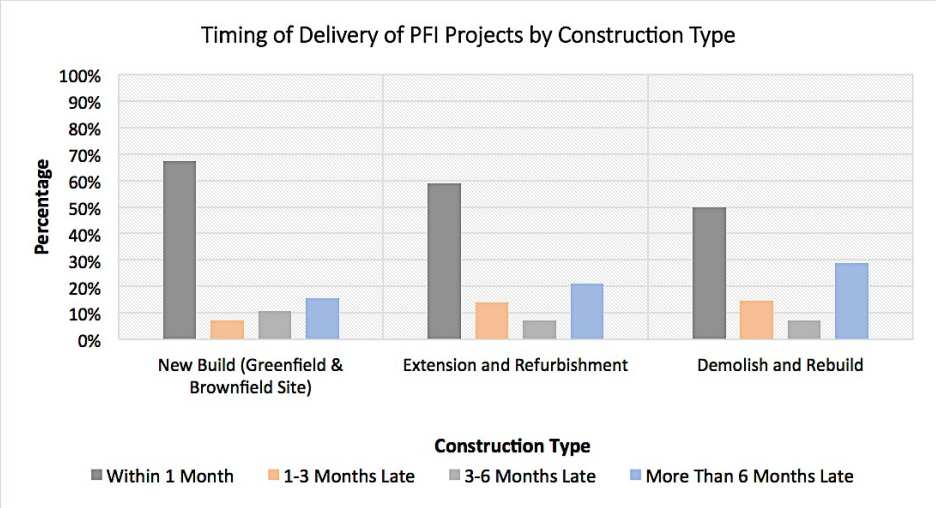
renewal investment upfront, and charging for this in the UCP. Chidambaram (2013) supports the idea that much more could be done for increasing infrastructure productivity via maintenance, repair and renewal than new investment, except for the fact political systems seem to reward investment in new projects. Further, looking specifically at roads, Rioja (2003) models investment in new assets against maintenance expenditure finding that re-distributing funds used for investment in new assets to maintenance of existing ones has positive effects on output. Departmental current budget do contain sums for maintenance. However, backlogs of under maintenance lead to need for major repair for which money has to come from capital budgets.

The tendency for PFI to have been used predominantly in new build projects, rather than more complex (and unpredictable) refurbishment projects, suggests this procurement method is more suitable when the client has an ex ante preference for a new facility. PFI has been applied in refurbishment projects, but from an estate owner's perspective, it may prove better for VfM to retain certain risks for which particular procurement methods struggle to provide appropriate institutional and incentive structures.

1.8 Type of works and time delays

Compared to refurbishment projects, where the existence of certain risks may lead to cost overruns, including the potential discovery of asbestos, the actual complexity of new build projects is arguably less. In this context time and cost commitments can be made with greater surety, pertinent in a fixed priced, time sensitive PFI contract. This is apparent in an analysis of the data behind the NAO's 2009 study into PFI construction performance. Accessed via freedom of information request (FOI) and detailing 114 PFI projects over various sectors delivered up to 2008, this data reveals notably less variance in the time delay associated with new build works compared to extension and refurbishment or demolition and rebuild projects.

Figure 4.6 (N=114, *n*=101)



Note: 13 projects are missing from this analysis because they had no responses in the NAO dataset

Figure 1-4: Timing of delivery of PFI projects by construction type: n = 101. Source: Naderi, 2015, figure 4.6.

1.9 Value for money comparisons

To place the following investigations into the effectiveness of recent programmes of public funded investment in PSAs, including those involving PFI compared to more conventional forms of procurement, the view of the NAO concerning the availability of data for operational assessment highlights the challenge faced:

> "We have yet to come across truly robust and systematic evaluation of the use of private finance built into PPPs at either a project or programme level. The systems are not in place to collect comparable data from similar projects using different procurement routes. Unless such systems are established, together with robust evaluation of the overall whole-life costs of alternative forms of procurement, Government cannot satisfy itself that private finance represents the best VFM option."
>
> NAO, 2009, p. 8.

The NAO recently restated this desire for more transparency on the use of private capital in PSA investment. It is proposed this level of transparency is required before fuller evaluations of programmes of investments can be achieved.

> "Improve the transparency of capital spending data. Trends in historical and forecast capital investment, and in the mix of financing and funding models, would be more readily observable if government reviewed the various public data sources and increased their consistency and completeness, which may support long-term planning."
>
> NAO, 2015, p. 10.

Throughout the literature there is disconnect between the ex ante business case appraisal for the use of PFI and ex post evaluation with operational data. The NAO provide further evidence that undermines the ex ante business case and approval for use of PFI, suggesting that the model used for assessing VfM in PFI projects fell short and fails to enable a comparison of private finance to government borrowing (National Audit Office, 2013).

1.10 Fiscal context

To provide some wider context on the headline fiscal positions over the long term, figure 1-6 below was produced using macroeconomic data from the Office of Budgetary Responsibility (2017). The figure shows the post war period in the UK is characterised by increasing investment in assets up towards the end of the 1970s. This included much investment in public housing. The increasing stock of public assets is indicated in the increasing levels of depreciation. This consistently decreases throughout the 1980s, in the main resulting from sale and privatisation of publicly owned assets, for which the depreciation will be recorded on private corporations financial statements. From 1997, there is a consistent increase in public sector net investment until the austerity period following the GFC, which include investments in those PSAs to be considered in this thesis. The temporary spike in public sector investment just following the GFC is partly a programme of Keynesian stimulus to reduce the impact of dramatic falls in demand for construction and other sectors. Depreciation continued to rise in recent decades and may be considered a reminder that investment in assets mandates their maintenance in preventing deterioration and obsolescence.

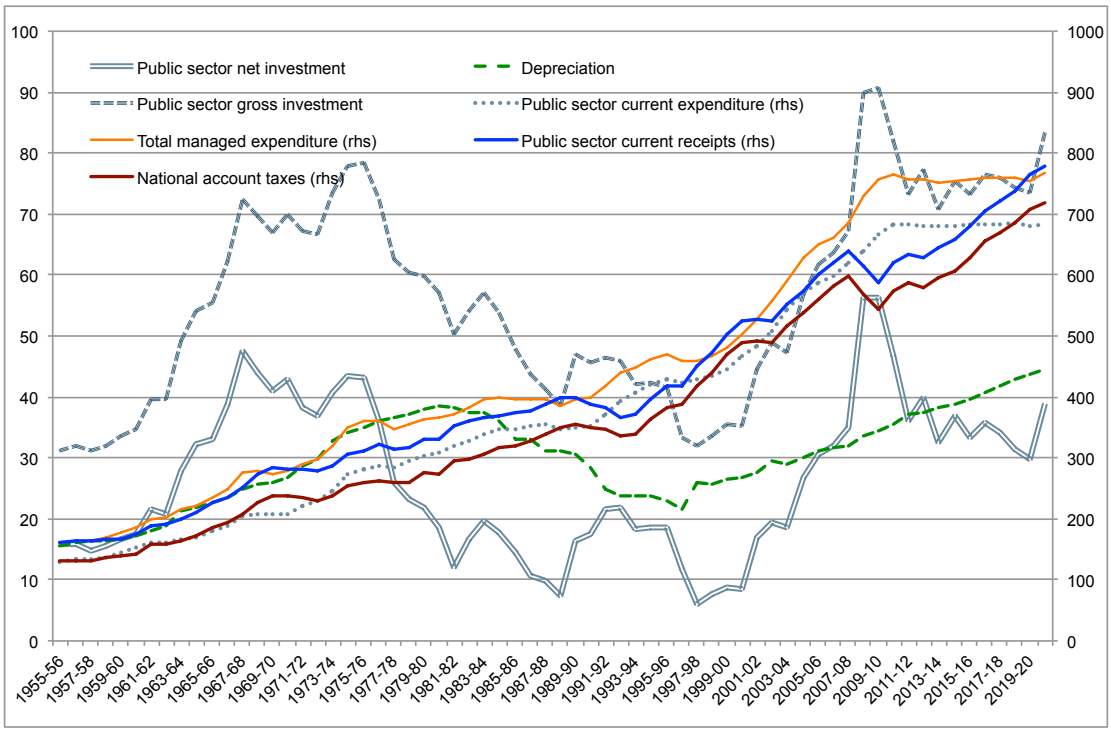


Figure 1-5: Key fiscal stocks and flows (1955 - 2015, forecast to 2020) 2015-16 prices (£bns). Source: OBR, 2017. Author analysis.

A further comment on the divergent rate of change in public sector current and investment expenditure follows, with the key point that funding of PFI investments relies upon on-going resource budgets, as opposed to the capital budgets required for conventional (non-PFI) forms of procurement:

> "If departments have insufficient budget to fund the construction of an asset, private finance may sometimes be the only option for investment. Publicly financed investment requires a large upfront capital and cash budget to fund an asset's construction. Private finance requires a commitment to make regular payments from the resource budget over a longer period (25 to 30 years) once the asset is built. Health and Education have used private finance to increase their capital investment more, in percentage terms, than other departments. The resource budgets for both departments have risen consistently, whereas their capital budgets have been more volatile and cut significantly in recent years."
>
> NAO, 2015, p.8.

1.11 Cost of capital

As stated, the cost of capital for SPVs higher than government's cost of capital on public financing. Appendix 5 shows how government borrowing costs since 2000 have averaged somewhere just above 4%, and lower in more recent years following successive rounds of loose monetary policy. Compare this to table 1-3 following indicating debt financing costs of PFI projects, with a typical cost of 6.5% on schools deals. An approximate weighted average cost of capital for PFI might reasonably be between 7% - 9% at project conception, with the finance provided by equity attracting anticipated internal rates of return (IRRs) between 12-15%.

Figure 4
Comparison of interest costs on PFI projects

	Standard Deals		Large Deals		
	Pre crisis	Post crisis	Pre crisis	Post crisis	
Key costs	Sample projects (2007)	School sample (2009)	FSTA (March 2008)	GMW (April 2009)	M25 (May 2009)
Level of project risk	Various	Low	High/medium	High	Medium
Interest rate margin (%)	0.79	2.51	1-1.15	3.25-4.50	2.5-3.5
Total interest cost (%)	5.9	6.9	5.9-6.1	7.7-8.91	6.9-7.9
Increase post crisis (minimum) (%)	–	+18	–	+31	+17

NOTES
1 The indicative level of project risk shown above illustrates the fact that the projects are not directly comparable. The change in interest margin percentages partly reflects this.
2 The Future Strategic Tanker Aircraft (FSTA) project raised funding of £2.5 billion. Greater Manchester Waste (GMW) borrowed £582 million.
3 The increase post crisis will rise with stepped increases in the interest rate margin if refinancing (see Glossary) does not take place.

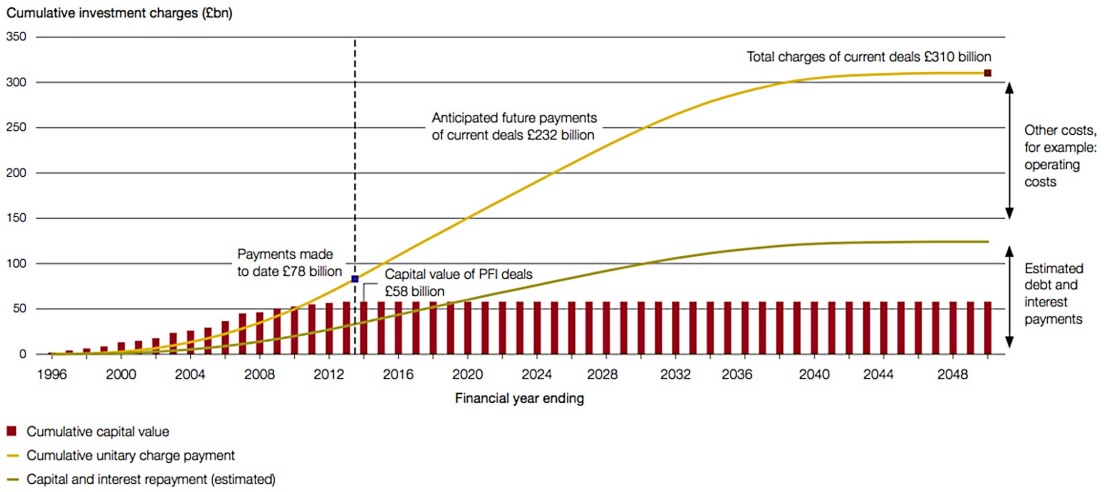
Source: KPMG and National Audit Office

Table 1-3: Comparison of interest costs on PFI projects. Source: NAO, 2010, fig. 4.

Another useful analysis produced in the NAO's report (2015) includes figure 1.7 below. This illustrates the accumulated capital value of investments, future unitary charge liabilities and estimated capital and interest charges as a sub-element within the total unitary charge payments. Reflecting on the relative magnitudes of these expenditures (yellow and green lines), it is difficult to conceive that PFI can offer VfM based upon the considerable excess the government will pay for use of private capital. From a programme level perspective, these expenditures suggest *significant* savings in operational services must be realised against non-private finance options to counter the higher finance cost.

Figure 10

Cumulative private finance investment and charges over time for all current deals (£ billion)



Notes

1 Capital and interest repayment is estimated to be 40% of the unitary charge.

2 Capital value of all current PFI deals is £58 billion. If more projects are signed, anticipated charges would increase.

Source: HM Treasury PFI database (updated 15 December 2014)

Figure 1-6: Cumulative private finance investment and charges over time for all current deals (£bn). Source: NAO, 2014, fig. 10.

However, for the pure comparison of weighted average costs of capital, one should arguably not use simply the government borrowing cost as the benchmark against private capital applied in PFIs. This would be appropriate if all PFI deals were of an average risk profile when compared to the portfolio of other government activities currently being financed by public gilts. In reality, this is not the case. It is hard to comment conclusively on how much more or less risky PFI investment projects are to *business as usual* government activity. What can be commented on concerns the evidence on the extent to which PFI projects seem to manage delivery risk better compared to government activity. This will be explored in proceeding chapters.

1.12 Thesis structure

Following is a summary of the structure of the thesis with brief indication as to what can be expected within each chapter:

- Chapter 1 – Introduction:
    - Setting out the context for public capital investment, including the challenges of assessing the ongoing cost and performance from investments in PSAs.
- Chapter 2 – Literature review
    - Reviews of the literature on what economic factors are commonly cited to bear upon capital investment and procurement decisions. WLC frameworks are explored as the basis for later work, with evidence of the cost and benefits of alternative procurement methods prior to and including PFI considered. Finally, this chapter considers literature on risk and uncertainty, relevant for the long-term durable nature of PSAs and the outcomes they support.
- Chapter 3 – Methodology
    - An outlining of the approach, methodological perspective and theoretical frameworks to be applied, as well as considerations of analytical scope, data sources, their validity and reliability. This chapter introduces proposals for how alternative procurement methods may influence WLC substitution between construction and operations as the basis for more specific research questions.
- Chapter 4 – Construction
    - A critical review of the construction costs of social infrastructure PSAs, including a range of analyses on data collected for this investigation, as well as observations of recent construction cost analysis produced by others. This includes recent advancements in construction cost measurement from the UK Government Cabinet Office.
- Chapter 5 – Operation
    - A critical review of the operational costs of social infrastructure PSAs, including a range of analyses on data collected for this investigation, as well as observations of facility management services, maintenance and staffing costs produced by others.
- Chapter 6 – Whole life cost
    - A summary chapter on the findings over the 2 preceding chapters, this section reflects on the implications of findings across facility construction and operations

representing PSA WLC. Some additional commentary serves to explore how WLC frameworks are potentially useful in ways that alternatives are not.

- Chapter 7 – Outcomes
    - A critical review of the outcomes observed in social infrastructure PSA investments, including empirical findings, modeling of their value and proposed methods for monetary valuation for future work where data has been found to be poor. Reflections on what developments are required to study the role of capital investment in healthcare PSA outcomes are posited.
- Chapter 8 – Return on investment
    - Analysis of the benefits achieved from PSA investment from both reduced operational cost and improved outcomes relative to investment cost. This chapter further contributes to the consideration of returns from investment in PSAs within risky and uncertain future *states of world*.
- Chapter 9 – Conclusions
    - Summary of thesis main findings, policy implications and guidance for how to improve evaluation of PSA investment programmes, with a view to informing better ex post evaluation for future ex ante capital allocations and decision making.

1.13 Thesis contribution

The main contributions made by this thesis can be summarised as:

- **Methodological contribution** - options and thresholds method for valuing outcomes in education as a key contribution – as a method it could be applied to interventions other than in education. It provides a way of going from quantity changes in EA, to a method for valuing changes in outcomes following capital investments. For applicability of this method it demands that the underpinning data required namely 1) proportion of people at different levels of education and 2) the wage up lifts associated with each level of education. Another significant methodological contribution involves the method developed to observe on-going operational
- **Empirical contribution** – findings on the stylised WLC ratios for schools of 1 (c) to 1 (f) to 5 (s) at 3.5% discount rate sets a benchmark for secondary comprehensives against which further studies can be compared. This is also a contribution in terms of

providing assessors of the business cases for schools capital investment can judge the proposed savings from investment in operations.

- **Procurement** – comparisons of the WLC of operating PSAs suggests that procurement has limited association with either higher or lower cost to the public sector, against the notion that PFI's integrated form of contracts incentives investment in operations. The relevance of procurement method does bear out when looking at individual services, such as catering in hospitals where private provision (PFI or outsourced) is associated with lower cost and equal or better quality of service.

Chapter 2 Literature review

A range of literatures will inform the perspectives on theorising and interpreting the issues involved in capital investment in PSAs. A common theme concerns dealing with costs and benefits extending into the distant future. The first set of theory that underpins the thesis concerns the relevance of WLC as an essential framework for the consideration of *costs in use* of PSAs. These frameworks are applied and built upon through this work with the important addition of concepts of value from observed outcomes. Additional theoretical support is found in the fundamental questions posed by institutional economics. Institutional economics is relevant here given the importance of contracts for PSA provision, which can be seen as a form of economic institution that allows public service providers to outsource provision. This may include purchase of operational services or for integrated construction and whole life delivery, or other permutations on period, risk transfer and scope. Given the pertinence of long-term contracting in the procurement of PSAs, transaction cost economics provides additional perspective on which to base questions and assess results. The key concern here is with transactions of extended duration, with relevant operational costs (inputs) and performance (output and outcomes) occurring into the distant future. The final set of literature attempts to introduce the reader to decision making under risky and uncertain future states of world, and apply this to public investment in and procurement of social PSAs.

- **Whole life cost** – to understand the assessment of WLC between projects, a framework for WLC concepts is presented and literature on life cycle costing considered. WLC as a concept for individual facilities relies on considering costs in the very long term and as such demands a consideration of long term factors in cost determination.
- **Institutional economics** – these works discuss the determination of a firm's scope in deciding which of those activities it requires to produce its output are deemed to be within its *in-house* domain, and which are better *outsourced* to an external firm. It has been the preference for the outsourcing of public investment in PSAs over the preceding three decades that requires consideration of the optimal form of procurement for particular capital investments.
- **Contracts** – this literature provides us with an important perspective on contract negotiation and ability of contracts to assure (or not as the case may be) both sides of achieving (and having delivered) their agreed terms. This is the most important set of literature when looking specifically at operational issues, especially with PFI projects, whose most fundamental economic characteristics are found within that important unit of

analysis, the contracts underpinning SPVs. An important aspect that this literature introduces is the consideration of ownership rights, and hence, residual control rights in uncertain futures.

- **Transaction Cost Economics** – closely related to the above is a set of literature concerning the economic framework within which transactions are made. Commissioning capital investment entails transacting with constructors and operators, a transaction that is typically low in frequency, high in asset specificity and relatively uncertain when compared with other types of investment. Contracting for longer-term operation brings its own problems with regard to TCE principles, as explored below.
- **Risk and uncertainty** – given the long-term durable nature of PSAs in receipt of capital investment, one is required to consider the future that they will continue to provide public services in.

2.1 WLC framework and developments

A useful definition of the WLC of buildings is provided by Addis and Talbot (2001).

> "The present value of the total cost of that asset over it's operational life. This includes initial capital cost, finance costs, operational costs, maintenance costs and the eventual disposal costs of the asset at the end of it's life. All future costs and benefits are reduced to present day values by use of discounting techniques."
>
> Addis and Talbot, 2001, p.1.

Ive (2006) lays down a framework for estimating the WLC for facilities, applying this to London commercial offices. The main costs are classified under construction cost (C), facility management cost (F) and final service provision (business operation) cost (S). These latter two categories are analysed in the proceeding chapter but discussed below within this WLC framework. Importantly, this approach makes sure to consider WLC as the summation of a range of costs incurred over long periods of time discounted to present value for means of like for like comparison and interpretation within investment evaluation frameworks. Such comparisons can be made within samples of similar types of facilities, as well as using average

indicators between different types of facilities to provide insights on the typical WLC profiles of different types of PSAs.

In London commercial offices, undiscounted ratios are found to be in the area of 1/3/30 (C / F / S), assuming a 20-year economic life (asset life) for the building. These results become 1/1.5/15 if future costs are discounted at a 7% real cost-of capital discount rate (Ive, 2006). Ive concluded, in such facilities, construction costs were much more substantial relative to facility management and business occupancy costs than previously widely cited literature (Evans et al., 1998) which suggest a 1/5/200 ratio. Other studies, such as Hughes et al. (2004), have offered strong support for the finding that the 1/5/200 ratio put forward by Evans is profoundly misleading. The basis for the ratios in Evans et al. (1998), and the findings in Ive (2006) are summarised as Tables 2.1 and 2.2, reproduced from Ive (2006).

Table 2-1: 'Example' of 1/5/200. Source: Ive, 2006, tab. 1a.

Gross floor area of the building (m^2)	Occupation density (gross m^2 per person)	Number of persons	Construction cost/gross m^2	Total construction cost of the building (*C*) over a 20-year life	Total *C* per year	*C*/m^2 per year	*c* per person per year	Total *c* per person over a 20-year life
10 000	10	1000	£1000	£10 million	£500 000	£50	£500	£10 000
				Total employment cost of the building (*S*) over a 20-year life	**Total employment cost (*S*) per year**	***S*/m^2 per year**	***s* per person per year**	**Total *s* per person over a 20-year life**
				£2 billion	£100 million	£10 000	£100 000	£2 million
				Total facility management cost of the building (*F*) over a 20-year life	**Total facility management cost (*F*) per year**	***F*/m^2 per year**	***f* per person per year**	**Total *f* per person over a 20-year life**
				£50 million	£2.5 million	£250	£2500	£50 000

Table 2-2: Resource costs to all parties, without discounting: not 1/5/200 but rather 1/3/30. Source: Ive, 2006, tab. 4.

	C per person per year	*F* per person per year	*S* per person per year
1. As in Evans *et al.* (1998)	£75/net m^2 per year (£1500 construction cost/net m^2 depreciated over 20 years) 6.66 net m^2 per person '*c*' per person per year = £500	£375/net m^2 per year 6.66 m^2 net area per person '*f*' per person per year = £2500	£100 000 average salary cost per person
2. Replace Evans *et al.*'s figures for FM costs/m^2 by those from Axcell *et al.*'s (2001) broad-based empirical study, of £330/m^2 of NIA		'*f*' per person per year = £330 × 6.66 = £2200	
3. Allow more generous space per person; allow 14 m^2 NIA (equivalent to 21 m^2 gross)	'*c*' per person per year = £75 × 14 = £1050	'*f*' per person per year = £330 × 14 = £4620	
4. Use Davis Langdon and Everest (2000) data for construction cost, of £1500/gross m^2 of floor area, equivalent to £2250/m^2 of NIA	'*c*' per person per year = £112.5/m^2 per year × 14 = £1575		
5. Alternative (source: Actium Consult (2002); see the text) figure for average salary cost in Central London offices			£45 000
6. Ratio	£1575	£4620	£45 000
7. Headline	1	3	30

NIA, net internal area.

The decision on the discount rate here is, as ever, important. This is arguably more so in the context of publicly funded capital investments in PSAs where considerably lower discount rates are justifiable, given the government's own weighted average cost of capital. This will tend to decrease the magnitude of C relative to F and S from WLC perspectives, as the present value of F and S is subject to lower discounting. Consequently, public investors in and operators of PSAs have a greater need to consider the WLC implications of investment in C for reductions in future F and S.

The analyses presented over the following chapter assert that 'this common framework can be applied to analyse data and calculate mean ratios for buildings of any function' (Ive, 2006, p. 230), and applies similar methods to data obtained from various sources for English secondary comprehensive schools. Data on hospitals is considered, but a lack of consistent and reliable data across the cost framework concepts precludes empirical investigations on sufficiently large samples of different types of hospitals.

In addition to applying the above framework, attention is given to developing a sense of the change in cost concepts following capital investment. Unlike the operational facility and staffing costs (F & S), construction expenditure constitutes a somewhat binary cost (present or not) typically at a single point in time, save for infrequent lifecycle allocations relevant in

considering PFI operations. Facility and staffing costs are observed and assessed as changes relative to those observed before capital investment, allowing a move away from WLC ratio averages to changes (deltas, Δ) in the presence of samples of one off capital investments across many facilities. This change from a focus on aggregate levels of C, F and S demonstrates a move away from resource budgeting to investment appraisal considerations, where the application of capital investment is seen as one way to reduce WLC on C, F & S.

2.1.1 Modelling assumptions

Over the years, there have been notable developments of standards regarding the terminologies, procedures and benefits of life cycle costing and WLC approaches. The most recent iteration of the International Organization for Standardization (ISO) on life cycle costing (ISO 15686-5:2017) was released in August 2017, providing a comprehensive set of terms and concepts in applying WLC approaches. While these resources are useful in the front end planning and appraisal of capital investments, their applications are limited in informing the use of operational data to inform evaluations ex post. Figure 2-1 below demonstrates that much of the scope concerns the earlier phase of investment planning and design. There is less detail on the post construction phase with regard to how empirical data of operating assets can help evaluate investments, or indeed go on to inform future investments.

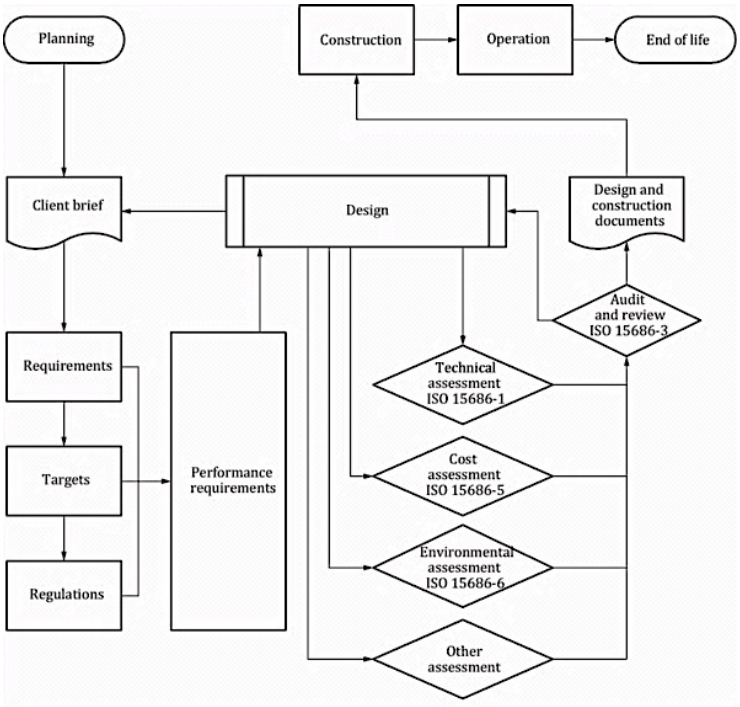


Figure 2-1: Performance requirements in the context of the project life cycle. Source: International Organization for Standardization, 2017.

A recent paper tracing the development of life-cycle costing techniques in academic sources compares the assumptions made in a range of different WLC modeling studies (Goh and Sun, 2016). Table 2.3 below illustrates how key parameters between studies vary significantly, making like-for-like comparisons between different studies and methods difficult. This same study finds that many WLC studies have been undertaken on housing and office buildings, with very few undertaken on public buildings. This review cites one study on hospitals (Kirkham et al., 2002) which looked at the running costs only in the absence of reliable capital expenditure data on hospital buildings. This summary of studies clearly demonstrates there is no one standard approach to WLC methodologies and that each must be suited to the particularities of the facility being considered.

Table 2.3 also serves to demonstrates that while there have been a number of empirical studies of the WLC of buildings generally, the vast majority of these have been on commercial buildings, supporting the relevance of PSAs studied in this work. Further points to raise from this source include the variance in both the asset life spans assumed, the capital expenditure relative to operational expenditures, as well as the discount rates applied. These are of course related issues in the complex process of estimating WLC. Higher discount rates applied to the operational costs of buildings in use will increase the proportion of overall construction cost relative to WLC. Despite this, the above summary of studies suggests there is wide ranging proportion of construction costs even between studies with similar discount rates applied.

The absence of long time series data on the on-going operational cost of facilities is an area the literature commonly cites. Records on the long-term costs of buildings over many years and types are all but impossible to find, and what is available is often less than wholly reliable. This is not surprising given that only recently has the focus on WLC incentivised facility operators to collect such data (Rintala, 2004). The relevance of using past operational cost data for anticipating future costs is also questionable, given that old working patterns and management regimes may not persist. Further, if the quality of data about historic operating cost is poor, this must in part undermine the process of valuing potential reduced costs from changes in the way facilities are operated or indeed built.

Table 2-3: Summary of assumptions for key input parameters and results from life cycle costing studies. Source: Goh and Sun, 2016, tab. 3.

Table 3 Summary of assumptions for the key input parameters applied to life-cycle costing (LCC) models

Publication S/N	Author(s) (year)	Type of building	Location	Sample S/N	Assumed lifespan (years)	Assumed capital cost (as a % of life-cycle cost)	Assumed running cost (as a % of life-cycle cost)	Assumed discount rate (%)
1	Ive (2006)	Commercial	UK	1	20	6%	94%	7%
2	Pellegrini-Masini et al. (2010)	Residential		2	25	63%	37%	3.5%
				3	25	58%	42%	3.5%
				4	25	16%	84%	3.5%
				5	25	61%	39%	3.5%
				6	25	20%	80%	3.5%
				7	25	68%	32%	3.5%
3	Flanagan et al. (1989)	Institutional		8	30	38%	62%	2%
4	Wong et al. (2010)	Commercial		9	60	25%	75%	4–10%
				10	60	28%	72%	4–10%
5	Wong et al. (2010)	Commercial	Malaysia	11	60	19%	81%	4–10%
				12	60	21%	79%	4–10%
6	Tuhus-Dubrow and Krarti (2010)	Commercial	US	13	30	50%	50%	5%
				14	30	34%	66%	5%
7	Kshirsagar, El-Gafy, & Abdelhamid (2010)	Institutional		15	38	12%	88%	6%
				16	38	62%	38%	6%
				17	50	39%	61%	6%
				18	50	48%	52%	6%
				19	109	41%	59%	6%
				20	109	62%	38%	6%
8	Aye et al. (2000)	Commercial	Australia	21	25	44%	56%	10%
				22	25	63%	37%	10%
9	Gurung and Mahendran (2002)	Industrial		23	50	65%	35%	11%
				24	50	54%	46%	7%
				25	50	46%	54%	5%
				26	50	60%	40%	9%
		Commercial		27	50	49%	51%	7%
				28	50	55%	45%	9%
				29	50	60%	40%	11%
				30	50	42%	58%	5%
10	Bromilow and Pawsey (1987)	Institutional		31	100	59%	41%	6%
11	Mithraratne & Gabe (2010)	Institutional	New Zealand	32	25	45%	55%	7%
				33	50	29%	71%	7%
				34	75	22%	78%	7%
				35	100	18%	82%	7%
12	Mithraratne and Vale (2004)	Residential		36	100	42%	58%	5%
13	Bogenstätter (2000)	Commercial	Italy	37	95	24%	76%	2%
14	Sacks, Nisbet, Ross, & Harinarain (2012)	Commercial	South Africa	38	20	17%	83%	2.2%
				39	20	29%	71%	2.2%
15	Wang, Zmeureanua, and Rivard (2005)	Commercial	Canada	40	40	75%	25%	9%
				41	40	80%	20%	9%
16	Cook (1997)	Commercial	Not stated	42	25	25%	75%	Not stated
17	Wang, Wei, and Sun (2014)	Residential	Not stated	43	30	31%	69%	Not stated

Considering these WLC frameworks in the context of procurement, the following clarification is pertinent.

> "The major change in the use of whole life costing techniques in the context of PFI is that it is applied only to the costs the ProjectCo incurs for service delivery over the life of the DBFO contract."
>
> Rintala, 2004, p 71.

This reminds us of the limited scope of PFI contracts over the wider WLC of PSAs, including their construction (C) and operation (F), but not their staffing (S).

2.1.2 Cost classification

There is an important distinction to be made between resource costs and financing costs in the context of long-term investments. Resource costs should be counted when they arise, but regardless of who incurs them:

> "Resource costs are the quantity of scarce resources (with alternative uses) used in the project, multiplied by the average opportunity cost of those resources. [. . .] The key distinction is between resource costs and financing costs. [. . .] The resource costs [. . .] of a project should be invariant to its method of financing. The latter [. . .] is subsumed under the discount rate (. . . at which the project's future resource cash flows will be discounted to present value)."
>
> Ive, 2006, p. 236–237

Both forms of cost are often estimated for purposes of project appraisal ex ante, and are incurred over long periods of time (and are thus inherently uncertain in their value). The project is considered to end either when the flow of output and outcomes end, or when the built asset is abandoned and/or redirected to a new use and/or replaced, whichever comes sooner.

In the UK public sector the distinction between what in textbooks are called respectively 'financial' and 'economic' appraisals is known as that between 'resource budgeting' (affordability, actual cash flows of the public sector body; how the project will be funded) and

'appraisal' (total costs and benefits, including externalities, valued at opportunity cost) (HM Treasury, 2013). The analyses proceeding over the following chapter considers both.

The extent to which risk can be transferred from the public to the private sector depends on a range of considerations:

1. extent to which specifications and standards of the asset (input) or service (outputs) can be defined
2. ability to put in place objective measurement systems to accurately determine if contractual performance has been achieved
3. extent to which payment can be contingent on performance specified in a contract
4. extent to which private capital expenditure can be realised before payment to maintain incentives for delivery
5. *extent of equity share*
6. *extent to which debt is at risk of default of payment*
7. *extent to which in case of private sector default or failure, losses fall back upon the public sector, either because non-provision is not an acceptable option, or because votes will continue to hold the government responsible for service non-performance*

2.2 Contracts

The relevance of contracts for understanding PFI is paramount, as well as for public capital investment generally. The basis for the valuation of a project financing business rests largely on contracts that secure the flow of inputs and outputs for the firm, determining it's expected profitability (Yescombe, 2002). This need for reliable contracts brings us to the issue of how *complete* contracts can be in an uncertain future world, and hence where residual risk lies in events not covered in the scope of contracts. PFI contracts involve the SPV taking on a range of risks associated with operational services, including those surrounding the on-going cost of operation of the PSA across the long-term life of the contract.

The apportionment of responsibility for failure of service or payment over such long-term contracts forms a key area for determining risk. Given that the transfer of much of this risk is considered a key benefit of PFI (National Audit Office, 2007), the specifics of risk allocation within the contracts for rare but high impact events will be important in determining the price charged for the contract. Indeed, many such risks can be and are transferred via insurance,

but residual risks will need to be very clearly defined in the contract to ensure proper risk transfer. Some useful commentary on this area comes from a specific paper on the economics of PFI:

> "In a world of efficient capital markets, full information, and complete contracts, the ownership transfer between the public and private sectors should have no economic effect. In practise, contracts cannot be complete and capital markets may not be perfect, so there is considerable scope for economic impact to arise as a result of the specific ownership and contractual structure."
>
> Grout, 1997, p. 56

> "If contracts can always be written to replicate any reward scheme, then it should not matter whether we have the same entity building, owning, and providing services, or have different entities with public ownership. The difficulty with this argument is that it assumes that contracts can always be complete in the sense that every eventuality can be covered and, therefore, incentives are not a problem."
>
> Ibid, p. 63.

There have been wider programme assessments of PPP against conventional procurements, albeit typically on a sector by sector basis (Blanc-Brude et al., 2006; Edkins et al., 2011b; Ive et al., 2010; KPMG, 2010; Murray et al., 2014; Wang, 2008). Blanc-Brude et al. (2006) found European PPP road ex ante construction prices to be on average 24% higher than conventionally procured projects, while noting that this differential corresponds roughly to the observed ex post overruns in traditionally procured projects, where construction cost risk is not transferred. The paper points out the inability to comment conclusively on WLC comparisons, as data is not available over the whole lives of assets., The result presented above, whereby PPP construction cost is greater by and large because of the transfer of construction risk, echoes findings of the NAO on the performance of construction in PFI projects, whereby responses to surveys supported that the risk transfer minimised price creep against contracted values (National Audit Office, 2009a). Further, where there were price increases, this was often down to the occurrence of risks held by the public sector, for

example from increased costs from delays in planning processes for waste treatment facilities, as well as the finding of asbestos in refurbishment projects.

One of the underlying principles of PFI procurement is that it enables and incentivises '*investment in operations*'. The SPV is the legal entity contractually liable to deliver the PFI project, backed up by key delivery partners typically as combination of contracts and equity investors. The use of SPVs is crucial in providing the sponsors with off-balance treatment and hence limited recourse by lenders to their own corporate assets. The capital and operational costs are at the discretion of a single agent, the SPV. They are thus in theory able to internalise the interdependencies between construction and operation of a built asset via one contract between them and the public client (Hart et al., 1997; Iossa and Martimort, 2008). The incentivisation comes in the form of higher residual profits on the UCP revenue stream if they are able to achieve a lower WLC (Rintala, 2005). The UCP is the predetermined price for the contract paid in periodic installments subject to adequate service provision. A key feature of the UCP in UK PFI is that a *'significant'* proportion of the payment must be *at risk* subject to quality of provision of predetermined output specification (ONS, 2006). This operational risk comes in many forms, dependent on the terms of the contract. It was required to be *significant,* represented by a minimum 20% of the UCP that must have some deductible element based on contractual performance, including elements relating to availability and service quality. This risk transfer allowed the government to classify liabilities on such contracts not as determined financial liabilities but rather as contingent on contractual performance. This avoided the requirements to place the significant sums of committed liabilities on the government balance sheet for national accounting purposes. As a result, this lead to the use of PFI as a means to deliver investment without the normal increases in the public sector borrowing requirement (PSBR) associated with conventional publicly financed procurements. In more recent years, criticism of this approach has led government to acknowledge the significant liabilities under PFI contracts (House of Commons Treasury Committee, 2011). Now, nearly the whole portfolio (over 90%) of projects are recorded as on *balance sheet* under International Financial Reporting Standards (IFRS), yet only a small minority (around 10%) are on balance sheet under the European System of Accounts[3].

The extent to which *investment in operations* can achieve lower WLC (this previously being a contractual externality, under separate construction and operational service contracts), will

[3] Augmented PFI signed projects list HM Treasury (2013)

depend on the interdependencies between capital and operational resources in delivering a specified service over the life of the contract (Frontier Economics, 2012). These will of course be incurred over time and will need to be considered in present value terms for comparison. This pay off will in part depend on the particular characteristics of the capital asset being invested in (Ive and Rintala, 2006), with their realisation determined by the knowledge the SPV has concerning WLC efficiencies and their ability to deliver them.

In light of these incentives one would expect SPVs to pursue design solutions that minimise WLC. This is especially the case for soft FM services given their large share in the charge under the UCP[4]. The longer-term competitiveness of these service contracts is as yet unclear given the infancy of these projects from a WLC point of view. The bulk of PFI projects are yet to have completed, and / or have undertaken and made available the findings of benchmarking and market testing exercises. Any loss in equity returns resulting from inflated operational contract prices will only in part be felt by the equity-owning delivery contractor, those being shared with other equity owners. The delivery contractor will wholly appropriate the gains in terms of higher revenues for operational contracts. This creates a moral hazard for the contractor to extract profits from operational contracts, rather than wait for future financial return on equity. The relevance of this point is limited by the extent to which equity owning contractors deliver these services. These are often sub-contracted to other providers, bringing with it further complexity in the management and delivery of VfM.

The ability of the operator to realise lower WLC from investment in operations is arguably higher concerning elements of hard FM, given that the functional on-going R&M cost of building performance is determined to a much greater extent during construction. Put another way, the interdependency between construction and hard FM operations is much stronger than with soft FM. This is in part why hard FM services are not subject to such strict tests of continuing competitive provision (National Audit Office, 2007).

Hodge and Greeve (2009) undertake a useful review of attempts to assess the effectiveness of PPP projects. They summarise the conflicting findings of around 25 studies, which range from

[4] Soft FM services are those services, usually labour intensive, which operate within the facility to support front line service delivery e.g. cleaning, catering, laundry, portering, security etc. They typically account for around 25% of the UC in a full scope hospital PFI contract, but this will vary somewhat between projects. As a case in point, consider one type of project that has proved popular in recent years for PFI, that of public street lighting, which will involve relatively little conventional *soft FM* provision, and so more *hard FM* maintenance type operational expenditures.

qualitative case studies of small numbers of projects (ACCA, 2004; Pollock, 2002; Pollock et al., 2007) to attempts to undertake programme wide quantitative analysis of samples of projects (Allen Consulting Group, 2007; Blanc-Brude et al., 2006; Mott Macdonald, 2002; Nasir, 2007). However, the authors state, "there have been no-meta analyses or statistical reviews of multiple quantitative PPP performance results to date", and "the data being used for these studies have, to put it politely, been dirty". While this thesis is not looking to provide meta analyses of current studies, a principal contribution includes the use of objective metrics for quantitative assessment of large samples of projects procured via PFI and conventional means. Hodge and Greeve go on to highlight that in assessments of PPP to date, very few have tried to incorporate a proper 'counterfactual', in the sense that there is rarely a good conventional (non-integrated) procurement benchmark against which to compare PFI cost and performance. Another pertinent point raised concerns that fact that of those studies which attempt to look at comparing cost, many rely on the ex ante costs anticipated at project evaluation stage (early on in the procurement), rather than a consistent use of ex post outturn costs as paid by the client or employer (in the case of in-house). The proceeding analyses have the benefit of hindsight in this regard. The collation of disparate datasets and a focus on facility level analysis (benefitting from variably good unique identifiers), allows us to observe cost and performance during the operations of alternatively procured PSAs.

2.2.1 Innovation

One of the principal arguments in favour of PFI comes from the supposed higher levels of innovation private providers achieve in the delivery of long-term PSAs. Hart (2003) suggests the lack of vertical integration between the client and provider incentivises innovation during operations in PPPs, as savings can be realised for the providers' benefit in terms of increased profit for the SPV. When innovations are pre-envisioned during the tendering, some of the benefits will be passed on to the client (assuming they are able to foster sufficient competitive tension during procurement). When innovations are not pre envisioned, the provider is more likely to reap more of the reward of later cost savings. Furthermore, Leiringer (2006) suggests innovation is more likely to occur if it has scope for application elsewhere, by reducing risk exposure to an uncertain single 'investment in operation'. Hart (1997) concedes that the freedom and incentive to innovate comes at a cost in terms of opportunity to shade on quality, as the provider's investments are non-verifiable. The economic case for PFI rests on the prospect that taking decisions about investment (be that for new assets or their maintenance) out of public hands has potential for more efficient decision-making.

In providing the SPV with a certain enough context in which to realise minimised WLC throughout a 25 plus year contract, there is however, a trade off in the flexibility of scope and standard in the operational services provided (HM Treasury, 2008; NAO, 2008). Some question the ability of PFI to deliver efficiency gains in sectors where the quality of the infrastructure cannot so directly reduce operational cost (including cost of provision of final services), such as in forms of social infrastructure, as opposed to say transport and water (Iossa & Martimort, 2008).

The potential for innovation in traditional tendering is arguably limited given the focus on price. On this, De Valance comments:

> "the traditional tendering process used by construction industry clients has them typically select on price and not pay for innovation in particular or intellectual property in general. This does not allow tenderers to appropriate the benefits of knowledge, thus removing the main incentive to innovation identified by endogenous growth theory."
>
> De Valance, 2010, p 57.

This is applicable to PFI given it is a fixed price form of contract, but also arguably not so as the fixed price element relates not just to construction but also operations. This makes the 'contractor' in whole life procurement the principal beneficiary of construction innovation in terms of reduced cost (and hence higher residual profit on the UCP) to deliver the PSA. The higher cost of private financial capital used to deliver PFI projects is a major impediment for the net value of these returns from investment in operations (Public Accounts Committee, 2011). Investment in operations remains a option for publicly financed projects, if such institutional practices could be instilled and delivered within public commissioning bodies (Mumford, 1998; Palmer, 2000).

Even if opportunities do exist for SPVs to reduce WLC through investment in operations and innovation, some comment that financiers, and specifically the providers of bank debt capital, are sufficiently risk averse that proposed novel design solutions will be precluded on their request, due to their risk aversion to non-traditional, proven technologies, or, arguably worse, debt will be excessively priced (Rintala, 2005). The overall affect of this is detrimental for WLC

if innovations cause the WACC to increase significantly through higher priced debt. Rintala (2005) begins by suggesting:

> "The client's use of PFI procurement and, thus, task integration improves the ProjectCo's opportunity to minimise CWLCP. This is because the fragmented and sequential traditional procurement creates contractual and organisational barriers between the private sector actors, which come under a single DBFO contract in PFI procurement. In addition, some of the private sector actors that are involved from the inception of PFI project development are only introduced to traditional service provision at a stage when the functionality and the quality of the building has already been determined."
>
> Rintala, 2005, p. 44.

However, a barrier to reduction in WLC is the fact the SPV often re-fragment the integrated scope of the PFI contract into separate sub-contracts for construction and operations (Rintala, 2005). The result of this fragmentation is that incentives for realising capital investment in saving operational costs are reduced by suboptimal co-ordination between those that may benefit from reduced WLC, and those who will not, such as fixed price construction contractors.

In a study of a range of projects commissioned by the Partnerships Victoria in Australia (Fitzgerald, 2004) , it was found that evaluation depended greatly on the discount rate adopted to assess the relative benefits of alternative procurement options. In this review, it was found an 8.65% discount rate led to a 9% saving through using PPP compared to conventional, while changing this discount rate to 5.7% provided the opposite result. This difference will be the result of very different profiles of the cash flows estimated between the alternative procurement options.

2.3 Ownership rights

On the completeness of contracts, Hart (2003) asserts that no contract can account for every possible eventuality. The legal ownership of assets has a particular relevance in a world (indeed, our real world) where contracts are unable to allocate liabilities for every potential future occurrence, whether they be beneficial or not to either party. Ownership of an asset

holds 'residual control right' meaning they have the right to decide what should be done concerning the asset in the event of some non contracted for eventuality. Put another way, 'the owner of a resource does not have to negotiate with another party to take advantage of a good idea' (Ricketts, 2009). The relevance of these residual control rights are paramount to the economic case for PFI, the idea being that if ownership right (and hence residual control right) sit with the public sector, those public sector operators face far weaker incentives to co-ordinate efficient pursuit of lower WLC. Public sector budget holders have little or no financial incentive to introduce innovations or cost saving measures, and so will not seek to *invest in operations* as might a private venture (Hart and Moore, 1990). On the other hand, public sector building contractors (and FM contractors) may have *overly strong* incentives to save costs at the expense of quality. This is partly solved in PFI, as it is easier to write a contract penalising failure to deliver predefined services, rather than one written to define asset quality.

2.4 Transaction Costs

Transaction cost economics provides an important framework for the understanding of PFI procurement. The genesis of this popular set of theories is attributed to the early work of Ronald Coase (1937), with major developments provided by Oliver Williamson (Eccles and Williamson, 1987; Williamson, 1979, 1981a). Appendix 6 illustrates the TCE framework, with the bottom branch highlighting the importance of measurement and governance structures. Procurement methods can be seen as alternative governance structures, with contractual mechanisms and output specifications attempts to incorporate the measurement aspect of monitoring transactions and their efficacy for service delivery. TCE attempts to explain the interactions (contractual or otherwise) of firms with reference to three core transactional characteristics, those of *asset specificity*, *frequency* and *uncertainty*. These concepts are the determinants of transaction costs and are defined and discuss below:

- Asset specificity – this concerns the extent to which the good or service being traded is truly *bespoke* or alternatively *off the shelf.* If a purchaser of a highly specific asset insists on such uniqueness, it is expected that the producer may request a higher price for the good, above and beyond the additional production costs attributable to it's individuality. On the other hand, purchasers of generic, standard products might well respond to a higher than common price by walking away and seeking the homogenous good elsewhere for a lower price, given the good's ample availability. PFI

could be argued to have both high and low asset specificity. The output specification for the service to be delivered in a PFI project suggests a high level of explicit requirement, while the actual asset used to deliver these services, is, to a variable extent, subject to the choices of the SPV in regard to how best deliver the service with minimal cost. Sunk costs are important here. With the use of PFI procurement comes the additional asset specificity problem given that ownership of the asset sits with the SPV, restricting the alternative uses for the asset. A benefit for this trade off was the ability to agree fixed price contract for PSA investment projects.

- Frequency – this aspect relates the extent to which trades are (or expected) to be repeated. If a seller's *business as usual* relies on repeat customers, as many firms do, the strategy chosen to undertake the transaction with a new buyer will, to an extent, be governed by the expectations about future transactions. A seller expecting future trade with a buyer will temper their pursuit of one off pay offs from less than scrupulous trades, and extract a lower level of profit in hope the buyer remains satisfied and returns. Akerlof's (1970) example of the second hand car market serves as example of the other extreme, where the seller does not expect repeat custom, so does their best to extract as much profit from selling a *lemon* for an average market price. The relevance of frequency to PFI is considerable, as reputation in the market may be considered a factor in future bid success for other contracts.
- Uncertainty – this factor concerns the ambiguity in the quality of any good or service in the presence of asymmetric information. In the case of PFI this might also concern the on-going operational cost of meeting contractual requirements, as a key source for the SPV's profit.

On the interplay between TCE frameworks and investment appraisal methodologies, Earl (1995) provides a useful comment:

> "The comparison of rival scenarios is not intended immediately to point towards a particular decision but rather to alert the decision-makers both to the kinds of risks they might be running if they choose particular courses of action and to the costs and benefits of choosing between schemes that differ in their degrees of flexibility."
>
> Earl, 1995, p. 122.

One interpretation of transaction costs is to consider them as the cost of running the prevailing economic system that has emerged, that of one relying on specialisation of knowledge and production such that trade is essential to consume the vast range of goods and services consumers have come to expect. As Coase puts it, 'it would seem to be that there is a cost of using the price mechanism' (1937). Coase went on to consider what might be achievable in the extremes of a world with zero transaction costs. With the added, admittedly bold, assumption of perfect information, he supposes that the boundaries of firms themselves would fade away as individuals could market their expertise and transact without any friction, such that the price paid for a producer's service would simply be a pure function of the producers' productivity. That is, rather than being based on the appropriation of economic rents from the benefits of asymmetric information or of quasi-rents from sunk costs.

The application of this theory is pertinent to the consideration of a client's contracting of external providers. The following table provides us with a useful sense as to where these types of investments sit across the range of two key concepts above, those of asset specificity and frequency.

		Investment Characteristics		
		Nonspecific	Mixed	Idiosyncratic
Frequency	Occasional	Purchasing Standard Equipment	Purchasing Customized Equipment	Constructing a Plant
	Recurrent	Purchasing Standard Material	Purchasing Customized Material	Site-Specific Transfer of Intermediate Product Across Successive Stages

FIGURE I
ILLUSTRATIVE COMMERCIAL TRANSACTIONS

Figure 2-2: TCE classification of transaction characteristics. Source: Williamson, 1979, fig. 1.

It is clear that investment in buildings, at least in the eyes of Williamson, conforms to a high specificity, low frequency transaction. These are fundamental characteristics of the transaction that a client undertakes in procuring capital investment in buildings. However, there remains subtle choices to be made as differing procurement methods turn these investment attributes into transaction attributes and thus, into transaction costs in varyingly effective ways (Ive and Chang, 2007).

2.5 Hold up

The hold up problem concerns the difference in renegotiating position between contractual parties following a contract agreement (Chang and Ive, 2007). It's relevance in contracting for investment in PSAs is determined to a great extent by the level of asset specificity. The PFI co has invested in building an asset with greatly reduced value if it has to be redeployed outside the original transaction with the public client. This makes them potentially vulnerable to client-initiated renegotiations (hence the inclusion of provisions for the SPV to be compensated for in this event). The ability of the client to change the specification of service output is limited by the extent to which the contractor will demand additional payment (in the form of supplementary compensation) to agree the change. The bargaining position of parties is an important factor here, as the incumbent provider can make use of their *near* monopoly status, given the inordinate transaction costs to be incurred from considering alternatives.

2.6 Commitment and Trust

Some writings have sought to explore the problem of commitment in more family related scenarios between child and parent (Williamson, 1979), and husband and wife in marriage (Shaw, 2008). Relationships between client and PFI contractors provides a good source of discussion about how commitment and trust can help economise on transactions costs (Smyth and Edkins, 2007, Bridge et al., 2015). The principle behind much of this approach to interpreting how interactions determine project success supposes that, if parties are able to 'put the contract in the drawer' and work more flexibly, transaction costs can be minimised and mutually beneficial trade offs agreed, if only tacitly. These benefits of more relaxed and flexible processes can be fostered, if not contracted for, as the project develops. These benefits might include more reasonably priced variations to the service provided that do not require arduous contractual amendments (Robinson and Scott, 2009). While this has been a goal of many PFI projects as forms of partnerships, it's prevalence might well be restricted by the fundamental importance of the transparent rights and liabilities as detailed in the PFI contract. The importance of this client interface is noted by Ive and Rintala (2006), who put forward the economics of the relationship between the principal (public client) and agent (SPV) as fundamental to determining how PFI contracts are managed.

2.6.1 Information asymmetries

The concept of information asymmetries was a fundamental step forward in economic theory (Akerlof, 1970). Besides introducing this powerful tool as a means for assessing transaction strategy, it is notable for highlighting the importance of quality of products and services, as an aspect that had come secondary to that of prices and quantities in much economic thinking. The discussion on how inferior second hand cars (*lemons*) are priced compared to their better quality alternatives (*plums*), and the proceeding demonstration on how information asymmetries can *unravel* markets, has clear comparisons within public procurement. The presence of information asymmetries is part of the fundamental business case of applying forms of PPP. It is the difference in knowledge about how *best* to provide a PSA that determines the efficiencies that might counteract the higher cost of capital (Hart et al., 1997) of private providers, and hence result in a high net present value compared to in-house provision with more conventional, non-integrated forms of contracting.

2.7 Principal agent and moral hazard

The principal agent problem applies to the effort exerted by a contractor (agent) on behalf of the client (principal). In the presence of high monitoring costs (as a form of transaction cost) and thus incomplete monitoring, it is possible, indeed likely, that the agent will not always act in the best interest of their employer (principal). Adam Smith provides a useful context for discussion of this:

> "The director of such [joint-stock] companies, however, being the managers rather of other people's money than of their own, it cannot well be expected, that they should watch over it with the same anxious vigilance with which the partners in a private copartnery frequently watch over their own. Like the stewards of a rich man, they are apt to consider attention to smaller matters as not for their master's honour, and easily give themselves dispensation from having it. Negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company."
>
> Smith, 1776.

This is a fundamental issue in considering the merits of contracting for investment in PSAs. If construction contractors are left to build an imperfectly specified building on a fixed price basis, it seems only logical that they would look for opportunities to minimise cost on aspects that have not been contractually stipulated, as might any firm look to reduce cost in the production of their output. This issue is magnified in construction given the heterogeneous nature of buildings (Ive and Gruneberg, 2000), and the prohibitive cost of complete monitoring of the construction process. Where constructors are given reasonable scope (by means of ill specified contracts), they might look to 'shirk' on the production of outputs where the quality is hard to measure ex post, and the imperfect contract may mean they can not be made liable for an assets inferior performance some years hence. This is a form of moral hazard in the traditional sense that it occurs post contractual agreement, rather than an asymmetric information issue, which occurs before the contractual agreement is made. Much of the basis for the integration of construction and operation within integrated forms of procurement, such as PFI, seeks to make a single agent bear the consequences of their decisions during construction, and hence incentivise better build quality (Hart, 2003, Ive and Chang, 2007).

2.8 Scope of government

It is assumed that for some sectors, public provision is considered the preferred model of delivery (or at least in terms of responsibility for provision). Taking specifically education, this necessitates governments to have access to (if not own) schools in which to deliver teaching. The first order question at this stage is to ask, if governments require schools in which to deliver teaching, should they see within their own scope of activities the ownership and operation of the school buildings, along with all the investment and maintenance requirements required for modern learning environments. It is by no means beyond the competence of governments to achieve this, as they have done for many years. The question is not can it be done, rather can someone else do it more efficiently, and via contracting, achieve better VfM than via public ownership and management?

The choice of boundary between market activities and non-market activities of governments is the focus of the Arrow's fundamental paper (1969). He advances our understanding of the boundary of markets through an exploration of how externalities can cause sub-optimal market behaviours in the case of public goods. He highlights that market failures are not always the result of externalities, but also from either lack of ability to exclude (pertinent to public goods), or lack of necessary information to permit market transactions (pertinent to

long-term contracting in this case). On agent's knowledge of prices, applicable to scenarios on client's knowledge of WLC for facility operations, he adds:

> "Because the costs of transmission are non negligible, even situations which are basically certain become uncertain for the individual; the typical economic agent simply cannot acquire in a meaningful sense the knowledge of all possible prices, even where they are each somewhere available."
>
> Arrow, 1969, p. 8.

The merits of vertical integration should be assessed against the reduction of transaction costs from engaging with the market. This is pertinent to looking at the merits of PFI as a form of long term contracting, which while might not represent a form vertical integration for the government directly, does so for the provision of whole life assets through transfer of responsibility for service procurement from the government to the SPV. The PFI method (contracted cash flows) also forms a market mechanism through which investors in the SPV are protected against risks.

There will be need to retender services throughout the life of PFI contracts, so it is worth considering whether the SPV as a private entity may be able to economise on transaction costs throughout the contract, arguably being more flexible and commercially savvy in terms of negotiating contracts. Shleifer (1998) seems to support this view, suggesting internal public provision is transactionally inefficient as officials do not fully consider the benefits of alternative forms of external provision. This lack of procurement capability results from inefficient expressions of state monopoly power and politicisation.

> "When governments are the investors, it is unreasonable to assume that *everywhere and always* whatever governments have spent and called investment was exactly equal to the (potential contribution) to the value of current and future production – the increment to capital stock."
>
> Pritchett, 2000, p. 363.

When one considers the capitalised value of investment from a public sector point of view, it should be borne in mind that while firms are only concerned with the internalised cash flows

of business operation, governments are concerned with a much wider set of non-market benefits. As such, the public sector makes use of social cost benefit analysis.

Table 2-4: The sources of return and appraisal concepts for firms and public sector

Investor	**Source relative to the investor**	**Appraisal concept**
Private firm	*Internal*	*Internal rate of return*
Public sector	*External*	Social Cost Benefit Analysis

2.8.1 Accountability

An investigation by the Institute of Public Policy Research into the inner workings of the senior civil service (Lodge and Rogers, 2006), where much of the development and role definition of PFI was undertaken, provides some insightful evidence on the level of accountability and motivations for senior officials. Some useful quotes taken from unnamed sources provide a useful backdrop to assess the policy implementation and on-going management.

> "Accountability is the central issue but it is difficult. The current arrangements are fraught with ambiguities – and remember this suits both sides. The accountability fudge we have now protects ministers and officials. Ministers can say "not me, guv" while officials hide behind them. This is not in the interest of effective government."
>
> *Senior Official*, Lodge and Rodgers, p. 9.

> "Why are we poor at delivery? Mainly it's because there aren't any rewards or sanctions for good delivery."
>
> ibid, p. 9.

2.9 Risk and uncertainty – capital investment as crucial decisions

The choices made around how much and where to allocate capital expenditure in the public sector is of course an area under considerable scrutiny. The bases for decisions are often cited as evidence on the costs and benefits of alternative options. Audits of these processes, and particularly the models on which future costs and benefits are based, have revealed

questionable practices around the quality assurance and internal review (Macpherson, 2013). The role of financial models as the basis for decision-making concerning long-term assets inherently requires some consideration of risk and uncertainty in the determination of both WLC and valuable outcomes. Using financial models implies that the decision rules are objective and rationally based.

The notion of the degree to which decision makers can conceive or imagine future states is a topic at the heart of Shacklian discourse. His perspective, often seen as unifying the important role of fundamental uncertainty from Keynes, with the entrepreneurial focus of the Austrian school, breaks down economic decisions between those which are *non-crucial* (functions of firms, or government in this sense, which are not subject to significant uncertainty as more mundane, mechanical and everyday), and those which are indeed *crucial* decisions. This is a convenient link between two schools of thought that bear upon this work in different regards. Keynes' view of future long-term risk and uncertainty relates to determinants of value (or sources of yield), while the Austrian school relates more to the choice of investment between alternatives.

Crocco (2002) suggests investment and financial decisions constitute forms of crucial decisions, in line with Shacklian discourse as decisions that require exercise of economic imagination. This is especially so for decisions involving alternative forms of financing, such as PFI in the procurement of PSAs.

> "the view that the expectations, which together with the drive of needs and ambitions make up the 'springs of action', are at all times so insubstantially founded upon data and so mutably suggested by the stream of 'news', that is, of counter-expected or totally unthought-of events, that they can undergo complete transformation in an hour or even a moment, as the patterns of a kaleidoscope dissolve at a touch; the view that men are conscious of their essential and irremediable state of un-knowledge and that they usually suppress this awareness in the interest of avoiding a paralysis of action; but that from time to time they succumb to its abiding mockery and menace, and withdraw from the field."
>
> Shackle, 1974, p. 42

Paralysis of action (or inaction) is of course a sub-optimal situation. Crocco goes on to support that the concept of grades of uncertainty (potentially useful in appraising alternative capital investments) are compatible with Shackle's more discrete view of uncertainty, where by potential future states of world should be considered as mutually exclusive, rather than sharing some overlap in their probability of occurrence, as an underlying assumption in risk based forms of analysis such as monte carlo analysis.

2.9.1 Evidence for decision making

Crocco (2002) presents a formalised model by Runde (1991) of Keynes' notion of *weight of evidence* to express the relationship between the probability of an event '*a*' (say the probability of rain), and knowledge of a state affecting its occurrence '*h*' (say the observance of black clouds), where K_r is the relevant knowledge and I_r is the relevant ignorance. This latter concept (I_r) may be alternatively termed *competitive zeal*, *attention-arresting power*, *animal spirits* or at least the ability to believe, and invest, in more favourable futures than mere risk analysis suggests.

Equation 1: Weight of evidence. Source: (Runde, 1991)

$$V(a/h) = K_r / (K_r + I_r)$$

> "The act of decision is a fusing of judgments of different kinds, and these judgments in effect are made all at once in that moment and have their mutually relevant existence in that moment. The chooser of action wishes to fix upon the best and worst imagined outcome of each action that are *possible enough*: the best that is possible enough to be worth hoping for, and the worst that is too possible to be dismissed."
>
> Shackle, 1988, p. 5.

2.9.2 Role of information

The role of information becomes central with regard to investment appraisal. Much as the above observation of grey skies gives the assessor a better *guess* as to the incoming weather, appraisers of investments benefit from greater information on which to base their estimations of risky prospects for the occurrence of resulting cost and benefits. Beyond the investment

appraisal techniques of NPV and Monte Carlo analysis, the emergence of Real Options theory came about in the 1980s (Dixit and Pindyck, 1994). It involves the consideration of any investment not simply as a single one shot game after which the returns are assessed probabilistically, but rather an extended period where by decisions to invest (or not) open up an unfolding plethora of mutually exclusive options. These branches of the decision tree reveal themselves through multiple stages of future rounds of decision-making and can be anticipated ex ante with current information. The fundamental development this appraisal method brought to previous established methods was to introduce the opportunity to update the estimations of investment returns into the future, and over time, as new information is accessed. Reflecting on this feature, the benefit of waiting reveals itself as a valuable option, in which time potential investors can accrue better evidence as to the prospects for returns.

> "in a world of irreversible investment, there are benefits in waiting to acquire more information about the likely success of investments."
>
> Baddeley, 2003, p. 110.

The relevance of this for capital investment programmes relates to the collation of information from previous capital investments that can go on to inform later ones. This also bears upon how a programme of investments might best be structured so as to adapt to emerging information, as the options to change how projects should be prioritised and delivered become clearer. For example, the asset condition of exists PSAs becomes an essential piece of information to decide where (which facilities) and how (new build versus refurbishment) investment is allocated.

2.10 Literature review summary

The review of literature has drawn on a broad set of evidence with regarding to investment theory, incentives, the scope of government and risk and uncertainty.

Theory on procurement suggest there may be differences in out turn WLC and asset performance as a result of the incentives inherent in the rules of the contract. The literature is clear in considering contracts integrating the provision of construction and operations as distinctive from previous forms used to date, and so empirical investigation as to the occurrence of differences is so warranted. Further, it lays down that one off, large

transactions such as building procurements, should be considered in the context of their institutional setting, partly a function of the procurement mechanisms applied.

Further, the literature highlights information as a core concern, be it about the possible returns from investment in operations, as well as it's role in helping make better decisions in the face of risk and uncertainty. Information about existing assets is also the basis for decisions about what form of capital investment is most appropriate between more intensive new build or less intensive refurbishment. Lack of information about the backlog maintenance in PSAs will be considered in later analysis and may be considered a barrier to better allocation of scarce capital in pursuit of WLC efficiencies.

Finally, the relevance of Shacklian perspectives on uncertainty is discussed, with reflection on their relevance for comparing the context of pure private and public investment decision-making. The imperative for considering multiple scenarios is raised to help understand the future drivers of returns from capital investment decisions, be those in pursuit of WLC reductions or improvements in outcomes. These points will be returned to later in this work to reflect on the role of government as monopoly provider of the services requiring the PSAs under investigation.

Chapter 3 Methodology

3.1 Philosophical approach

> "Ask a scientist what he conceives the scientific method to be, and he will adopt an expression that is at once solemn and shift-eyed: solemn, because he feels that he ought to declare an opinion; shift-eyed, because he is wondering how to conceal the fact that he has no opinion to declare"
>
> Medawar, 1982, p. 40.

This thesis takes a positivist approach in relation to the empirical work, seeing the outputs and outcomes of projects as determined by the actual occurrences of causal factors (the most pertinent being that of the procurement method applied).

> "Positivism currently offers the best way to reduce subjectivity and to discipline undisciplined researchers and the results, in terms of advancement of science, are nothing short of spectacular. Why reject it for something less useful?"
>
> Runeson, 1997, p. 302.

This is pertinent as it puts forward that the performance of a facility is determinable (or at least in part) within the causal mechanisms of a facilities' construction, operation, procurement and management. There are a range of non-observed factors that do determine these outputs (and outcomes) but they are the result of stochastic processes, as such one can not generate predictions for single cases. The resulting goal is to observe many cases, such that they bear upon their context, from which one can compare for means of insight on the efficacy of their characteristics (be that form of capital investment or procurement method as explored here).

Beside applying a positivist perspective, the thesis is sensitive to consider critical realism (Bhaskar, 2010) (in the face of some incompatibilities with positivism). This supports the view that, had many of what became PFI projects been delivered under conventional procurement methods, their outcomes would be materially different, as a constructivist view might

consider social forms (forms of capital investment as refurbishment or rebuild), as well as procurement methods.

3.2 Induction versus deduction

In line with the positivist approach applied, this thesis applies deductive approaches in its attempt to test whether abstract economic theories concerning cost and performance of PSA are compatible with what is empirically observable. Inductive methods are not discounted mind, with opportunities for comments beyond the set theories pursued from observations in the data.

The bulk of analysis within the thesis constitutes first level inferential statistical analysis of large sample sets of facilities. The samples have been formed to represent as large as possible coverage of the estates of renewed schools and hospitals. While it is accepted that there are downsides to inferential statistical approaches (principally, data accessibility, see below), the benefit of undertaking programme wide generalised observations for policy appraisal is a key source of generalisability for the review of PFI and capital investment in PSAs. This generalisability of findings is confined to the context of renewed PSAs.

The use of sample data at the facility level over differing procurement contexts will be the basis for comparative analysis. The eventual samples are invariably close to the programme populations given the scope of the datasets applied. More accurate estimation of coverage is often prevented by an agreed and reliable source for the full scope of investment programmes. This is a particular feature of school and hospital programmes, being as they are, commissioned by numerous uncoordinated local authorities. Datasets mainly consist of centralised authority databases collected and maintained by public sector organisations concerning the cost and performance of national estates of schools and hospitals.

This chapter presents a method by which hypotheses can be derived concerning the effect of capital investment and procurement methods, and how they may have influence on the cost and performance of the PSAs. In reality, the complexity of the determinants of facility performance, as discussed in the previous chapter, mean there are constraints on how much can be deduced from any limited set of observations as presented here. Notwithstanding, efforts will focus on interpreting the empirical results within the framework of economic factors discussed in the literature and developed here.

3.3 Validity and reliability

In the empirics to be presented, there is pursuit of both validity and reliability. Validity here requires that observations made of either cost or performance relating to facilities are accurately reflecting those concepts, that is the conception of cost (meaningfully normalised, see below) or performance of a PSA, or a sub element of the facilities services, relates directly to what is being measured. Reliability here relates the to the replicability, and hence consistency, of observed results. While common methods of normalisation and indexing of costs are applied, reference to other studies to assess reliability is difficult in a context where data has not been openly accessible for others to produce analysis. In support of empirical reliability, detailed step-by-step methods have been provided in the hope that others might seek to replicate and compare the results presented here. Where reference to similar analysis is possible (mainly in the area of construction cost or facility service cost), it has been pursued, for example with use of EC Harris indicative construction cost data (EC Harris, 2006).

To place validity and reliability into context, target diagrams are useful to visually represent the goal and empirical outcome. Below are presented three target diagrams. In the first diagram, observations made are within the generic topic and are somewhat valid, as a range of observed school capital investments (top part of vertical axis eludes to variance in pupil admission type), applying varying procurement methods (left of diagram are conventionally procured and the right are PFI) and wide ranging levels of capital intensity (bottom part of the vertical axis). These units are unreliable in regards to their comparability given their dispersion over admission type and capital intensity, an undesirable feature of *this* sample and one which later methods seek to control for. The second diagram shows observations made that are comparable to one another (reliable) as a set of PFI school investments applying similar levels of capital intensity. These observations though do not provide the variance over the key characteristic of procurement method (left to right, admittedly a discrete non-continuous characteristic). The third diagram demonstrates both validity of the observations made covering alternative procurement methods, as well as reliability in terms of their comparability of the admission type for schools and the levels of capital investment, hence reducing bias in the representation of what is being observed. Needless to say, the final scenario is the most desirable and methods throughout the production of this thesis have sought to achieve this through defining samples for empirical analysis.

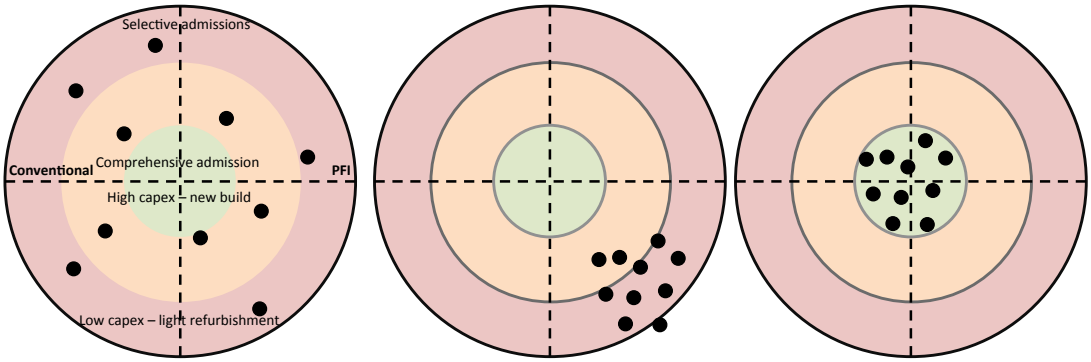


Figure 3-1: Validity and reliability targets

3.4 Unit of analysis and sampling

The unit of analysis throughout the study is the facility that the capital investment has brought about, the PSA. Both schools and hospitals are investigated, as data permits, to allow opportunity for insight on different aspects of WLC, as well as discuss the challenges in valuation of outcomes from the public services provided in these facilities. Further, they share a common context as the sectors where public delivery prevails, including employment of front line staff. The estates that comprise schools and hospitals include large proportions of older facilities, such that investment often constitutes a refurbishment of an existing asset. For means of control, samples of facilities that have not been subject to capital investment will be used at times where appropriate, for example in measuring deviations from national trends in secondary school level educational attainment. This allows the creation of an *as normal* scenario to indicate population cost and performance in the absence of investment.

The sampling approach is to start with the most definitive sources of the population of all facilities, both new and old. Data, often sourced from numerous organisations, are then applied to isolate which of these have received capital investment in recent years. Where possible, additional sub-divisions are created applying data on the form of capital investment, be that full rebuild or part refurbishment. Finally, procurement method indicators are used to further break down samples where there is sufficient reporting such that comparative analysis by procurement method is made possible. Subsequent chapters will describe in detail the specific methods applied in each analysis, along with the resulting sample sizes.

3.5 Level of analysis and effect magnitudes

Rather than attempt to amalgamate different indicators of the cost and performance of a single PSA, analysis pursues a more discrete consideration of the range of metrics about samples of facilities under different procurement methods. For example, where data exists on both the aggregate operating cost of a PSA, as well as some detailed data on the on-going operational cost of numerous services (catering, cleaning, building maintenance etc), breakdowns of individual expenditures have been analysed. Rather, each is considered in isolation in the context of alternative procurement methods. Integration of these costs have been aggregated for development of WLC ratios where relevant.

The limited sample sizes available when studying such large discrete investment as PSAs at times prevents the application of more sophisticated inferential techniques (e.g. logistic regression and multi level modelling). The pertinence of these techniques is of course sensitive to the particularities of what is being measured. It is supposed that some measures will prove to be relatively invariant over the range of procurement methods (as is supported in observed results, for example when looking at cleaning cost in healthcare facilities). Analyses of such measures are limited in their ability to apportion causal inference regardless of analytical sophistication, given the marginal effect sizes observed at the first classification of comparative sample between different procurement routes.

3.6 Normalisation

To enable comparison of cost and performance metrics in facilities of differing sizes, methods of normalisation are applied using additional data gathered during collation of initial datasets. For example, when normalising the headline cost for a range of operational services and CAPEX within school facilities, the ideal normaliser to account for size of facility might include total usable floor area (TUFA). This data is not available universally for all schools (see later commentary), while *pupil capacity* is, and hence is applied as the normaliser. Pupil capacity will of course be highly correlated with the size of the school and serves as a sufficiently good basis for cost normalisation. Indeed, since key benefits in performance have to be 'per pupil' it is positively desirable that costs are also expressed per pupil.

The impact of normalisation method is noteworthy, especially in the context of less homogenous units of analysis. A case in point here constitutes the much greater diversity in

the range in term of both size and type of hospitals studied when compared to schools. Further discussion on the implications of this is included in respective chapters

3.7 Data sources

A large and diverse set of datasets was collated to produce the proceeding analyses. Many datasets are available from central administrative bodies, such as the DoH and DfE. More specialised organisations and agencies of government were useful in the provision of additional, often more detailed, datasets. These organisations included the NHS Information Centre, the National Patient Safety Agency (dissolved in 2012) and Partnerships for Schools (as of 2012 the Education Funding Agency). Tables 3.1 and 3.2 below summarise the range of datasets and sources within the frameworks of WLC and value, along with indications of coverage and limitations of scope. Where concepts have not been analysed in this work, suggestions are included in these tables within italics as suggestions as to where data might be sourced. Their specific application in empirical analysis is detailed in later chapters. The intended value of the research was in bringing together the various data sources through use of unique identifiers for PSAs.

3.8 Classification of renewal

The following sections detail the sampling processes for generating the population of renewed school and hospital facilities. Additional analysis of these facilities via cross matching data means that some subsequent analysis present sub-samples of these populations and is indicated where relevant.

3.8.1 Renewed schools

i. A comprehensive list of over 65,000 educational establishments in England and Wales was obtained from the DfE's Edubase system. The number of secondary schools within the dataset was 4,225. The dataset was filtered by admission type to include only comprehensives. This left 3,188 schools[5].

[5] Other admissions types excluded were 'selective', 'modern' and 'N/A'. This step also removed Academies as well as Welsh establishments from the sample, as they did not have sufficient admission type information.

ii. These 3,188 schools were then cross-matched with the School Building Survey (SBS) of 2007 and 2009[6]. This identified which schools reported they had been renewed between financial years 1992/93 and 2007/08. This included some 403 schools.

iii. A very small number of schools had inconsistent data between the SBS of 2007 and 2009. The data was verified from external sources such as school websites and most such schools were retained in the core sample:

- Five schools were removed from the sample as SBS of 2007 and 2009 contained conflicting information;
- Two schools which appeared to have been renewed twice were removed from the sample;
- One school was found to be an Academy and was removed.

iv. The remaining **395** schools formed the population of renewed schools. 133 were identified as being PFI schools according to a specific PFI marker within the initial Edubase dataset. The remaining 262 are considered Non-PFI.

3.8.2 Expenditure variables

Expenditure data for each school having received capital investment is then retrieved in accordance with the process below:

i. The Consistent Financial Reporting (CFR) dataset for financial years 2002/03 to 2008/09 was obtained from the DfE. There is thus a maximum of seven years cost data potentially available for any specific school, if it was renewed before 2002/03; reducing to a minimum of one year if it was renewed in 2007/08. In attempt to see more years of operation, a cross sectional approach was applied. A panel requirement here would have considerably reduced sample sizes given sporadic failure to report individual cost items for some schools between years.

ii. From the range of available expenditure lines, an operational cost basket was created. The basket is not exhaustive of all services provided within a school, but was collated

[6] Survey undertaken by DfE, completed and by local authorities and provided by Partnerships for Schools.

to cover the core soft and hard FM[7] expenditures typically included within the scope of a PFI school contract. The components of the basket, and corresponding CFR reference for clarity, include[8]:

1. Building maintenance (E 12);
2. Grounds maintenance (E13);
3. Cleaning and caretaking (E14);
4. Premises staff - in-house caretakers and other similar staff (E04);
5. Bought in professional services - inc. PFI management fee (E28);
6. Catering supplies - including contracted catering services (E25);
7. Catering staff - capturing in-house catering staff (E06);
8. ICT learning resources (E20).

iii. Expenditures were converted to constant April 2010 prices using RPIX data from the Office of National Statistics. The expenditures for each school were divided by the school's pupil capacity[9] for normalisation.

iv. Data for each school were rearranged into elapsed time from that school's renewal point using the year of capital works from the SBS as a point of reference.

v. The cost data were sampled separately for each of the nine elapsed years after completion of the capital investment. A school was only included in the analysis if it had returns for all eight of the operational cost expenditure lines identified above. This was an attempt to minimise the possibility of inaccurate reporting between expenditure lines.

[7] Hard FM is typically understood to include the management and maintenance of the core fabric of the building. Soft FM services are those pertaining to the management and provision of services provided within the building, e.g. cleaning and catering.

[8] Detailed descriptions of what each expenditure line includes can be found on the School Financial Benchmarking website: https://sfb.teachernet.gov.uk/Assets/metrichelp.htm#I01

[9] Provided in the initial Edubase dataset of educational establishments in England and Wales.

3.8.3 Renewed hospitals

3.8.3.1 Sampling process

The site level HEFS reports formed the basis of the renewed population of hospitals.

Sampling process – population of renewed hospitals 2007/08

1. The untouched 2007/08 HEFS (ERIC) site level report covers 1,965 sites
2. Removing all forms of aggregated site and sites where patients are not both treated and accommodated (including GP properties, Support Facilities, Treatment Centres and Non-hospitals) and sites with no data provided for site type leaves 1,052 hospitals. These include Community hospitals, General acute hospitals, Long stay hospitals, Multi-service hospitals, Short-term non-acute hospitals and Specialist hospitals.
3. In attempting to control for age of the facility as this may affect cost/performance, all sites with any part of the age asset profile dated before 1995 (as well as sites without the data to confirm they have been wholly built after 1994) were removed. This produced a population of **136** renewed hospitals.
4. Finally, the 4 sites which returned zero results for cost of cleaning or '*No Data Provided*' were removed, leaving 132 hospitals to allocate to either PFI or Non-PFI procurement subsets. This was also the stage at which the patient environment and food rating samples were produced by cross matching the 136 hospitals from the previous stage with publically available results for hospitals.
5. The Hard FM costs and corresponding Backlog maintenance samples were taken from hospitals built since 2000 (data for 2004/05), or since 2005 (data for 2005/06 onwards) so as to minimise any bias in favour of PFI. The reporting of asset age profile changed in 2005/06. Prior to this the date assets were reported as built (or not) from 1995 to 2000 and since 2000. From 2005/06 onwards, they are reported separately as 1995 to 2005 and 2005 onwards. A higher proportion of the PFI sample has the more recent construction dates (the average age of PFI sample is somewhat lower that that of the Non-PFI sample). This aspect was not considered so important in the other cost and performance variables as all are essentially 'new' hospitals and any negative effect from the deterioration of older non-PFI facilities may well be compensated for

by a longer operational phase allowing for improvements in standards over time. The 2004/05 Hard FM cost and Backlog maintenance samples were for sites wholly constructed since 2000. The corresponding 2005/06 – 2007/08 samples were from sites wholly constructed since 2005. This did have the impact of reducing sample sizes but is a necessary step for like for like comparison.

Table 3-1: School datasets across the range of cost and value concepts

Concept	Dataset	Source	Coverage / scope	Limitations
C	School Building Survey 2009 & 2011 (SBS)	Partnerships for Schools (PfS, an agency of DfE)	Capital works on schools having received recent investment	Construction cost data is often estimated ex-ante rather than observed ex post out turn
c	Edubase (various years)	DfE	Array of different school level details, including pupil capacity used as the standard normaliser for many analyses	Annual results only and some lack of data on cohort characteristics
F	Consistent financial reporting database (CFR)	DfE	A database covering a wide range of expenditure categories at the school level, including those relevant to facility management and maintenance.	Some expenditure lines inc. quite diverse sets of expenditures, creating considerable variance in some concepts between schools
f	Normalised as indicated above			
S	Consistent financial reporting database (CFR)	DfE	As above, covering staff costs for teachers, teaching assistants and administrative staff	Purely based on sums expended rather than quantity of resources used.
s	Normalised as indicated above			
V	National attainment tables	DfE	Comprehensive statistics on school level educational attainment as well as key cohort characteristics	Main measures of attainment change over time e.g. 5 GCSEs A* - C to 5 GCSEs A* - C inc. English and Maths. Care must be taken to ensure the same concept is used in time series studies.
v	Wage uplift studies	UK Commission for Employment and Skills	Statistics on higher incomes of individuals with higher levels of educations	These are based on historic observations and so will be imperfect estimates for future returns from education.
Procurement	Edubase	DfE	Edubase provides a PFI marker for schools that have pursued this procurement route.	The BSF marker does not clarify if a school under the BSF programme was being procured conventionally (design and build) or via PFI.
	School Building Survey (2009 & 2011)	PfS	The school building survey indicates procurement route applied, that is whether if capital investment applied a PFI or generic BSF process	

Table 3-2: Hospital datasets across the range of cost and value concepts (*italic – as potential sources for future work not covered here).*

Concept	Dataset	Source	Coverage / scope	Limits
C	Hospitals capital expenditures	Cabinet Office construction cost benchmarking	Normalised construction cost for a range of healthcare facilities	Coverage seem to focus on smaller facilities, not including the largest acute hospitals built in recent years
c	Hospitals Estates Facility Statistics (HEFS) – Estates Return Information Collection (ERIC)	NHS Information Centre	Facility size metrics as well as a complete population of hospitals against which coverage of CAPEX data could be judged	The presence of legacy elements within large hospitals sites will requires the need for sensitive attributions and normalisation of headline CAPEX
F	Hospitals Estates Facility Statistics (HEFS) – Estates Return Information Collection (ERIC)	NHS Information Centre as above	Provides the population of hospital facilities along with a range of useful facility descriptors, cost and performance metrics on both soft FM cost and performance, and some hard FM costs as well as other pertinent statistics e.g. energy use	The reporting (coverage and reliability) of some key metrics, notably backlog maintenance, is poor.
f	As above			
S	*Clinical staff expenditure*	*Trust accounts*	*These might include detailed breakdowns on clinical staff expenditure*	*To attribute to particular facilities, detailed information would be needed on staff allocations*
s				
V	*Hospitals episode statistics (HES)*	*NHS Digital*	*Range of statistics covering healthcare output and outcomes*	*Incidence of healthcare outcomes is typically given at the trust level and is difficult to attribute to particular facilities.*
v	*Patient outcomes data*			*The sensitivity of using patient data may preclude sensitive analysis of outcomes data.*
Procurement	PFI hospital list - compiled via NHS info centre and desktop research	NHS information Centre	A list of hospitals which NHS Information Centre were aware of having been procured via PFI on their estates database	This list was not a comprehensive set of PFI hospitals, though at the time was possibly the most complete version.

3.9 Whole life cost ratios

The primary framework to be applied in the analysis is based on cost and value concepts of investing in, and operating, PSAs. It is based on four concepts, namely: construction cost '*C*', facility operation cost '*F*', operational staffing cost '*S*' and service value '*V*'. This framework is developed and applied in a recent work to assess the pay offs from investing in secondary comprehensive schools (Ive, Murray and Marsh, 2015). The idea is to compare present value asset life estimates for these concepts to assess if capital investment (*C)* pays off in terms of economies during operations (lower S and F) or value enhancing performance (higher V) during life of projects. The work provides direct empirical observations of these concepts, or sub elements of them where data scope dictates, to comment on the pay offs from capital investments, and the relative merits of alternative procurement methods used to deliver them.

This method was applied in an earlier study looking at the relative cost ratios of London offices (Ive, 2006), a study which dispelled a myth concerning the average ratios of these concepts to be in the order of 1 C / 5 F / 200 S (Evans et al., 1998). Ive found for offices, the relative ratios to be in the order of 1 / 1.5 / 15 over a 30-year asset life discounted at 7%. Analysis of schools suggests this ratio to be 1 / 0.5 / 2.5 over a 60 year[10] asset life discounted at 7% (Ive et al., 2015), or 1 / 1 / 5 discounted at 3%. The importance of these cost ratios becomes apparent when one considers the business case for making savings in operations from, at the first order question, any investment in a PSA, and as a second order consideration, marginal changes in the investment sum. If the business case for an investment rests on assumptions about lower WLC, there should be a good understanding of the relative magnitudes and substitutability of the different forms of cost relating to the long-term operation of assets. In comparison to the earlier supposed ratios by Evans of 1 / 5 / 200, the lower observed ratios make the business case for returns in operation seem much less achievable, given that construction cost is many times greater (relative to F and S) than the supposed Evans ratios suggest. This goes regardless of what procurement route is pursued, but does have bearing upon how different procurement methods might result in different ratio values.

[10] Arguably more appropriate for schools that are not invested in as frequently as London offices.

3.9.1 C and F substitutability

The substitutability of costs in the context of PFI becomes central. It is the integration of construction (C) and operations (F) that provide the opportunity for the agent (SPV) to pursue WLC minimisation strategies (Hart et al., 1997). Following is an exploration of this aspect of substitutability of C and F in the context of public procurement options concerning alternative forms of procurement. It applies the principles of the classical production view at the level of a facilities' WLC and performance, in terms of the SPV's choice between factor inputs (here, present value concepts of *C* and *F, or K and L*) in the production of its output (the provision of a PSA to some specifiable availability and quality). This framework provides sufficient flexibility to consider the stylised decision making from alternative procurement methods with relation to the choice of C and F, as well as consider how different procurement methods might impact on the relative productivities of these factor inputs in producing output.

The use of isocosts and isoquants allows us to build a theoretical view within a production framework as to how efficient alternative procurement methods are at achieving lower WLC. For the application of this approach we require one important assumption, which can be relaxed later. This concerns the present value of units of F, as a factor that is applied *through time*, and as such whose present value will depend very much on exactly when it is applied and what discount rate is used. This is not required for a present value view of C, given that the near entirety of this cost is incurred at the beginning of any investment, hence is not subject to much, if any discounting. This allows us to create a theoretical isocost (green line below) showing us the same level of WLC for a particular PSA that would be incurred over varying levels of C and F. The gradient of this line is determined by the relative factor prices of units of each of these resources[11], an aspect which is explored later.

To represent the relative productivities of each factor C (K) and F (L), isoquants are used (orange line below). This represents productive output in terms of an availability and facility service level as

[11] The divisibility into factor inputs of the construction and operation of a facility is questionable in reality, at least at the single project level, given the long-term contract and the uncertainty about what *actual* expenditures on F will be against what that is *expected*. This issue is sidelined here in pursuit of a generalizable framework within which empirically testable hypotheses can be generated based on theory, in line with a deductive approach.

specifiable in a contract. Assuming that similar levels of output are achieved by alternative procurement methods (to be explored empirically later), we can investigate the scenarios in which relative procurement methods may / may not minimise WLC. The shape of isoquant is determined by the marginal rate of technical substitution, itself a function of the relative productivities of both units of C and F in producing output of a PSA. This presents a constrained optimisation problem, demanding that the producer seek to minimise the combined cost of applying combinations of factor inputs to meet the specified level of availability and facility service (point A below). This approach is applied to support the perspective that this optimisation can be considered as the internalisation of a positive externality unavailable in non-integrated forms of procurement of PSAs (Bennett and `Iossa, 2006). This externality is the potential for WLC savings when there are separate contracts for the design, build and operation, which in UK health and education capital investment has been a prevalent form of construction procurement in recent years. Furthermore, it is not just the bundling of the contract that is relevant, but the ownership and stewardship of the asset. This matters especially when investment cannot be verified or measured (Hart et al., 1997). Placing asset ownership within the SPV is expected to incentivise optimal WLC investment to ensure the asset value is maintained, in terms of meeting contractual standards and the resulting revenue stream.

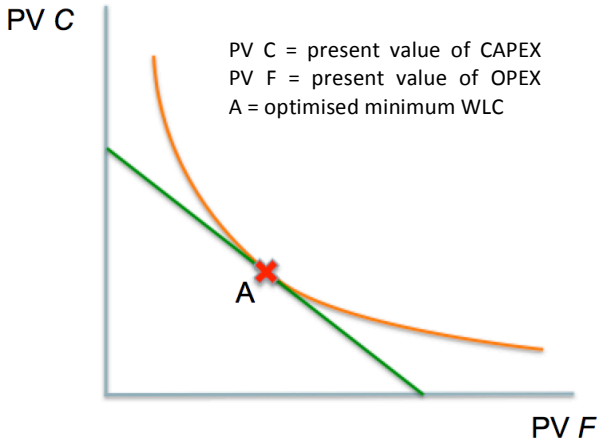


Figure 3-2: Classical view of production choices

At this stage, the question of what constitutes a unit of output requires attention, especially for accurate assessment of return on investment if increases in capacity are a key driver of that investment. As discussed previously, the benefits of investment in PSAs constitute a combination of

savings in S, an increase in capacity of a facility and improvements in the quality of the final capacity (ideally read value of outcomes, but often in practice relying only on data on outputs). In reality, investment often seeks to deliver both[12].

Given the output-based nature of the PFI contracts, it is proposed that:

- SPVs will trade-off capital resource on design quality for contractible build quality, resulting in higher levels of the latter (than in Non-PFI facilities) per unit of *C*. This will tend to reduce *F* both in annual facilities management and life cycle replacement.
- The relatively high discount rate SPVs will use in investment decisions, taken together with their ability to commit to higher levels of maintenance and replacement expenditure, will lead them to spend more on *F* relative to *C*.
- Banks will want as much as possible of the total expenditure to be *C*, so that when the riskiest period of the project is complete, i.e. construction, the cost risk can be minimised (and so costly monitoring activity reduced).

3.9.2 Project value - V

The concept of V, the value of outcomes resulting from interaction between users and the asset, can be imagined where the isoquant is not the availability of a facility, but rather for outcomes. This would be a function of a concept translating asset performance (availability and facility service) into a value measure, across the varying values of C and F. It might reasonably resemble the form of the actual isoquant on facility output, but may vary from this based on separate effects on V between varying levels of C and F. That is to say, the point of optimisation with regard to C and F for the determination of outcomes, V, may not necessarily be at the point where minimised WLC cost occurs with regard the proportion of C & F at point A. An example of this might include higher F resulting from the additional utility for the operator of more labour intensive forms of security service on site, where adequate security could be provided by purely capital solutions using WLC cost reducing innovative new technologies. This bears upon the theoretical distinction

[12] Though there may be instances of reduced capacity, e.g. some site rationalisation projects, but the supposed quality improvements here outweigh this loss, at least for the client.

between WLC and WLV, whereby decisions made to optimise either are done so at the expense of sub-optimal pursuit of the alternative concept.

3.9.3 Applicability

It is reasonable to consider whether the choices this framework provides are reflected in the every day choices of client and operators in the context of PSA provision. Buildings are inherently heterogeneous (Ive and Gruneberg, 2000). This limits the applicability of a model based on the choice about continuous units of inputs, whereas the construction (if not operation) of PSAs more realistically involve idiosyncratic, discrete, *lumpy* allocations. The abstraction of this approach is justified given the vast variety of specifics from case by case consideration, be that in experience of procurement teams, budgetary scenarios and local historic investment. Homogeneity and input divisibility are convenient assumptions applied here to test wider abstract hypotheses concerning the role of procurement in influencing WLC.

At the extreme ends of the isocost line we might imagine two completely different forms of provision based on the extreme application of either C or F. In the first case, a building that has negligible F but very high C might look like any other, except for a complete lack of (or negligible) human staffing for facility maintenance functions. The reality of wide spread application of these types of *robot* buildings might be some way off, but not as far as one might expect. The other extreme might best be represented by a make shift tented military hospital, of which staffing costs, when compared to the build cost, will be far greater than initial construction (although the implications of asset life in each must be considered, and indeed remain, a less well considered consequence of procurement choice). In reality, the *normal* way of operating invested in schools and hospitals is a mix of both modern environments and considerable levels of staffing for management and maintenance. There is undoubtedly considerable variance in the application of C and F in real projects, much of which will be attributable to specific contexts (e.g. higher levels of normalised cleaning costs for mental health hospitals influenced by issues of building layout and specific required security procedures). Identifying the variance attributable to procurement methods applied must be considered as one of many factors that might explain resulting inputs, outputs and outputs.

For means of integrating the proposed framework into a real world context, see below for examples of outputs (facility service level above) and outcomes (the basis for calculating V). This table from the Green Book (2011) serves to highlight the relevance of exam results and improvements in human capital as output and outcomes in school contexts, explored later in this work.

Table 3-3: Example of outputs and outcomes. Source: Green Book, 2003, box 6.

BOX 6: EXAMPLES OF OUTPUTS AND OUTCOMES

Policy area	Outputs	Outcomes
Job search / Job matching	Number of job seekers assisted.	Value of extra output, or improvement in efficiency of job search
Development of skills	Number of training places and / or numbers completing training	Value of extra human capital, and / or earnings capacity
Social outputs: Schools; Health centres	Exam results (schools), People treated (health centres).	Improvements in human capital (schools); Measures of health gain (health centres).
Environmental improvement	Hectares of derelict land freed of pollution.	Improvement to the productivity of the land.

As is eluded to above, the consideration of project value following investment in healthcare facilities constitutes some improvement in the capacity or quality of service the facility is able to provide (outputs), or improvement in healthcare outcomes such as lower incidence of re-admission, infection rates (e.g. MRSA or C-Diff) or increased life expectancy compared to a base case. Accessing data in this area is difficult as not being so consistently available at the facility level. This has improved in recent years following the 2010's coalition government's attempts to increase transparency in public datasets, but gaps remain. Further, given the heterogeneity of hospitals, it is difficult to triangulate improvements in outcomes given the varying specialisms of certain facilities. Comparing the outcomes (such as the prevalence of MRSA or C Diff infection rates) of a general acute hospital with that of a specialist cancer treatment facility serves as a case in point.

3.9.3.1 The internal capital constraint

The first scenario to be considered with regard to procurement method is the choice for the government to contract for an initial design and build contract for a PSA, with the on-going service provided in-house. In this case, a common observation is imposed. In the pursuit of lower overall capital costs resulting from a more myopic view with regard to future liabilities, government develops a capital aversion. In the context of devolved public clients typically requiring central government sign off on capital allocations, even benevolent local clients could not reasonably hope to overcome an institutional preferred strategy of selecting lowest priced tenders, what ever the implications of these may be. Aside from this myopia as the source of this capital constraint, it may well result from lack of good information about the relative productivities of C and F in providing a lower WLC facility. To represent this we impose a capital constraint some distance lower than the optimal point. Using this framework we can interpret the impact of this choice. By imposing a maximum value on C, it is necessary to substitute higher levels of F if one are to achieve a similar level of output (availability and quality of facility service) can be provided (point B). The diminishing marginal productivity of F in delivering these outputs at higher levels of application results in a higher WLC overall (blue dashed line below).

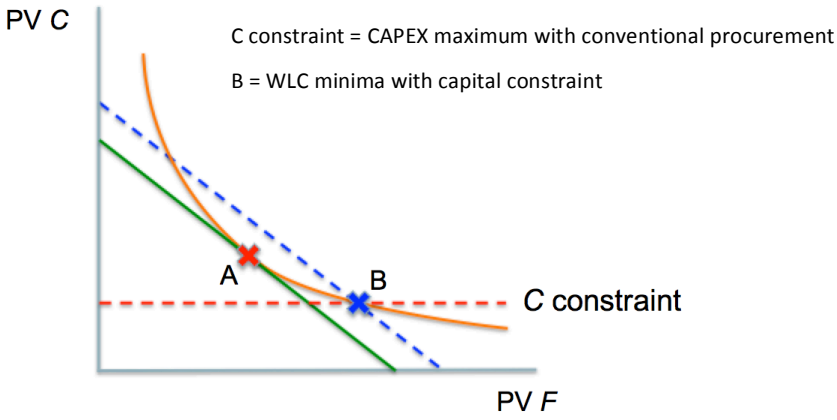


Figure 3-3: The internal public sector capital constraint

The presence of a myopic view about general levels of expenditure in a public authority (given the budgetary horizon typically being forecast up to 5 years ahead)[13], may constrain the public sector in pursuing more efficient longer-term investments in reducing the WLC of operating buildings. Myopia is a focus on the short term, whereby longer-term pay offs may be undervalued. It may express itself in a particularly high discount rate, or an unwillingness to consider costs and benefits beyond certain period. This could be considered as an increasing (geometric) discount rate through time, a concept incompatible with conventional investment appraisal approaches.

This is pertinent to the application of PFI as essentially a form of fixed price contracting. However, as a form of long-term service contract, it combines the arguably more predictable construction cost (incurred upfront), with that of long term servicing cost. The greater level of uncertainty concerning longer-term operational costs, and the transferring of these risks to the SPV operator, constitutes a key economic driver in the supposed VfM of PFI contracts.

This framework implies that outside PFI, public clients will underinvest in capital per unit of capacity. The long-term liability of higher WLC resulting from this under investment is borne by future owners / operators of the asset, with limited recourse to adjust (re-allocate) initial capital investment.

3.9.3.2 Bundling and contract length – potential for higher investment in capital

In a scenario where the client has commissioned a design and build contract, and then outsources operations to an external provider, there may be opportunity for an external provider to consider marginal capital investment to reduce it's own WLC over the contract. This will be tempered by the generally shorter period of outsourced contracts (typically 2-5 years), hence limiting the period over which the provider is able to recoup *investment in operations*, but for some labour intensive activities (catering) there may be potential for labour substitution from the use of dedicated off site facilities using highly capitalised means of production. These investments can be represented by a

[13] There may be little reason to suppose a private company at the corporate level would have greater foresight about it's own future revenues and expenditures. The point to be made here concerns project finance as very different form of procuring and managing a specific asset, usually involving high levels of capital investment, along with which comes a more predictable long term business context provided by the *contract*. The financial model developed by financial consultants for the client, provides detailed estimations of project costs (and of course revenues in the UCP) over the life of the contract.

shift along the isoquant towards the point of optimisation, above the capital constraint amenable to in-house provision. This may lead to a lower overall WLC, represented by the yellow line below (when compared to the previous blue line above). Another factor influencing this pursuit of WLC, is the asset specificity of capital equipment for the delivery of FM services. This pertains to the outsourced provider's ability to use these investments beyond the life of their contract.

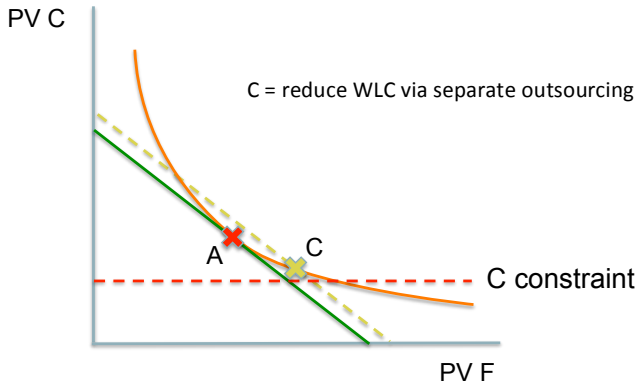


Figure 3-4: Minimising WLC via ex ante integration of building and operation

3.9.3.3 Higher cost of capital for PFI

Another scenario this framework allows us to explore concerns the case against PFI resulting from the application of higher costs of private capital on the discount rate. It is assumed here that the bulk of this effect will translate into making the present value of units of capital resource more expensive relative value of streams of F under public finance.

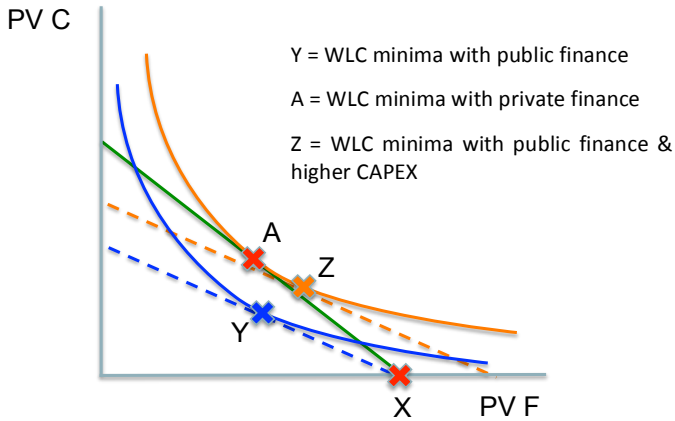


Figure 3-5: The production effect of higher cost private finance

The impact of this increase in the relative price of C (due to the higher cost of capital required to finance it's investment), increases the preference to forgo the option to invest in operations. This is consistent with the fundamental meaning of the discount rate, as representing the preference for benefits in the present against costs in the future.

The higher cost of private financial capital used to deliver PFI projects is a major impediment for the net VfM (compared to a public sector comparator (PSC)) from investment in operations (Public Accounts Committee, 2011). The present values of capital expenses (put, arguably too simply, as a function of discounted factor price (r) and quantity (C_i)) will be subject to little discounting, given that the bulk are incurred at the front-end on construction of the asset. Their present value thus will be markedly greater, compared to future operational expenses (a function of discounted factor price (w) and quantity (O_i)). This limits the extent to which present value reductions of WLC can be achieved via investment in operations. That is, the future potential savings from investment in operations translated into present value will have to exceed the additional undiscounted capital required to achieve the savings. This effect is made all the stronger by the higher discount rate applied resulting from, in the main, us of higher cost private finance.

Here, *'w'* is used for its resonance with wages, to convey the higher proportion of future operational expenses provided by labour factors of production in the form of cleaning, catering, security and other operational service staff. These expenditures are at some risk in the context of inevitable variability in labour cost. Operational costs are typically adjusted by being indexed against RPIX variable or by fixed 2.5% per annum within PFI contracts. Considering the long-term nature of the contracts, it is feasible SPVs may witness periods of above index wage increases, though at least not in recent years following the GFC in the UK. On the other hand, if wages increase at less than 2.5% or RPIX, then free cash flows emerge, to be shared between the SPV and it's FM providers.

The downward constraint to this minimisation of WLC is the minimum service provision required under the long-term service contract (P_i)[14], and the ability of capital and operational resources to

[14] In reality it may prove more profitable for an SPV to run riskier lower cost asset management regimes, that incur infrequent penalties and do not meet P_i completely ('s*weating the asset*' and holding back lifecycle allocations).

deliver these (Murray, et al., 2013). Another limit on PFI's ability to realise returns from investment in operations, at least in a hospital context, concerns the generally labour intensive types of services required. While there may be instances of innovations in the way operational services are delivered under PFI, the prevalence is for services that closely resemble forms of delivery seen in non-integrated outsourcing contracts. This suggests a lack of effective innovation in operational service delivery achievable via unbound investment in *long-term* operations. A further consideration on the pursuit of novel innovations in to achieve lower WLCs concerns the risk aversion of debt providers to back new, untested, perceivably risky design solutions (Leiringer, 2006, Ive, 2004; National Audit Office, 2010a; Rintala, 2005).

Equation 2: *The constrained optimisation of whole life asset provision (Murray et al, 2013)*

Min WLC: $r_i C_i + w_i O_i$

Subject to: $f (C_i, O_i) = P_i$

3.9.3.4 Operational efficiencies via PFI (reduction of x-inefficiency)

The final case to be considered using this framework concerns the supposed efficiency benefits that applying PFI procurement can foster through the application of improved technologies for delivery of serviced PSAs. If PFI operators are able to operate facilities more efficiently in delivering a similar level of service and availability compared to conventional delivery, then we can represent that with two alternative isoquants over the range of values of C and F. As the isoquants converge (point F) we see that the difference between the isoquants is not one of output, but rather efficiency. In this this case a higher level of efficiency with the application of F (facility resources) in the black line (representing PFI as supposedly more efficient). As can be seen, for all values of F below point H the PFI operator requires increasingly less capital resource (C) to deliver the same level of facility output. The consequence of this is a lower overall level of WLC (blue dashed isocost).

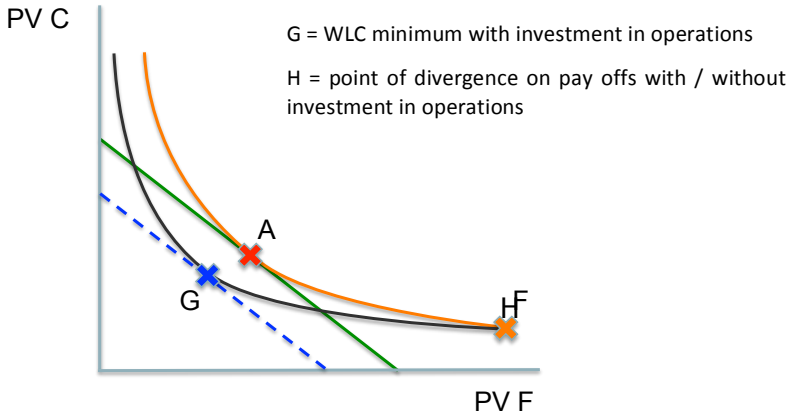


Figure 3-6: WLC efficiencies from investment in operations

Of the explored scenarios above, even with extensive data on all aspects considered, a range of methods would be required to isolate factors to observable facility attributes, only one of which would be procurement thereof. The research is limited in it's ability to observe such isoquants and isocosts at the facility level in entirety, although at times these can be observed in part at different points of the contract. The framework stands as a method of representing the relative benefits of alternative procurement methods concerning the achievement of lower WLC, and as such allows us to better understand the mechanisms by which it may happen, and the consequence of such improvements.

3.10 Analytical structure

The following schematic lays out the concepts to be considered within the Green Book and WLC frameworks. Inputs are forms of cost, including normalised construction (c) and operating expenses (f & s) and will be dealt with in chapter 4 and 5 respectively. Outputs, as indicators of the performance of the PSA or services being provided within them during operations is also covered in Chapter 5. Chapter 6 will then combine and summarise the findings on PSA costs to apply and discuss WLC frameworks in schools, with consideration of how similar insight might be achieved in hospital PSAs. The benefit to users of PSAs are considered as outcomes and will be explored empirically in Chapter 7 with assessing educational attainment change following capital investment. Chapter 8 will conclude the analysis with assessment of returns from investment in school PSAs and discussion of how methods might be developed and applied to hospital PSAs.

Impacts, as the effects of interventions on wider societal goals, such as reduced criminality from prisoner rehabilitation, are beyond the scope of this thesis.

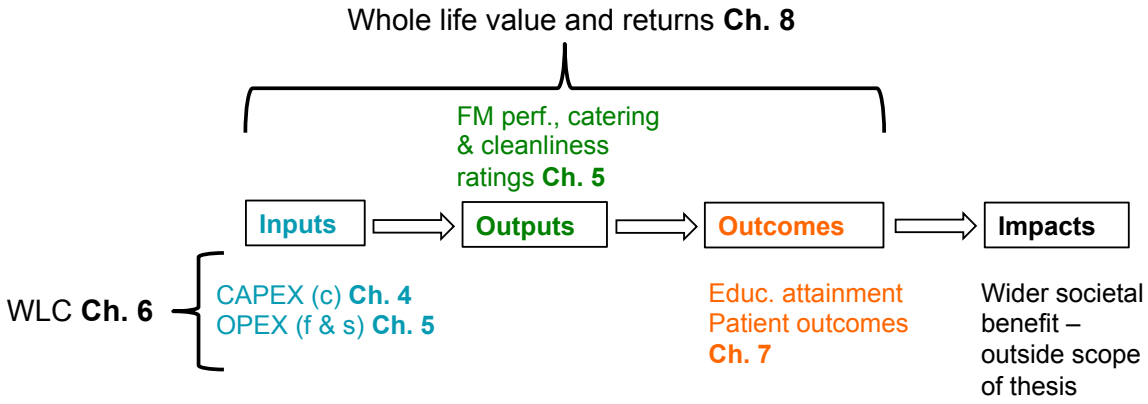


Figure 3-7: Thesis structure across Green Book, WLC and value frameworks.

3.11 Chapter summary

The preceding chapter has explained the philosophical underpinning of the thesis as one based on positivist perspectives. Sampling methods applied to reach the populations of renewed facilities have been outlined, with additional detail on next steps to reach final samples provided in the forthcoming chapters. Finally, examples of how WLC of PSAs might be influenced were laid out, including the potentially testable substitutability between CAPEX (c) and OPEX (f & S), as well as propositions for how procurement route might bear upon WLC.

Chapter 4 Construction

4.1 Motives for capital investment

The estates of PSAs that support the delivery of education and healthcare are made up of a diverse mix of facilities by age and condition. Capital spend in these estates is directed at three principal motives, where works may entail elements of each considering their scope:

- A - improvement of assets above and beyond their historic state via **a**lteration and improvement
- B - maintaining original stock conditions by reducing capitalised **b**acklog maintenance (via refurbishment or replacement of decommissioned stock).
- C - the addition of new stock to add to estate **c**apacity (via extension of existing facilities or additional new build facilities

The allocation of such capital spend has typically been assessed on a case-by-case basis determined by the business cases of individual local authorities and NHS bodies for particular projects. In recent years the devolution of financial responsibility for education and healthcare via establishment of academies and foundation trust status demonstrates a significant change in the fiscal independence of certain authorities in their investment in and operation of PSAs. This has allowed some schools and hospitals to gain greater control of their assets operation, maintenance and capital investment.

In light of fiscal austerity policies following the financial crisis (2007-8), pressures on fiscal budgets have contributed to a call for better information on PSAs with which to prioritise investment to meet motive B, given a lack of appetite for more expensive programmes of A. Austerity period policies have focused on PSAs where capitalised backlog maintenance has accumulated, most notable in the recent Priority School Building Programme. Estate wide asset and condition surveys serve as a means to prioritise this investment on those facilities in most need of capital investment in preventing deterioration or unacceptable states of repair. This is particularly the case for schools following the abandonment of the BSF programme in 2010, where future capital programmes are intended to be refurbishments of type B motive on existing facilities (Education Funding Agency, 2015).

Below is presented a spectrum of construction risk based on the type of facility. This is produced by observing the cost of capital and financial statements of construction and engineering firms (Standard & Poors, 2013). The perceived complexity of schools and hospitals is relatively low, when compared to construction of civil engineering or emerging technology type assets. Clients should consider this aspect when contracting for PSAs to help determine the transfer of construction risk. An alternative perspective on complexity to that put forward here may draw on transaction cost economic perspectives, suggesting that the lower level of risk associated with the firms delivering such assets may be as much a function of their transactional environment as a reflection of the risk involved in the construction of particular types of assets. The common purchaser of the government in the case of schools and hospitals may suggest that such firms in this industry, may benefit from having lower client risk associated with contracting with government. This would be at odds with observation of *tunnels and bridges* above medium risk, given that the vast bulk of these assets are commissioned by public organisations (Network Rail and Highways England). Beside the roll of public clients in potentially reducing general risk in contracting operations, more generally it seems that natural monopoly types of assets are considered less risky (gas pipeline, arenas, barracks) while more competitive industrial settings lead to commissioning of more complex constructed assets (complex power / processing plants, industrial tasks).

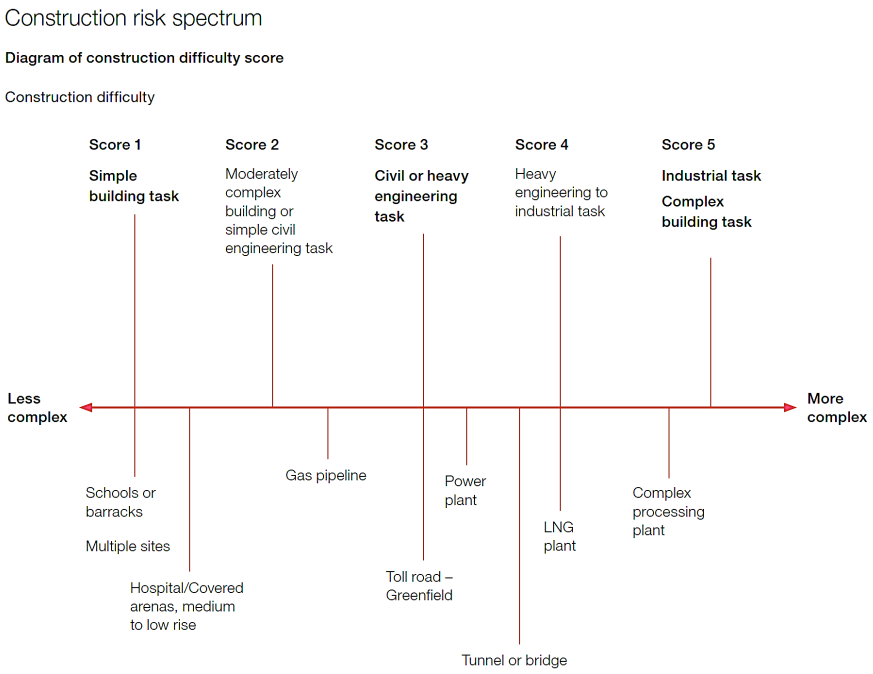


Figure 4-1: Construction risk spectrum. Source: Standard & Poors, 2013.

4.1.1 Decision to invest

The allocation of capital spending for schools investment is made in the context of a large devolved estate. Traditionally, local authorities bid for capital allocations based on self-reporting of the condition of their estate and project proposals for specific capital investments (James, 2011). It is up to Department for Education (or the equivalent government agency responsible for capital investment allocation) to assess bids and allocate funds within their headline departmental budget constraints. In this context, decisions to invest in PSAs resemble the processes used by banks whereby credit committees are charged with reviewing multiple business proposals and assessing each on their own merits, as well as against the range of prospective investments *on the table*. Whereas the proposals a credit committee receive for consideration will be based on a set of assumptions about the commercial prospect of investments (related current and future costs and revenues), PSA investment proposals are required to consider a much less tangible, less definable and measurable set of costs and sources of non-commercial (non-market) benefits. This highlights the difference between private firms seeking assurance for investment viability in the internal cash flows of the firm, and public authorities basing much of the case for investment on the non-internal benefit flows. These, ideally positive externalities, accruing from the use of PSAs are no doubt valuable – few would question the benefits of mandatory education up to 16. The problem for the decision to invest becomes that if these benefits are the basis of investment, their estimation reveals considerable uncertainty in their longer-term value.

4.2 James review of education capital

One clear recommendation of the James review of education capital (James, 2011) was to undertake annual surveys of the school estate on a rolling basis to ensure information on the estate was adequate and up to date. A range of excerpts from the James review are provided below for means of teasing out the insight provided by this comprehensive examination of the BSF programme and the established procedures in delivering capital investment in schools:

> "Over time, the approach to capital investment has become very cumbersome and accountability for time, cost and quality has been dispersed both within programmes and across programmes."
>
> James review, 2011, p. 4.

> "Multiple funding streams diverted funds to those most adept at winning bids rather than necessarily to those in most need."
>
> *ibid,* p. 5.

> "Currently, there is no information held centrally on the condition of the estate and different Responsible Bodies receive capital in different ways."
>
> *ibid*, p. 5.

> "The large number of different funding streams has created complexity, confusion and unnecessary bureaucracy. Each specific stream has its own process for allocation. This can result in many bids for multiple streams, with different criteria to satisfy and different processes to follow in each case."
>
> *ibid,* p. 32.

> "The range of statutory and non-statutory guidance has led to confusion about what applies to which type of school, and whether guidance is compulsory or optional. For example, the use of Building Bulletin 98 as a means of calculating funding has meant that over time the Building Bulletins and other guidance have become rigidly followed by schools, Local Authorities and contractors, effectively acquiring the force of law. When printed out on A4, regulations and guidelines governing the design and building of state schools in England are over 3,000 pages long."
>
> *ibid*, p. 35.

The quotes and surrounding review describe a competitive system where some local commissioning bodies are able to attract capital grants from the centre, as part of the rationing process of national allocation. This process may lead to opportunities for capital investment being missed where commissioning bodies are less able to produce high quality proposals for capital grants.

4.3 Age and condition of PSA estates

4.3.1 Schools

In pursuit of more focused investment allocation, the Education Funding Agency, following recommendation no. 8 made in the James review of educational capital (James, 2011), undertook a *near* complete survey of the current school estate between 2012 and 2014. This survey notably excludes recently *modernised* facilities that have received investments since 2004, PFI operated facilities and academies as independently accountable for their operations (Education Funding Agency, 2015). This prohibits insight on the majority of PFI or conventionally procured investment in recent years. This Priority Data Survey Programme (PDSP) completed these surveys in the summer of 2014 and produced a detailed elemental picture of the condition of school buildings, with headline findings being published in 2015 (Education Funding Agency, 2015). Looking at schools covered by the PDS survey across the English estate (devolved national authorities have responsibility for their own estate maintenance), we see a combined 52.8 million m^2 of gross internal floor area for those schools covered in the PDSP (table 4.1). The sheer vastness of this estate of PSAs facilitating delivery of education serves to highlight the relevance of considering the WLC and maintenance of PSA estates in managing obsolescence and loss of capacity from deterioration. Using the estate size, establishments and educational block indicators by region, it can be seen in table 4.1 below that London stands out with fewer facilities (11%) than their estate share in the national floor area level would suggest (15%). London schools will tend to be larger facilities than schools elsewhere, in part reflecting the higher population density. North West schools seem to comprise of facilities with fewer separate blocks (10%) than their national estate floor area contribution (13%).

Table 4-1: Breakdown of GIFA, blocks and establishments surveyed under the PDSP by region. Source: Education Funding Agency, 2015, table 2.

Regions	Sum of Gross Internal Floor Area		Education Establishments		Education Blocks	
	Total (m2)	% of Total	Total Number	% of Total	Total Number	% of Total
East Midlands	4,166,748	8%	1,760	9%	5,481	9%
East of England	6,838,344	13%	2,364	13%	8,202	14%
London	7,738,604	15%	2,084	11%	8,033	13%
North East	2,276,754	4%	954	5%	2,243	4%
North West	6,900,554	13%	2,720	14%	5,977	10%
South East	9,594,187	18%	3,065	16%	11,505	19%
South West	5,080,622	10%	2,049	11%	6,631	11%
West Midlands	5,581,415	11%	1,976	10%	6,476	11%
Yorkshire and the Humber	4,600,639	9%	1,858	10%	5,419	9%
Totals	**52,777,867**		**18,830**		**59,967**	

Table 2: Breakdown of GIFA, blocks and establishments surveyed under the PDSP by region

In secondary schools, the PDSP shows that while the majority of facilities were constructed post 1967 (by both GIFA and blocks), there remains a considerable part of the estate built before 1945 (13% by GIFA and 9% by blocks). The considerable proportion of the estate originating from between 1967 - 1976 (considering this period is only 9 years in length), will be in part down the raising of the school leaving age in 1972 from 15 to 16. This of course necessitated a larger estate to house an additional year of pupils. This is also a result of moves toward comprehensive schools, where some new facilities were required to adapt from secondary modern facilities that did not have the amenities to teach a modern comprehensive syllabus (including new blocks for science and language labs). Sixth form blocks were also required where comprehensive school wished to provide post 16 education.

Table 4-2: Breakdown of secondary GIFA, blocks and establishments surveyed under PDSP by building type. Source: Education Funding Agency, 2015, table 6.

Secondary				
Building Types	Sum of Gross Internal Floor Area		Education Blocks	
	Total (m2)	% of Total	Total Number	% of Total
Pre 1919	1,488,162	6%	989	5%
Inter War	1,708,367	7%	814	4%
From 1945 to 1966	6,602,225	28%	3,461	18%
From 1967 to 1976	5,416,198	23%	3,925	21%
Post 1976	7,792,166	33%	7,022	37%
Temporary premises	436,923	2%	2,663	14%
Totals	**23,444,041**		**18,874**	

Table 6: Breakdown of Secondary GIFA, blocks and establishments surveyed under the PDSP by building type

Source: PDSP 2014

Summary findings from a first analysis of the PDSP data on asset condition assessment reveals the greatest need for investment in the stock originating from 1919 to 1966, compared to average. There is a noticeable lack of need for investment in the pre 1919 built stock, aligning with anecdotal commentary that while some of the oldest buildings (particularly Victorian facilities) have issues in terms of maintenance and lack of adaptability in internal layouts, their durability in terms of building fabric and structure is often superior to more modern post-war constructed buildings within the estate.

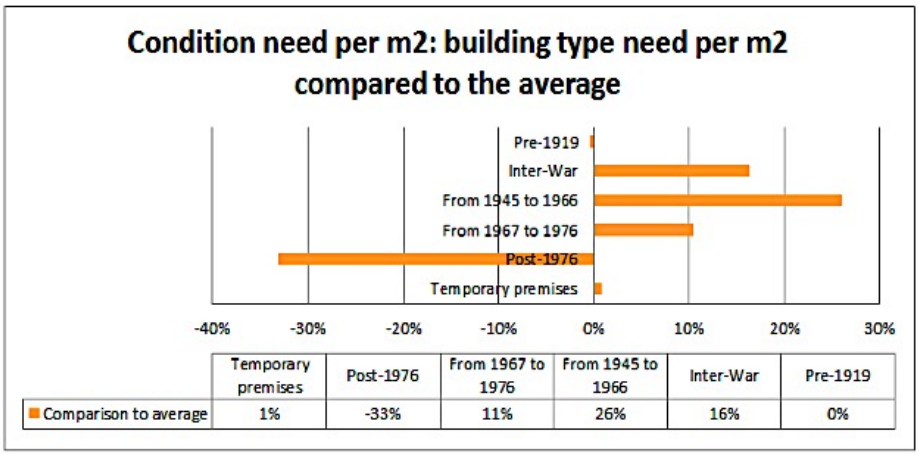


Figure 12: Condition need per m2: building type need per m2 compared to the average

Source: PDSP 2014

Figure 4-2: Condition need per m^2 - by building type compared to average. Source: Education Funding Agency, 2015, fig. 12.

Using the surveyor's grade classification (A being best condition and not in need of investment, D being the poorest and in urgent need of repair or replacement to avert obsolescence), the proportion of need for investment can be attributable to the number of records of asset condition by grade bandings. 49 elements of building condition are considered within blocks of facilities as part of the PDSP surveys, though no per m2 allocation of condition need or detailed costings for remedial works are presented. While 35% of asset records are considered to be in Grade B, these elements make up 52% of the need for investment. With just 0.5% classified as grade D, this still generates 9% of the overall need for investment given the higher expense of rectifying building elements in such disrepair.

PDSP condition data			
	% of estate (by record)	**Condition need / total condition need**	**Condition need per record**
Grade A - 1,468,515 records	58.8	**0**	**0.00**
Grade B – 874,641 records	35	52	**1.49**
Grade C – 142,669 records	5.7	39	**6.84**
Grade D – 11,318 records	0.5	9	**18.00**
Total	100	100	

Figure 4-3: Need for investment in the school estate by condition classification. Source: Author analysis.

The importance of continual monitoring of PSAs physical state is apparent given the additional costs that might be required to maintain parts of the estate that have lacked investment such that deterioration accelerates. While the initial PDSP exercise was valuable, the NAO recently supported additional surveys and deeper analysis of patterns of deterioration over the estate:

> "Recommendation C: The Department should continue to improve its understanding of the condition of the school estate and consider how it can get more value out of the next property data survey. For example, it should compare the findings with the previous survey and analyse the data in greater depth to understand patterns of condition need."
>
> NAO, 2017, p. 13.

Some additional insight from the James review on this point follows, suggesting that allocation of capital funds might be better prioritised to focus on schools in most need of reducing their backlog maintenance (motive B). This is especially the case if the negative effects of dilapidated environments on educational attainment can more easily be managed than investment allocations for above average trend improvements:

> "Dilapidation and the general state of school buildings was not part of the consideration when deciding which areas should be first to receive BSF funding. Local Authorities did sometimes take condition into account when allocating funding within an area but also a large number of other factors. The result is that there is poor correlation overall between the condition of schools and the order in which they were refurbished or rebuilt."
>
> James review, p. 13.

> "However, the current (broadly) per-pupil allocation of funds for small works and maintenance as DFC is inefficient. Each school gets an allocation on a national formula. Therefore funding is being allocated to schools no matter what the actual requirement is for that school."
>
> *ibid*, p. 48.

4.3.2 Hospitals

Data on the age asset profile and condition of hospitals is collated annually via the Estates Return Information Collection (ERIC) and combined into the Hospitals Estates and Facility Statistics (HEFS). A key difference between this data and the above PDSP data for schools concerns how ERIC data is self-reported by hospital estate managers, as opposed to being detailed elemental condition data undertaken by independent surveyors in the case of the PDSP. Hence, some question the reliability of ERIC data. The NHS Information Centre who holds the central dataset make very clear in their disclaimer that the "completeness and accuracy of this data is the responsibility of the provider organisation." (Health and Social Care Information Centre, 2015). However, it remains the best source of high coverage and wide scoping data on the hospital estate.

Table 4-3: Age distribution of the hospital estate in 2015. Source: ERIC, Author analysis.

Period	%
2015 to present (%)	0.7
2005 to 2014 (%)	16.8
1995 to 2004 (%)	19.3
1985 to 1994 (%)	19.7
1975 to 1984 (%)	11.0
1965 to 1974 (%)	9.1
1955 to 1964 (%)	3.3
1948 to 1954 (%)	1.7
pre 1948 (%)	18.3

Looking at the 2014/15 report, we see that the age asset profile of the hospital estate (comprising 1,251 separate and diverse hospital facilities) is relatively new with 50% of facilities having been built between 1975 and 2004 (compared to 35% between 1976 to 2004 for secondary schools). A higher proportion of the hospital estate originates from pre 1948 when the NHS was founded (18.3%) compared to 13% of the secondary comprehensive estate pre-1945.

The combined estate GIFA for the above hospitals is 26.362mn m^2, about half the school combined estate area above (comparable to just secondary comprehensive estate at 23.444mn m^2). Condition data for hospitals is sparse and less than wholly reliable. The following analyses attempts

to use the NHS collated Estates Return Information Collection (ERIC) data on the backlog maintenance in renewed hospital facilities.

Table 4-4: Backlog maintenance for UK hospitals renewed since 1995 (£ per m^2). Source: ERIC, 2005-8. Author analysis.

Backlog maintenance	*Mean*					*t-Test*				
Year	*Group*	*N*	*Mean*	*Std. Dev.*	*Std. error mean*	*t*	*df*	*Sig. 2 tailed*	*Mean diff.*	*Std. error diff.*
2004/05[†]	*Non-PFI*	*35*	*1.10*	*3.67*	*0.62*	*1.57*	*34.88*	*0.127*	*0.98*	*0.62*
	PFI	*16*	*0.13*	*0.28*	*0.07*					
2005/06	*Non-PFI*	*8*	*0.11*	*0.24*	*0.08*	*0.78*	*9*	*0.455*	*0.11*	*0.14*
	PFI	*3*	*0.00*	*0.00*	*0.00*					
2006/07	*Non-PFI*	*13*	*0.13*	*0.46*	*0.13*	*-0.94*	*7.05*	*0.379*	*-2.08*	*2.21*
	PFI	*8*	*2.21*	*6.24*	*2.21*					
2007/08	*Non-PFI*	*13*	*132.8*	*474.8*	*131.7*	*1.01*	*12.00*	*0.333*	*132.74*	*13.70*
	PFI	*13*	*0.06*	*0.21*	*0.06*					

[†] Levene's test of equality of variance showed statistical significance at 0.035 for 2004/05, 0.011 for 2006/07 and 0.039 for 2007/08; *equal variances not assumed* test results are presented

The few very high standard deviations relative to means belie the quality of the underlying data beside the low sample sizes of facilities that record sufficient data to be evaluated. The 2007/08 high average is driven by one instance of a multi million pound record for capitalised backlog maintenance, as potentially the only valid facility level estimate in the sample, at odds with numerous zero records.

One would expect to find lower levels of Backlog maintenance in PFI compared to non-PFI hospitals. This is because PFI contracts provide both opportunity (by ring-fencing of funds) and incentives (long term contracts on fixed price basis) to prevent build-up of backlog maintenance. However, findings here on Backlog maintenance remain elusive as available sample sizes are limited, and require more accurate allocation by asset age. The sample sizes drop considerably into year 2005 onwards as the opportunity to use more granular age asset profile data became available. In making comparisons on backlog maintenance it is preferable to compare buildings on as close to similar characteristics as possible.

4.4 Allocation of capital investment for schools

To provide an overarching context for consideration of schools, Appendix 7 provides information on the organisations and lines of accountability involved in school funding. As is apparent, there is now a clear distinction between the maintained schools under the jurisdiction of the 152 local authorities and a growing number of schools operated under the relatively new academy (and free schools) policy. This institutional structure was not as relevant during the period when recent large-scale school capital procurement were under way. Before the current EFA, there was a precursor organisation named Partnerships for Schools, which provided the capital investment function of the Department for Education. They were principally charged with delivering the BSF programme and assessed the capital bids from local authorities for capital grants.

The positioning of the Education Funding Agency as separate to the Department for Education is intentional, as a way to bring about the independence granted to *arms length* agencies like the EFA. Such attempts by government to distance the public bodies charged with making key expenditure decisions (including capital investment allocations, subject to DfE centrally agreed budgets), is by no means a new phenomena. The pursuit of greater independence for key investment decision-making is apparent in other sectors, with a recent parallel in the roads sector in the establishment of Highways England in April 2015, accountable to the Office of Road and Rail independent regulator. This is in part in acknowledgement that capital allocations can be subject to political influence that can lead to sub-optimal allocation.

The independence of academies in their funding, reporting and responsibility makes their study more challenging. As data on school renewal was sourced from the School building Survey 2009 (a survey of local authorities), the research was unable to source data on independent academies, as not being under the jurisdiction of the LA. As such, academies are not included in the scope of analyses.

4.4.1 Educational capital policy in the period of BSF

The commitment to increased spending on school buildings, which was in 2004 to become the BSF programme, began in a small way. In the 1998 Budget, £90 million of capital funding was allocated: £35 million to remove the outside toilets still being used at 600 schools; £15 million to allow up to

500 schools to replace or improve their inefficient heating systems; and £40 million to provide extra classrooms to help the government deliver on its pledge that no child aged five to seven should be taught in a class of more than 30 children. This was presented largely as the government intending to address a backlog of maintenance and repairs in the schools sector (motive B and some C). The Department for Education and Employment (DfEE) did note that the improvements to heating systems would reduce fuel used and assist in reducing CO^2 emissions. In 1999 and 2000, various further announcements were made in what was known as the New Deal for Schools, all of which focused on the repairs backlog and the replacement of temporary classrooms (House of Commons Education and Skills Committee, 2007, p. 10). Up to this point, objectives were therefore more in terms of assuring a *decent* minimum standard of facilities for all, rather than obtaining wider economic benefits of investment-induced increases in educational attainment (motive A).

The capital programme took on a different dimension later in the year 2000. In September, the department announced capital expenditure of £7.8 billion for 2001–02 to 2003–04. This funding was to be used completely to transform or replace 650 schools, both primary and secondary. By this time the government had committed about £10 billion to be spent on school repairs and rebuilding since coming into office. In January 2001, for the first time, the Department for Education and Employment drew attention to the 'performance' case, in a research brief published by DfEE (PriceWaterhouseCoopers LLP, 2001) and Press Notice (Dept. for Education and Employment, 2001). Both press notice and research brief referred to research undertaken for the Department by Pricewaterhouse Coopers (PwC), supplemented by additional work in 2003 (PricewaterhouseCoopers LLP., 2003) and glossed its findings as supporting the claim that capital investment had been shown to have positive association with educational attainment.

The House of Commons Education and Skills Committee later referred back to the Department's belief that 'Capital investment impacts positively on pupil performance, particularly in terms of improving teacher morale and motivating pupils' (HoC Committee, 2007). The authors of the research referred to actually wrote 'on balance, the research suggests that, where there are statistically significant effects of capital on performance, these are positive' (PwC, 2001, p. 42).

In a speech by David Miliband, then Minister of State for School Standards, in October 2002 (Miliband, 2002), the redevelopment of schools was put forward explicitly as a means of improving

educational standards, a point returned to by the House of Commons Education and Skills Committee in its report on BSF in 2007 (Educational and Skills Committee, 2007, p. 11). Improvement of educational performance had become the main aim of and justification for the proceeding rebuilding programme. Despite this quite clear objective, the criteria by which improved outcomes should be measured, to allow ex ante appraisal and ex post evaluation of the programme, were never made explicit.

Whilst the government of the time had many goals for education, including those embodied in Every Child Matters: Change for Children (HM Government, 2003) of promoting and securing child health, safety, attendance at school, and behaviour, as well as economic well-being through employment, the proceeding analyses focus upon the last of these policy goals. The goal of *educational transformation* and improved educational attainment (EA) resulting from investment in schools is the focus.

4.4.2 Building Schools for the Future (BSF)

In 2004 BSF was launched. It was an ambitious programme designed to rebuild or refurbish all secondary schools in England over 15 years at a cost of £45 billion, with local authorities participating in a series of 15 'waves'. The James review tells us this programme was intended to renew the entire secondary school estate with a programme of 50% new build, 35% major upgrade and 15% minor upgrade, suggesting the programme involved capital allocations in pursuit of all three of the construction motives considered above. The figure below shows the development of capital allocations for the education estate. As is evident, the academies programme is a minor element up until 2009/10 with the bulk of capital allocations under capital maintenance grants and strategic area based renewal (including BSF).

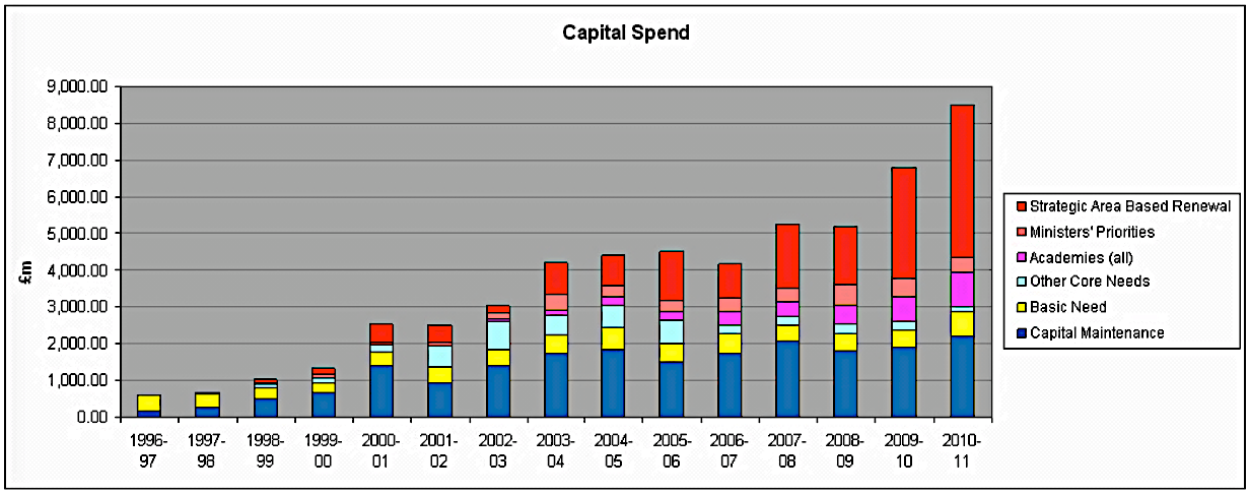


Figure 4-4: Capital spending in schools 1996-2011. Source: James, 2011, fig. 1.

For a longer term more aggregate historical view of capital investment in schools, we can turn to a 2007 report on capital investment in education (Dept. for Education and Skills, 2007). As is apparent, the school estate had undergone 2 decades of relatively minimal investment against historic levels. Further, the capital programme up to 2008 (and the inertia of the programme from announcements to curtail investment in 2010) was significantly larger than previous programmes in the 1960s and 1970s.

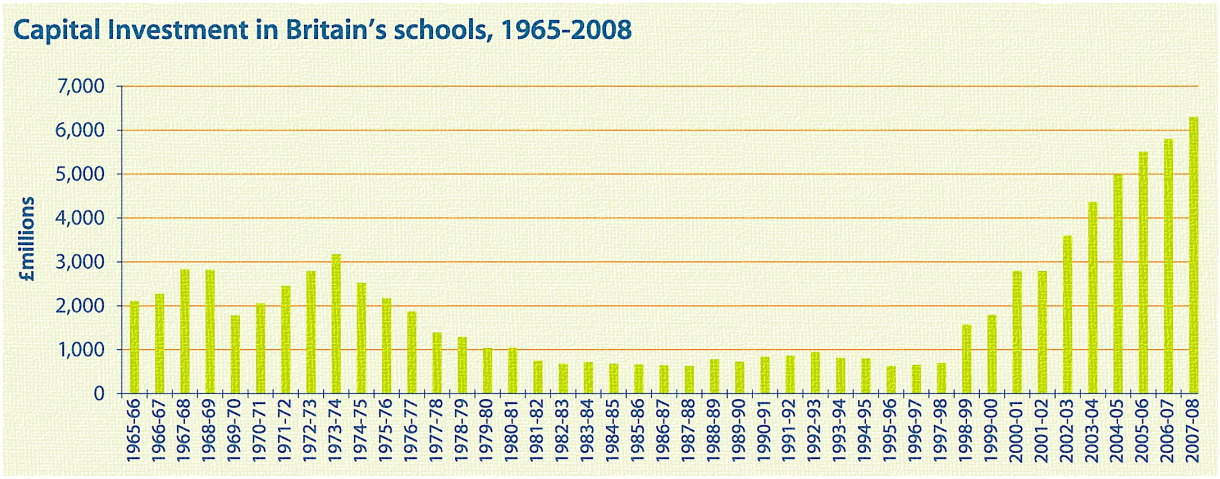


Figure 4-5: Capital investment in Britain's schools, 1965-2008. Source: Dept. for Education and Skills, 2007.

As well as intending to improve the fabric of school buildings and provide considerable investment in information and communication technology (ICT), BSF was intended to transform the

educational experiences of pupils (House of Commons, 2007, p. 4). The Commons' Select Committee stated:

> "investment in the three decades before BSF was announced had been minimal, meaning that there were very few architects, procurement experts or head teachers in the system with experience to build on. Even the research base has little to tell us about how we should design sustainable learning environments for the future."
>
> House of Commons Committee, 2007, p. 12.

BSF was conceived as a long-term programme of investment and change in England to help transform education for 3.3 million students aged 11-19. Although originally planned as a 15–20 year programme, it was announced by the new Secretary of State for Education on 5 July 2010 that only projects that had achieved Outline Business Case (OBC) approval by 1 January 2010 would continue. The James review suggested that around 840 of the approximately 3,500 secondary schools had received (or soon would) investment via BSF (James, 2011, p. 52) with only 8% of the planned renewal being delivered after 7 years of the programme (ibid, p 12).

4.4.3 Procurement in Schools

The ultimate funding of comprehensive secondary education in the UK remains via tax receipts. However, between 1997 and 2010, the use of the PFI to finance upfront capital investment in schools has been considerable. According to the HM Treasury PFI signed project list of March 2015, the DfE has 171 PFI projects (158 in operation, 13 in construction). The capital value of these contracts is £8.4bn (average contract value £49m (st. dv. £34.6m), length 26.2 years (st. dv. 2.1 years)). Nearly all of these contracts are for bundled school investment projects by local authority, including both primary and secondary schools. The average contract value is roughly 2.5 times that for the construction cost of a typical new build 1,000 pupil capacity secondary school (circa £20m around the time of BSF). This bundling is in part due to the high transaction cost of arranging PFI projects, and the relatively low capital value of a single school facility investment.

The original intention of the BSF programme seems to have been to have a clear split between new build schools, to be constructed and operated under PFI contracts, and refurbished schools, which would be the subject of DBOM contracts (Design, Build, Operate and Maintain). In most cases DBOM became just 'Design and Build', with or without separate FM contracts. In addition, many of the schools originally had expected to be procured under PFI became conventional capital projects using Design and Build contracts. This will in part be a result of the reluctance (or excessive pricing) of PFI sponsors to take on refurbishment projects.

The James review does go on to note the potential for standard designs and specifications in reducing WLC, through common material specification and lower energy use. It also puts forward the central funding body as best placed to drive programme efficiencies considering the purchasing power of a unified procurer of capital investment programmes. The review does not consider the role of private finance in capital investment.

The cancelation of the BSF programme in 2010 (the majority of whose spending related to use of PFI), suggested the future scope of PFI capital investment in the school building stock would be less than recent years. This became apparent in the policy that came to follow BSF, the Priority School Building Programme (PSBP). A £4.4bn programme to focus capital allocations on schools in the worst condition, the first phase of 260 schools saw only 46 being delivered under the PF2 replacement to PFI (Education Fudning Agency, 2016). Given the greater suitability of PFI type procurement to new build projects, given the pricing of risks associated with refurbishment projects, coupled with a policy of maintaining the existing estate (motive B, rather than expansion with new buildings, motive C or A), the use of PF2 in this area of future capital allocation will likely be more constrained.

4.5 Schools CAPEX - method and findings

This section serves to describe the process of collating the data and calculating the cost ratio concepts required for analysis of school construction cost, using the 395 population of renewed schools detailed in the Chapter 4.

The data for cost of works comes from the Partnerships for Schools 2009 school building survey (SBS). This survey was distributed to local authorities by PfS to complete based on their own

information to hand. Values for construction cost are based on answers to the survey question 'Actual or estimated total cost of works at school?'. Of the 395 schools identified as renewed using the SBS 2009 (refurbished, rebuilt or new build), only 266 reported a sum for works done (or impending works). Working with this data revealed some worrying issues when normalised by a meaningful indicator of school facility size. In an attempt to clean the data, an estimated CAPEX per unit of pupil capacity was calculated for each school, to be compared with that reported. The method for this estimation is given in Table 4.5 below.

Table 4-5: Method for estimation of schools CAPEX and normalised pupil capacity unit cost.

Step	Method	Data source
1. Estimate school size (m^2)	Take reported pupil capacity of the school and multiply it by the minimum guidance space for schools (accounting for whether they include post-16 facilities)	Pupil capacity (Department for Education, 2012b)
		Space guidance – Building Bulletin 98 (DfES, 2004)
2. Multiply estimated school size by cost per m^2 indicators	Take the estimated m^2 and multiply by the EC Harris cost indicators for school buildings (with adjustment for London prices)	EC Harris cost indicators (EC Harris, 2006)
3. Normalize to CAPEX per unit of pupil capacity	Divide the CAPEX per school at 2009 prices by the school's pupil capacity to obtain CAPEX per pupil capacity unit	Pupil capacity (Department for Education, 2012)

This estimated CAPEX per school (the result from step 2) was then regressed against reported CAPEX to investigate how well they correlated. Analysis revealed a raft of data points far too low to be considered as reasonable sums for the significant works indicated in the SBS 2009. These were identified by use of conservative lower limits for reported against estimated CAPEX based on type of works indicated (refurbishment – 20%, new and rebuilt – 60%) and removed from the samples. This revealed a subsample of 166 schools (C:166, of the 266 that reported sums) that had credible sums for CAPEX, the schools for which were taken forward for further analysis of WLC ratios.

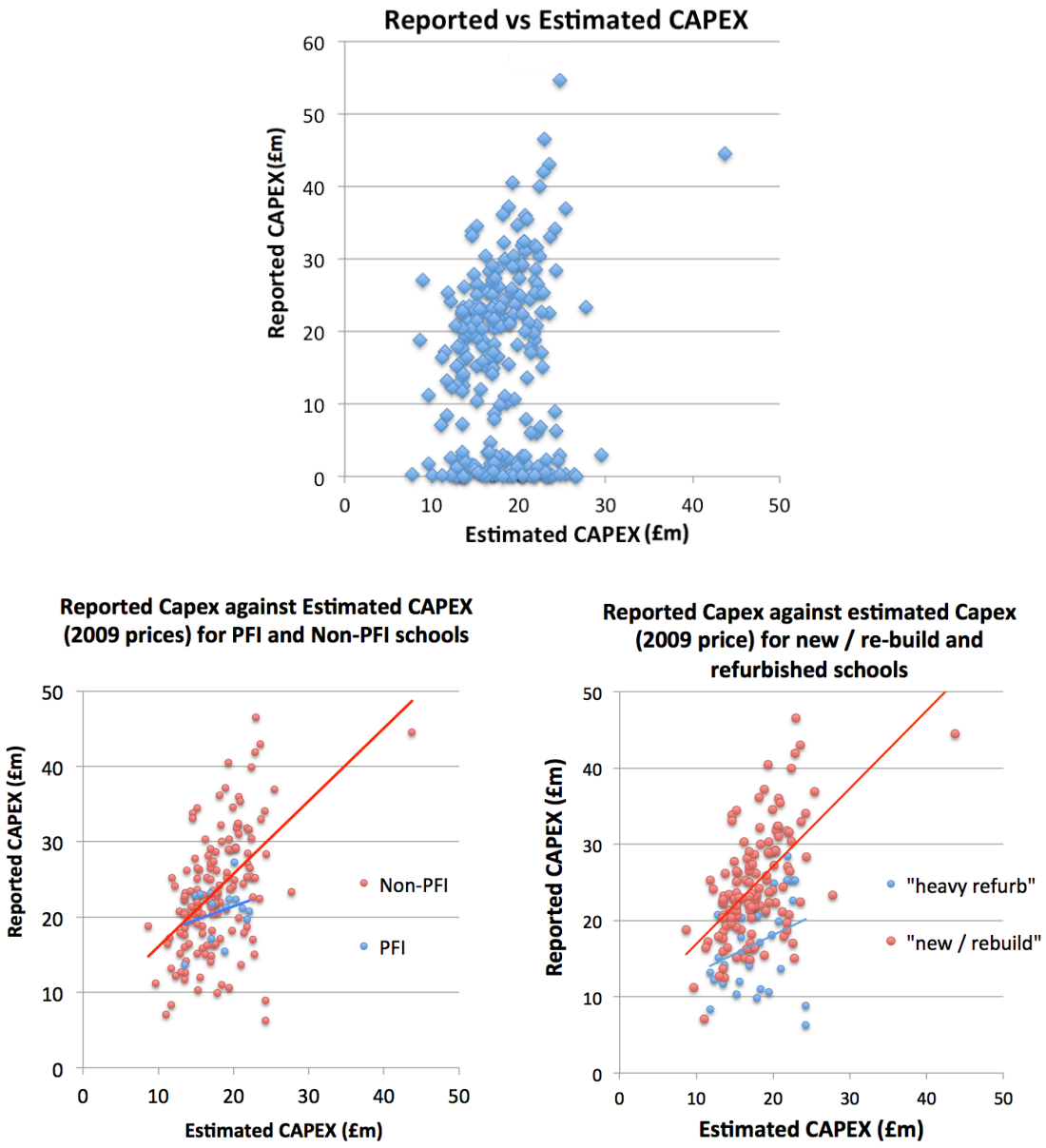


Figure 4-6: Reported CAPEX against estimated CAPEX (n=166) by procurement and capital works type. Source: Edubase, SBS, EC Harris, 2006. Author Analysis.

As is apparent, reported CAPEX tends to be higher than estimated CAPEX, which may be down to the estimating method using minimum design guidance to estimate schools size. The schools as built may be somewhat larger than estimated. This C 166 sample is comprised of schools that, in the main, received these capital investment from 2008 to 2011, as indicated by Figure 4.7 below.

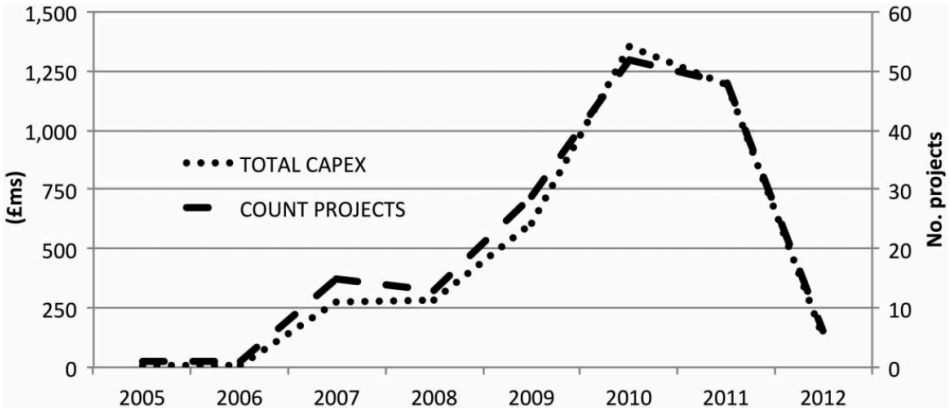


Figure 4-7: Timing of investment in core 166 CAPEX sample.

In the case of the PFI samples above, the question of what the price of construction works (to the public client) is not a simple one. PFI wraps up the CAPEX investment for the facility's construction into the UCP payment liable over many years. The actual capital investment by the SPV may not be so clearly apparent to the client in this case, as while constituting a form of fixed price contract, control of what CAPEX is expended remain at the discretion (and within the property rights) of the SPV. It would appear that in quite a few cases of renewal by PFI, the school did not know, and so could not report the level of CAPEX. This is may in part be the result of bundling individual school capital work over a single contract for many facilities. As such, each school may know the capital value of the bundled contract CAPEX value (for many schools), rather than individual school allocation.

Table 4.6 below shows a range of statistics made possible through combination of the above CAPEX sample with other datasets providing partial information on school buildings. Pupil capacity and pupils on roll are provided in the Edubase database (Dept. for Education, 2014a), with total usable floor area (TUFA) available for a limited number of schools from aggregating Display Energy Certificate (DEC) surveys (Department for Communities and Local Government, 2015).

The average £20,497 CAPEX per pupil capacity fits well with the stylised fact that *typical* comprehensive schools can accommodate around 1,000 pupils and cost around £20m. However, within the sample there are about a 5th of schools achieving build costs of less than £15,000 per pupil capacity unit against a small number of schools costing more than twice this. Facility size will explain some of this variance with the obvious benefits of economies of scale available in large

facilities, along with the clear difference in cost indicated above between new / rebuild and refurbishment capital works.

The indicator of TUFA per pupil on roll demonstrates that while stylised assumptions can be used in the estimation of normalised WLC components (including construction costs), the deviation from assumed values can have large effects on outturn WLC cost indicators.

Table 4-6: C sample variance in key construction ratios and capacity utilisation rate. Source: Edubase, SBS, DEC, Attainment tables. Author Analysis.

Variance on key ratios	Reported CAPEX per pupil capacity unit (£)	Reported CAPEX per pupil on roll in 2012 (£)	Reported CAPEX per TUFA m^2 (£)	TUFA (m^2) per pupil on roll 2012	TUFA per pupil capacity unit (m^2)	Capacity utilization rate (pupils on roll 2012/capacity)
Average	20 497	27 266	3552	9.24	8.38	0.87
SD	6383	27925	5705	3.40	3.41	0.22
n	166	166	56	56	56	166
Minimum	3672	3679	703	0.79	0.72	0.12
Maximum	39 267	298 361	43 324	18.77	24.38	1.97
Percentile						
10th	12 578	14 038	1466	6.8	4.2	0.61
20th	14 929	17 172	1750	7.3	6.9	0.72
30th	17 817	19 943	1876	7.7	7.4	0.81
40th	19 463	21 566	2148	8.3	7.8	0.88
50th	20 285	22 457	2453	9.4	8.4	0.91
60th	21 898	24 913	2629	9.9	9.2	0.94
70th	22 972	27 039	3085	10.3	9.6	0.97
80th	24 541	30 332	3641	10.8	9.8	1.00
90th	27 738	35 896	4423	12.7	10.6	1.06
100th	39 267	298 361	43 324	18.8	24.4	1.97

Table 4.7 below provides average construction cost per gross internal floor area (GIFA m2) for BSF schools in 2009 prices. These data were obtained from the DfE following the above analyses. It provides a useful cross check on the accuracy of the above estimations. Its use in this way is justifiable given the prevalence of BSF schools within the sample (be they PFI or otherwise given that a significant part of the BSF programme was more conventional D&B). With some interpretation, it can be compared with the sample data in Table 4.6 above.

Table 4-7: BSF normalised build cost. Source: Dept. for Education.

Gross internal floor area (GIFA) (m^2)	BSF (2q 2009 prices)		
	Average	20th percentile	80th percentile
0–2000	£2851	£2021	£3712
2000–4000	£2780	£1999	£3442
4000–6000	£2566	£1914	£3033
6000–8000	£2303	£2132	£2508
8000–10 000	£2158	£1863	£2403
10 000–12 000	£1980	£1837	£2081
12 000–14 000	£1899	£1701	£2017
14 000–16 000	£2075	£1845	£2299
16 000–18 000	£1962	£1690	£2180
18 000–20 000	£1938	£1786	£2105

Table 4.6 provides TUFA per pupil on roll weighted mean as 8.62 m^2, and TUFA per unit pupil capacity weighted mean as 7.95 m^2. A reasonable approximation of the average value of construction price per m^2 from the BSF data above might be £2,400. Assume further that TUFA is *similar* to GIFA. Multiplying this £2,400 by 7.95 (the weighted mean TUFA per unit pupil capacity - Table 4-6) gives £19,080 estimated construction cost per unit pupil capacity for the DfE BSF data, a value quite close to the £19,982 shown in Table 4.8 below, for the research data derived from SBS 2009. As shown in Table 4.7 above, there are considerable economies of scale in construction costs for school facilities, with a facility between 12 000 and 14 000 m^2 costing two-thirds that of a facility between 0 and 2000 m^2 on a per m^2 basis. Notice also the considerable variance in normalised cost for smaller facilities.

Table 4-8: Weighted average indicators for 166 sample. Source: Edubase, DEC, SBS. Author analysis.

Table 11 *C* sample totals and weighted means of construction ratios and capacity utilization rate

Weighted averages	Total CAPEX (£)/total pupil capacity	Total CAPEX (£)/ total number of pupils on roll	Total CAPEX (£)/ total usable floor area (m^2)	TUFA (m^2)/ total number of pupils on roll (2012)	TUFA (m^2)/ total pupil capacity	Total number of pupils/total pupil capacity
Average	19 982	23 282	2550	8.62	7.95	0.86
Total numerator	3872 million	3872 million	1289 million	505 764	505 764	166 316
Total denominator	193 781	166 316	505 764	58 691	63 589	193 781
Sample *n*	166	166	56	56	56	166

Note: All monetary values are in 2009 prices.

The particular location of construction of course has an influence on any CAPEX. Regional CAPEX costs vary considerably across the UK and so where investment is made can have considerable bearing on overall programme cost. Below are the regional adjustments used by EC Harris (a leading building cost consultant) in there 2006 indicative building cost report, used to adjust for estimated CAPEX above as to whether works were undertaken in London or not.

Table 4-9: Regional tender price adjustments made in indicative building cost estimates. Source: EC Harris, 2006.

Region	**%**
Outer London	+3
Inner London	+14
London Postal Districts	+9
East Anglia, South West	-7
North West, Northern, Yorks and Humber	-11
E & W Midlands	-13
Scotland, Wales	-15
Northern Ireland	-36

4.6 Interdepartmental construction cost benchmarking

More recent work undertaken by the Cabinet Office applied public sector data amassed from project level sources to look into normalised construction cost measures across several government departments (Cabinet Office, 2015). Figure 4-8 below is drawn from this recent report and provides a good indication of the economies of scale achievable for larger facilities within the BSF programme.

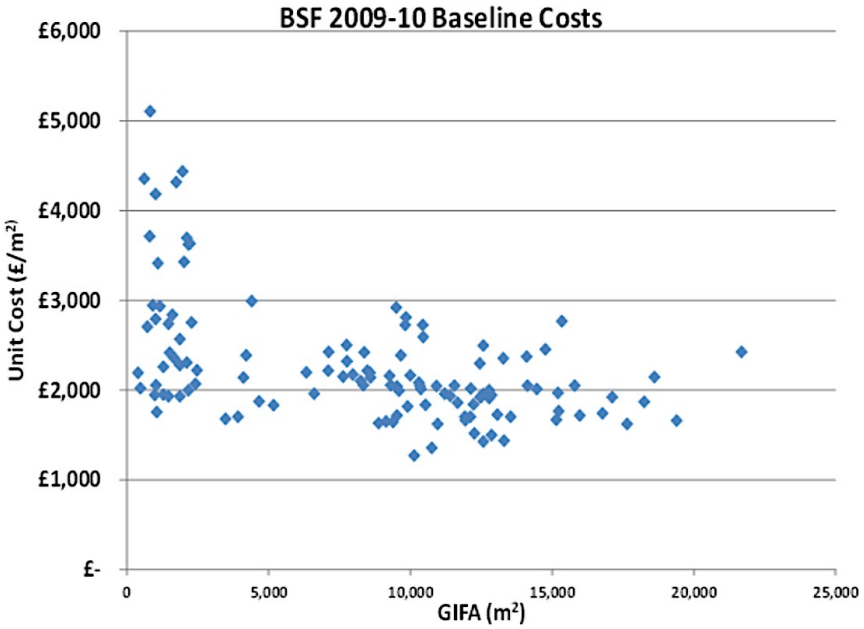


Figure 4-8: Normalised build cost per meter squared for BSF 2009-10 works. Source: Cabinet Office, 2015, chart 29.

Using a sample of schools delivered in more recent capital projects, we see that in light of austerity, there has been a drive to get more for less. While this has, in part, been achieved compared with BSF benchmarks, the current investments are likely to be lower specification on fabric, design and finish when compared to the previous BSF programme. This typically higher specification in BSF might manifest itself in use of more durable and expensive materials, as well as the common *gold plating* of BSF projects with star architect designs providing large, high-end, atrium entrance areas. Further, one might question the validity of comparisons being made between different programmes. BSF tended to involve more rebuild and new build investments compared to the recent, more refurbishment based programme, Priority School Building Programme.

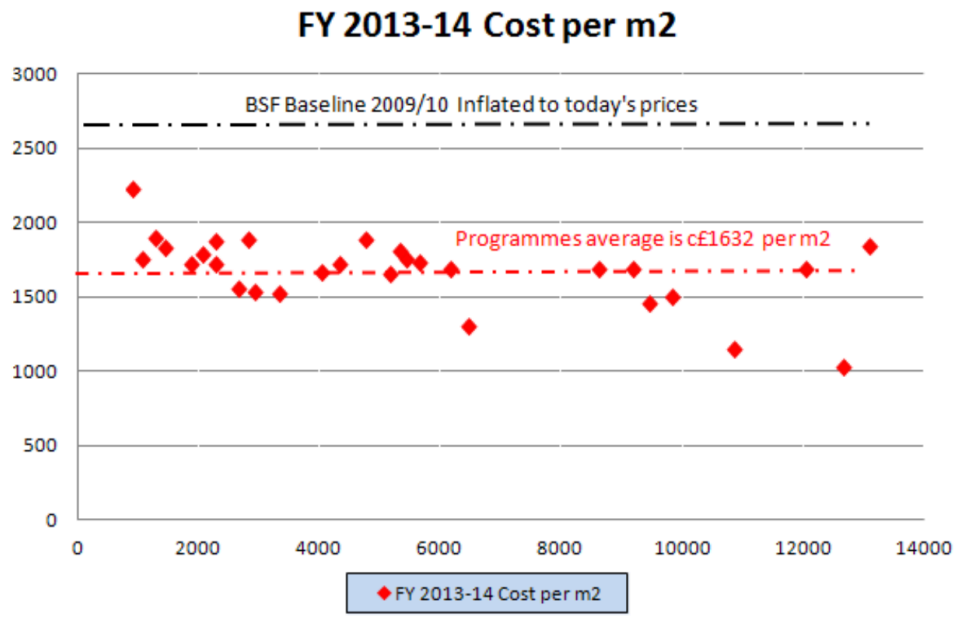


Figure 4-9: Post BSF schools build costs. Source: Cabinet Office, 2014, chart 23.

The consistency in benchmarking practises and construction costing remains an area in need of further consistency, rigour and coverage. The recent work of the Cabinet Office in improving publicly commissioned construction data represents a considerable improvement, not least because significant progress has been made collating data across multiple sectors and government departments. The final in a series of reports (Cabinet Office, 2015) report suggests:

> "This section demonstrates only limited progress since last year on the work undertaken by Departments to compare their cost benchmarks with those of private construction clients, so over the tenure of the new GCS (Government Commercial Services), we will seek to work with organisations such as the Building Cost Information Service (BCIS) to make anonymised public sector to private sector comparisons."
>
> Cabinet Office, 2015, p. 131.

It is the stated objective of the EFA to continue to develop construction cost benchmarks with particular focus on assessing cost of the current PSBP (Cabinet Office, 2015, p. 135). In the admittedly short time since publication of the 2015 report, little additional benchmarking efforts have been published.

4.7 Hospitals CAPEX – from normalising per metre squared towards per patient

While data on the capital expenditure for schools was available for analysis, publicly accessible data on investment in the range of hospitals in recent years is scant, with no equivalent to the SBS for devolved NHS Trusts able to be sourced. A key point about hospitals concerns their much greater diversity in both scale and scope as facilities compared to schools. Hospitals range from very large Acute facilities, with many wards and hundreds of in-patient beds for secondary care, to small local facilities providing specialist, mainly out-patient, services. As such, bed space is an imperfect unit for normalization. The heterogeneity of hospitals creates difficulty generating a *stylised* value for C per hospital, or indeed a normalised *per patient* (or per bed space) *c*, as the equivalent to pupil capacity in schools.

From a pure building profession point of view, the obvious normaliser becomes metres squared (m^2), but while this makes the construction cost of PSAs more comparable, can not be integrated into the per patient (or per pupil) frameworks applied here. The form of service provision for buildings vary, and this must be accounted for in the framework applied in this thesis, which has to embrace both staffing cost and value of outcomes to provide insight on WLC and value ratios. Construction cost's contribution to the WLC of PSAs is significant, but as will be seen, other operational costs of PSA's constitute a much greater proportion of WLC (principally the front line staffing costs). These operational costs will in part be determined by the built specification of the PSA, but also by the user intensity (indicated by floor area per patient in the case of hospitals) and the staffing intensity (indicated by floor area per nurse or doctor in this case). The use of m^2 is of course useful for comparison but alone precludes more detailed appreciation of the WLC of buildings, without the additional data indicated above. Staffing costs per meter squared will vary enormously depending on the context of care provision – one might compare the nurse intensity per metre square in an Intensive Care Unit (ICU) with that of a low risk outpatient or geriatric hospital setting.

While data on hospital construction costs is not so readily available from public sources, there have been recent advances in government reporting on the costs of hospital construction. In the Cabinet Office's 2015 report, they have made notable improvements in collating the data required for PSA construction cost benchmarking. Most data in this report relates to hospital investments delivered

under the Procure 21+ programme, as the publicly financed alternative to PFI procurement using mainly D&B type contracts.

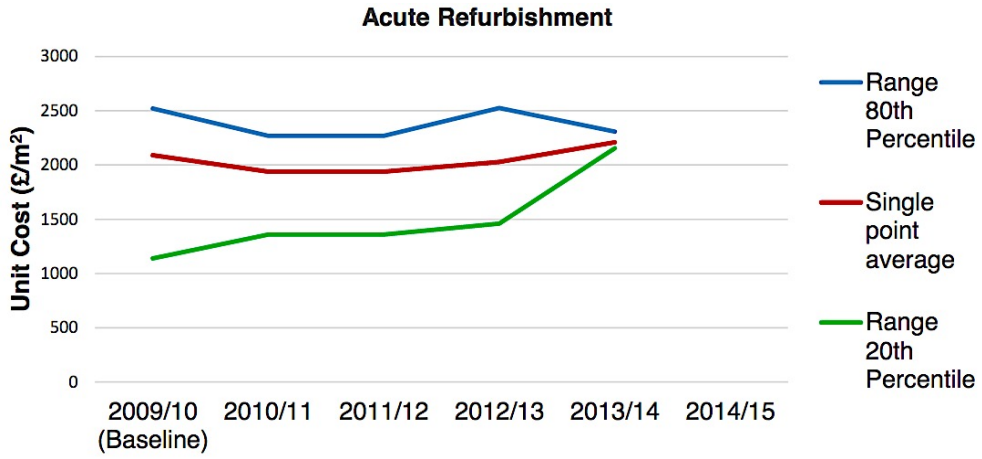


Figure 4-10: Normalised refurbishment cost of acute hospital capital works. Source: Cabinet Office, 2015, chart 35.

Average refurbishment costs for acute hospitals hover around £2000 per square meter for recent years. This will of course be specific to the particular building type. The variance in the earliest year (2009/10) is notably high than other years, with a tendency for construction costs to reduce in their range over time. This is likely driven by the reducing sample size rather than necessarily the efficacy of the procurements (2009/10 – 31, 2011/12 – 6, 2012/13 – 17, 2013/14 – 5).

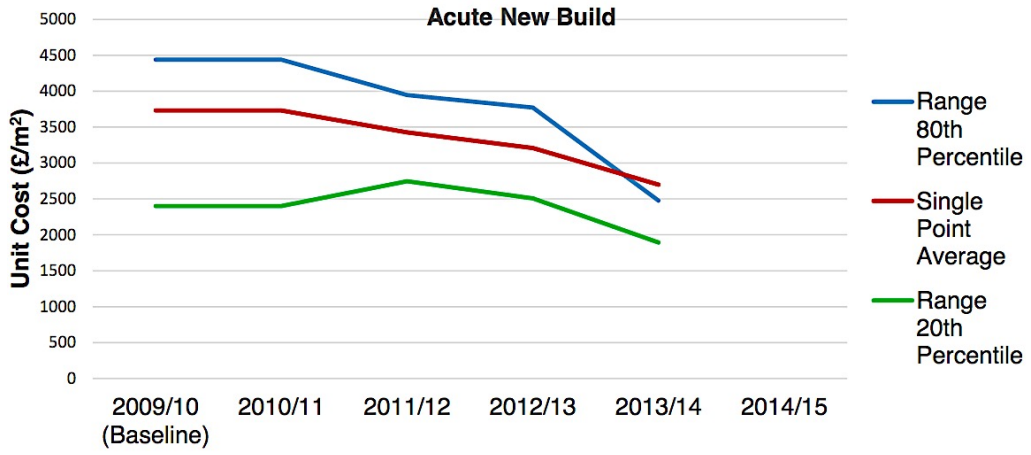


Figure 4-11: Normalised new build costs for acute hospital capital works. Source: Cabinet Office, 2015, fig. 34.

The cited cost of new build for acute hospitals varies for the middle 60% of the sample from £2,500 to £4,500 per square metre in 2009/10 (a ratio of 5 to 9). This dispersion relative to mean construction cost is closely comparable to the cost variance for the middle 60% of the sample of schools in table 4.6 above. The sample sizes for the annual indicators are as follow (2009/10 – 48, 2010/11 – 5, 2011/12 – 5, 2012/13 – 10, 2013/14 – 12). The lack of projects in particular years makes comparisons through time difficult to make and justify, and may lead to the estimations of construction cost ratios being very sensitive to the facilities for which data is available. Lack of such data may limit the ability to generalize on stylised WLC cost ratios over particular investment programmes, if not over different types of PSAs. More work is needed to collect information about the hospitals analysed above for means of informing more sensitive benchmarks of normalised and facility level construction costs. At the rate of renewal in recent year indicated in the above analyses, it may be wise to seek more historic information about hospital capital projects or alternatively wait for more projects to be approved to collate reliable datasets for further analysis. Variance in construction cost will be driven by a range of factors including location, specification of the building, site restrictions and time scale for capital works. Any and all systematic information about such aspects of capital project can and should be included in comparisons between particular projects.

Using an earlier HEFS dataset from 2008[15], and just looking at NHS hospitals that are completely new as of 1995 (and hence are not the same set of hospitals analyzed above), we see that where as there are over twice as many new non-PFI hospitals, (95 to 37), the gross internal floor area of the proportion of the estate these PFI facilities manage is over 4 times that of non-PFI conventionally procured facilities. Given the typical size of PFI procured facilities are much larger than their non-PFI procured comparators, like for like comparison of construction cost attributable to procurement route should account for this.

[15] Hospital Estate Facility Statistics (HEFS), as collated via the Estate Return and Information Collection (ERIC) within the NHS England for the NHS Information Centre, Leeds, available from *hefs.hscic.gov.uk.*

Table 4-10: Renewed UK hospital by type of facility and size. Source: Ive et al., 2010, tab. 9.

Type of hospital	*PFI*			*Non-PFI*		
	Number	*Size*		*Number*	*Size*	
		Average GIFA (m^2)	*Std. dev*		*Average GIFA (m^2)*	*Std. dev*
Community	*7*	*4,696*	*2,168*	*16*	*3,728*	*2,008*
General acute	*8*	*51,777*	*39,410*	*5*	*6,509*	*4,481*
Long stay	*6*	*8,018*	*5,519*	*20*	*3,982*	*3,919*
Multi-service	*3*	*26,081*	*38,402*	*4*	*3,003*	*269*
Short term non-acute	*11*	*6,600*	*5,654*	*33*	*3,463*	*3,632*
Specialist	*2*	*8,733*	*7,869*	*17*	*5,440*	*7,166*
TOTAL	*37*	*17,933*	*27,459*	*95*	*4,112*	*4,323*

Figure 4.12 below shows samples of hospital normalised build cost between the types of hospitals. These results suggest a credible economy of scale achievable on larger facilities and, even with small samples, a difference in the average build cost between different types of facilities, with mental health hospitals costing more than community hospitals. Reflecting on the range of observations over the size of facilities, it is evident these observations include a set of facilities somewhat smaller than the general acute hospitals that make up large swathes of the healthcare estate, as facilities which are typically around 50,000m^2 and up to 200,000m^2 for the largest facilities. Any method that might seek to develop a patient normalised metric for CAPEX cost should represent the *typical* facility. While the results below are useful for comparing small scale healthcare PSAs, a C figure (non normalised) for large acute new / rebuild is of particular interest, given these facilities accommodate the bulk of secondary care provision.

It should be noted that while the below analyses have been assembled from public tender documentation and project level report, they will not include the full costs of delivering capital projects, including all type of first costs such as transactions cost incurred during procurement. Much wider reporting of capital project functioning may aid in building a picture of the typical procurement and tendering overhead costs associated with large capital programmes.

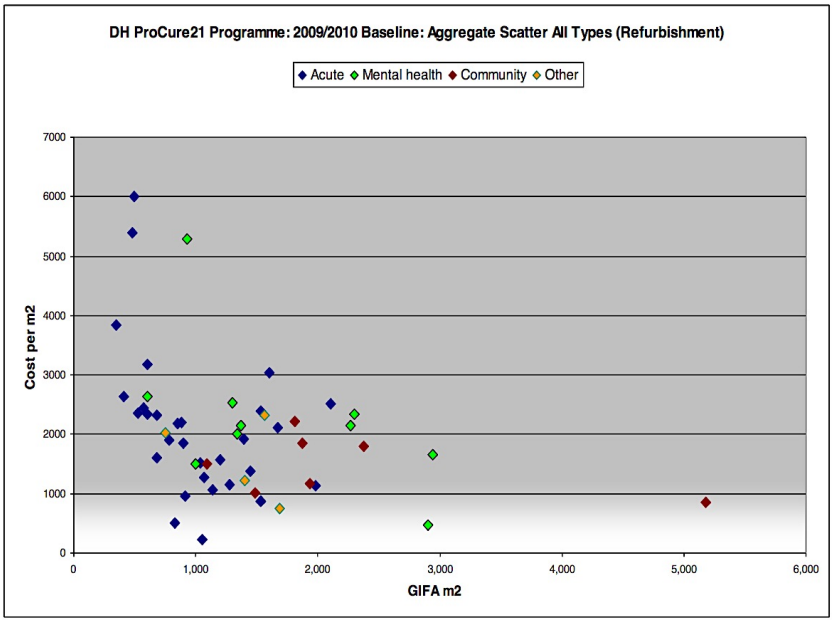


Figure 4-12: Indicative normalised build costs for a range of hospitals types. Source: Cabinet Office, 2015.

A crude attempt can be made to estimate the per bed space construction cost of hospitals through use of m^2 per bed space estimates from ERIC data. Looking at only acute hospitals (n=230) a stylised 90 m^2 per bed estimate can be observed (against a per pupil m^2 in schools of around 10 m^2). Multiply this by the cost per m^2 cost indicated above for new build projects (£3,000) gives a value of £270,000 c (CAPEX per bed space). This is based on the patient bed density of currently operating facilities, which may be somewhat larger than more recently constructed hospitals, and as such would be an overestimate in this regard. This data suggests the numbers of beds across acute sites varies with median values of around 750 (with some very large acute hospitals having nearer 2,000). Multiplying the above c by this provides a facility C estimate of £202.5m, a figure some ten times that of a typical school and well within the realms of headline cost indicators for the few large acute hospitals built in recent years.

Analysis of this sample of acute hospitals reveals that only around 50% of hospital GIFA is patient *occupied floor area*. This demonstrates that hospitals are quite different to schools in term of the intensity of use by the *users*, with the near entirety of a school being used by *pupils* (save for the staff room and limited utility / catering areas). Further, as hospitals essentially provide accommodation, they are required to host a wider set of facilities to meet the needs of the visiting public (canteens, kitchens, waiting areas). Of course, medical treatment involves numerous other

parts of the facility that do not provide accommodation to patients (laboratories, surgical theatres, medical staff facilities). Clearly, there is some way to go in collating detailed capital costs for the set of larger hospitals built in recent years for means of developing stylised WLC concepts.

4.7.1 PFI hospital contract data

There is opportunity for using information about the contracts for PFI hospitals, constituting the small number of large hospitals capital investments, to generate insights into construction cost and particularly the benefits resulting from economies of scale effects on normalised construction costs. Usefully, the HM Treasury PFI signed projects list provides a 'capital value' for contracts, including the debt, equity and public sector capital contribution towards the capital cost. As hospitals are usually large enough facilities to allow for use of single PFI contract (as opposed to their bundling in school contracts), this could be used as an imperfect proxy indicator of construction cost (C per hospital). The accuracy of this metric for particular hospitals may not be sufficiently precise for individual PSAs, but may be a reasonable indicator of C over the few largest hospitals procured through PFI. There is currently no systematic way to collate data from the few sources on hospitals construction and operations as there is in schools. Recommendations for improving the collation of data for hospitals are included in the concluding chapter.

On the implications of PFI's use in hospitals building, a recent NAO report on the Financial Sustainability of NHS bodies commented:

> "Historic private finance initiative (PFI) debt can make it more difficult to change the way estates and buildings are used. Among organisations with PFI commitments, those with the highest capital charges, as a proportion of their income, were the most likely to report weak financial results in 2013-14."
>
> NAO, 2014, p. 8.

4.7.2 Construction delay in hospital PFIs

PFI hospitals stand out as the sector across the programme of PFI witnessing the most considerable delays on construction completion. The more frequent significant delays in PFI hospital projects is

in part explainable by the numerous and complex site rationalisation projects seen within these range of contracts. Many involve the consolidations of significant estates spread over urban localities and having to deal with partial refurbishments of buildings in which operations continue to be delivered. Schools on the other hand, typically involve less complex capital works, with the preference of PFI sponsors for new / re-build projects, as more predictable for timely delivery.

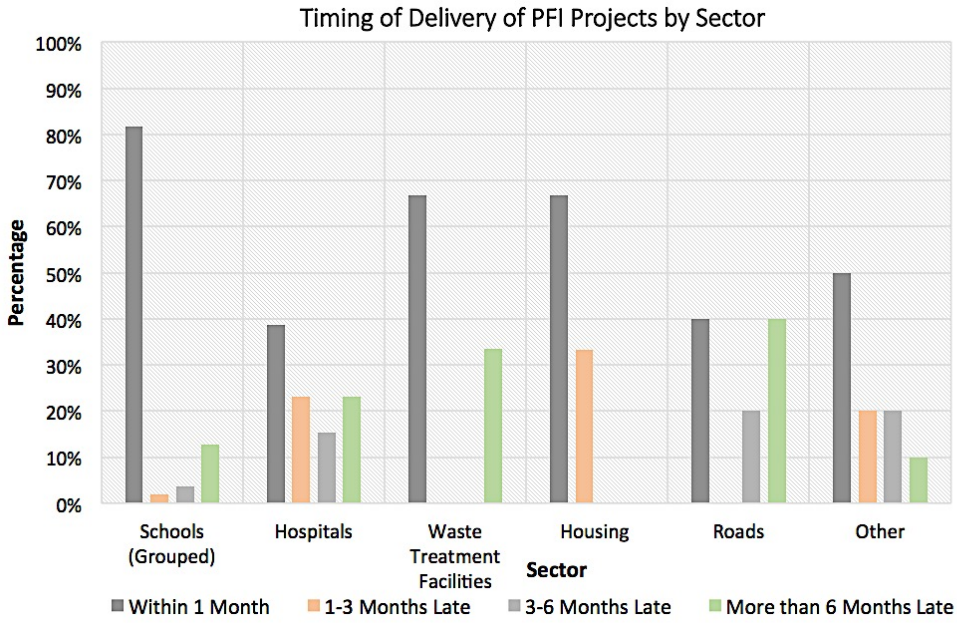


Figure 4-13: PFI time delivery performance by sector, n = 101. Source: Naderi, 2015.

4.8 Chapter summary

This chapter has presented analyses and available data on the construction costs of school and hospitals PSAs. While the stylised finding that a typical pupil place cost around £20k in spend (£20m for a 1,000 pupil capacity schools), no comparator benchmark could be established for healthcare facilities, given the difficulty in sourcing facility CAPEX and more complex requirement of normalising such headline metrics.

Chapter 5 Operations

The following chapter presents a range of analyses on the comparative cost and performance of operational services (F, *f*) in schools and hospitals, including some insight on front line public sector staffing cost (S, *s*) where data permits in schools. Comparative samples are defined by both different procurement methods and the form of capital work applied. This includes operational services provided in-house, outsourced or part of an integrated PFI contract within PSAs.

An important distinction here includes the differences between some forms of integrated contracts, which include only the Hard FM (maintenance), classified as DBFM contracts, and those including a range of soft FM operational services, such as cleaning and catering, classified as DBFO. PFI contracts differ in terms of scope, for example, some including significant investment and on-going support of ICT equipment (notably within the BSF programme), or the inclusion / exclusion of cleaning and catering within hospital contracts. This is important, as the potential for savings to be made and captured by the investor from capital (C) *investment in operations* will depend on contract scope during operations. One such WLC saving innovation might include improvements of facility logistics for movement of FM related resources around the facility. An example here includes the Royal Infirmary in Edinburgh, a relatively early PFI hospital development with a capital value of £180m and a 33 year contract, which has a dedicated lower floor for the movement of laundry and other soft FM activities around the hospital. This was intended to reduce the slowing up of moving FM resources around the hospital. Improvements in operational services (lower cost or improved quality) may also result between projects with common operators from opportunities to co-locate services off site, such as large scale catering facilities, or centralised monitoring of CCTV security over multiple sites. When within scope, soft FM services typically account for around 20-30% of the UCP (depending on their contract specification), and so represent a considerable proportion of full scoped PFI contract revenues (see figure 5.1 below). Much of the following analysis focuses on particular forms of soft FM services within conventionally procured facilities and service as well as under PFI contracts, particularly cleaning and catering where data was most readily available.

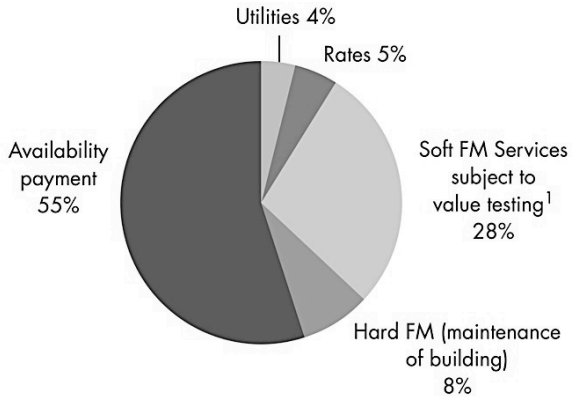


Figure 5-1: Breakdown of Darent Valley hospital budgeted unitary charge 2004-05 - annual PFI cost (£19 mn). Source: NAO, 2007, fig. 1.

5.1 Contract scope

The scope of operational services in PFI contracts is important in defining the SPV's exposure to potential for investment in operations, as well as the risks attached to levels of service. There is significant variance in the scope of PFI contracts, especially with regard to soft FM services. This is indicated by a survey of hospital contracts undertaken by the NAO (2010) findings that around one third of hospital PFI contracts did not include core soft FM services such as cleaning and catering. With reduced scope of soft FM service, the contracts resemble more DBFM (maintenance) rather than DBFO (operation) classification. The net negative impact on VfM from the higher cost of capital of PFI projects arguably increases here by reducing scope of operations. This is because the higher cost of capital incurred, mainly from private financing of construction, must be at least compensated for by future returns from construction and operational efficiencies, if VfM of PFI is to be superior to conventionally procured Design & Building and separate Operation contracts (with conventional public financing). In the DBFM case, the client will fund relatively expensive private finance for a facility in which a separately outsourced operational contractor has not been given the opportunity, or incentive, to *invest in operations*. This may involve catering services, as a service perceivably more open to benefit from better quality and quantity capital provision as forms of *investment in operations*.

Many of the school and hospital PFI projects studied here were DBFM, rather than full DBFO. This subtle difference concerns the scope of on-going provision during operations. Where in the case of

a prison commissioned by the Ministry of Justice, the responsibility of the SPV cover all aspects of operation (including all prison staffing and custodial services), in school and hospital PFIs they concern almost completely the facility management of the asset and not including the front line staffing of teachers, doctors and nurses respectively. It is likely because in prisons, the scope for operations are aligned with overall facility management (and procurement), that operational cost benchmarks by procurement method have been forthcoming, including data on comparisons of in-house, PFI and operate and manage regimes. The National Offender Management Service provides some insightful annual normalised cost per place and per prisoner measures drawing on direct resource expenditure headlines (Ministry of Justice, 2015). These show that PFI cost per place in 2013-14 is around a third more expensive than public sector provision (£46,155 to £35,732), while this gap is much smaller when looking at per prisoner costs (PFI £39,455 to public sector £33,226). This suggests PFI prisons have higher levels of capacity utilisation and that PFI is overall more expensive. One might maintain some skepticism about the full *all in* cost of public provision when relying on averages from headline direct resource budgets, as to whether it includes some capital allocation, even if the facility has been fully depreciated in an accounting sense. This will be included within the PFI cost indicator as part of the UCP includes an availability element for the provision of the asset.

This FM provision in schools and hospitals includes many support services required for day-to-day operation of the facility (including cleaning, catering, security, portering and laundry referred to as soft FM). Indeed, more recent outsourcing initiatives have included some services that might have traditionally been considered final services provided by *front line staff,* such as pathology and laboratory testing services. This limited the expansion of scope of early PFI contracts, where if there was too much novelty, complexity or opportunity for disagreement, such as the flexibility in the service of pathology functions within hospitals, PFI was considered unsuitable as a means of delivery. Where straightforward objectively measurable service outputs can be specified, and costs to achieve that delivery can be priced and wrapped into an integrated contract, PFI was deemed more appropriate. Where complex subjective service outcomes are present, risk of delivery will be impossible to price accurately, so will likely include margins of safety that prevent optimal VfM being achieved. Recent efforts to develop contracts to incentivise prison service providers to reduce reoffending rates (Ministry of Justice, 2014) can be considered as objectively measurable,

except it is not a service output (directly within control of the provider), rather an outcome[16] (a result of interaction between service outputs and other forces affecting the behaviour of ex-prisoners). In this case, the service provider is not taking the downside risk of deductions arising from increased re-offending rates, but does have the upside risk of extra payments arising from reduced re-offending rates.

5.1.1 Contract length and conventional outsourcing

The period of the contract will of course be important, in part determining the intensity of the incentive for investment in operations. If the contract is short (say 1 – 5 years) there will be limited scope for the contractor to realise returns from investments in the asset to be operated, hence one of the fundamental reasons why PFI contracts are of such considerable length. Considering some specific potential scenarios of asset ownership, the provision of catering serves as a case in which there is variability in both form of provision and extent of asset ownership. These two aspects will have bearing upon one another in line with transaction cost economics (TCE) theory (Mumford, 1998).

5.1.2 Long-term competition and WLC innovation in Soft FM

Operational costs are downwardly constrained by the quality of service the providers are contracted to provide in the output specification (or under alternative forms of service level agreement). Non-adherence to these levels of provision incurs (or at least risks) financial penalties.

The price the SPV can charge for Soft FM services, rather than what it costs them to provide, is open to a form of re-assessment usually every 5 – 7 years. This periodic contesting of soft services is referred to as the benchmarking and market-testing procedures (B&MT), which attempts to maintain VfM in the quasi monopoly scenario of a PFI contracted provider during operations (National Audit Office, 2007). One potential effect of this on VfM includes limiting the extent to which WLC risk is actually transferred if the trend in FM cost varies from the assumed rate of indexation, resulting from uncertainty about the long-term price to be charged as well as the underlying cost for such services.

[16] Refer to Green Book classifications on input, outputs, outcomes and impacts.

Further, the extent to which there is incentive to *invest in operations* will also depend on the ownership structure within the SPV. Whoever owns the sub-contractor firm providing the operational service, and has an equity stake within the SPV, will have two sources of financial return. These include the profits from their provision of operational services (paid via operational sub-contracts with the SPV) and future shareholder returns from their ownership of residual profits in the SPV. This raises questions about the transfer pricing of services agreed between providers who are also majority shareholders, and hence account for the SPV as a subsidiary to the corporate group.

Problems arise when opportunities to reduce WLC for soft FM services become apparent ex-post. If capital sums are required to achieve this, such as for re-configuration of internal layouts or acquisition of additional long-term fixed capital, the incentives to incur additional sunk costs will be tempered, given the potential future *competition* introduced via B&MT. This is pertinent given the likelihood that WLC reducing innovations may result from accumulated knowledge about operations of often unique facilities (Grant & Ries, 2013). The effectiveness of WLC innovations can only be evaluated during operations given their novelty, and so, are difficult to specify ex-ante contractually based on an output specification. One might imagine an outsourced contractor who is not an SPV shareholder having little incentive within their short-term contract of between 2 - 5 years, to undertake WLC reducing investments in fixed capital with asset lives beyond the current contract length. As such, they face uncertainty about the alternative use of such assets should they fail to retain the contract. A further point concerns the limits to which well anticipated ex-ante WLC innovations are achieved in the context of extensive sub-contracting even in *integrated* forms of procurement (Rintala, 2004).

The financial consequences for the SPV of underperforming in operations are less punitive compared to cost overrun or time delay during construction. Without commissioning, UCPs will not begin to flow into the SPV. Conversely, with sub-par operational services the SPV will only incur partial deductions, although these deductions do form a key sensitive risk for the financial performance of the SPV (see Appendix 8). Given that this incentive structure for provision of these services is similar to conventional outsourced contracted FM services, one might expect to see a smaller differential between contracted operational service prices in PFI and those in the open market for outsourced soft FM services. Price differentials for operational service contracts may of

course also be down to differing levels of productivity between forms of service provision, as well as variance in the margins charged between private suppliers. The following analysis looks first at a basket of school FM costs, followed by a review of individual FM cost categories for hospitals.

5.2 Schools – method and findings

5.2.1 School operational costs

The SBSs of 2009 and 2011 reveals less than 15% of secondary comprehensive schools had undergone capital works greater than 50% refurbishment during the period 1992 – 2009 period.

The following analysis benchmarks the operational expenditures of schools according to:

- the procurement method applied in the capital investment, comparing PFI with conventionally procured (non-PFI);
- the form of capital investment undergone, comparing re-build with refurbished schools.

This analysis looks specifically at a core basket of FM costs within scope of typical PFI contracted provision. The analysis does not control for CAPEX or asset condition given the unavailability of such data at the time of analysis.

5.2.2 Sampling schools

Chapter 3 explains the creation of the population of renewed schools. The additional sampling steps to move from this to the following analysis are as follows:

- 395 schools formed the population of renewed schools. 133 were identified as being PFI schools according to a specific PFI marker within the initial *Edubase* dataset. The remaining 262 are considered Non-PFI.
- By type of capital works, the core sample of 395 schools divides into 193 rebuilt and 202 refurbished schools. For these comparisons, rebuilt refers to facilities listed within the SBS's as either 'new build' or 're-build', and refurbished refers to schools listed as either '80% - 100% refurbishment' or '50% - 80% refurbishment'.

Expenditure data for each school having received capital investment is then retrieved in accordance with the process below:

- The Consistent Financial Reporting (CFR) dataset for financial years 2002/03 to 2008/09 was obtained from the DfE under a non-disclosure agreement. There is thus a maximum of seven years (2002 – 2009) post-renewal cost data potentially available for any specific school in the following elapsed time analysis, if it was renewed before 2002/03; reducing to a minimum of one year if it was renewed in 2007/08. In attempting to increase sample size, schools were included if data was available for at least one year of operation post-renewal. A panel requirement here would have considerably reduced sample sizes given sporadic failure to report individual cost items for some schools in particular years.
- From the range of available expenditure lines, an operational cost *basket* was created based on the scope of costs included in a typical PFI contract for means of procurement benchmarking. The basket is not exhaustive of all services provided within a school, but was collated to cover the core soft and hard FM expenditures. The components of the basket, and corresponding CFR reference for clarity include[17]:
    - Building maintenance (E 12)
    - Grounds maintenance (E13)
    - Cleaning and caretaking (E14);
    - Premises staff - in-house caretakers and other similar staff (E04);
    - Bought in professional services - inc. PFI management fee (E28);
    - Catering supplies - including contracted catering services (E25);
    - Catering staff - capturing in-house catering staff (E06);
    - ICT learning resources (E20)

Expenditures were converted to constant April 2010 prices using RPIX data from the Office of National Statistics (Dept. for Business, Innovation and Skills, 2013). The expenditures for each school were divided by the school's pupil capacity for normalisation. Data for each school were rearranged into time elapsed from that school's renewal point using the year of capital works from the SBS as a point of reference. The cost data were sampled separately for each of the elapsed

[17] Detailed descriptions of what each expenditure line includes can be found via a Education Funding Agency document available: https://goo.gl/EuEwd5

years after completion of the capital investment. A school was only included in the analysis if it had returns for all eight of the operational cost expenditure lines in each year identified above. This was an attempt to minimise the possibility of inaccurate reporting between expenditure lines.

5.2.3 Statistical testing

Independent sample two-tailed t-tests were applied for annual comparisons of total basket expenditure. When interpreting the results, if Levene's test for equality of variance found significance, the *equal variance not assumed* p-value was used.

5.2.4 Accounting of expenditure

Looking at the expenditure lines within the CFR data definitions, the soft and hard FM expenditure lines for PFI schools refer to contract payments. The amounts allocated here represent the amount paid by the public authority for the associated service as part of the UCP.

For certain services like catering services, expenditures break down between catering staff employed by the school and catering supplies. Catering supplies includes the cost of outsourced services that will include the labour cost of catering staff not directly employed by the school.

5.2.5 Findings

5.2.5.1 PFI versus non-PFI

Fig 5.2 below and the following tables reveal three main findings concerning the comparative operational cost of PFI and non-PFI schools:

- The average total expenditures on the basket of FM related services are higher for PFI school samples in six of the nine elapsed years observed. Non-PFI expenditures are higher in three years. None of these differences of means are statistically significant[18], even in years 6, 7 & 8

[18] In year 7, a statistically significant difference assuming equality of variance between the samples was observed, with a p value of 0.028, but this is rejected, as the Levene's test for equality of variance result is strongly significant. That is to say, variances between the samples differ for some other reason than procurement.

where PFI is around 15% - 20% more expensive, given large variance within procurement defined samples about average costs. This suggests the presence of other overriding determinants of operational cost separate from any procurement effect.

- Higher levels of *Building maintenance (E12)* expenditures in PFI schools are observed from year 5 onwards, in line with expectation from typical planned expenditures from integrated forms of contract taking life cycle risk. This finding contrasts to the near flat Hard FM expenditure profile observed in Non-PFI facilities over the 9 years of operation. No asset level indicators of backlog maintenance are as yet available to investigate the effectiveness of this expenditure, or to be compared between PFI and non-PFI schools[19].
- The *Bought in professional services (BIPS - E28)* expenditure line is consistently higher in PFI schools. This expenditure line includes the PFI management fee charged by SPVs to schools for the co-ordination of services provided within the contract. There is a considerable increase in this expenditure line going in year 7 of operation. One explanation for this may include the costing of the obligatory B&MT exercises being undertaken by the SPV and passed on to the public sector through the PFI management fee. In this year, this single cost category represents over one third of considered FM costs, a potential source of concern when considered from a public sector VfM perspective.

[19] The EFA are continuing to survey schools following the PDSP survey programme, and have indicated survey of schools that have received capital works since 2004 are planned, as these schools were not included in the original PDSP survey.

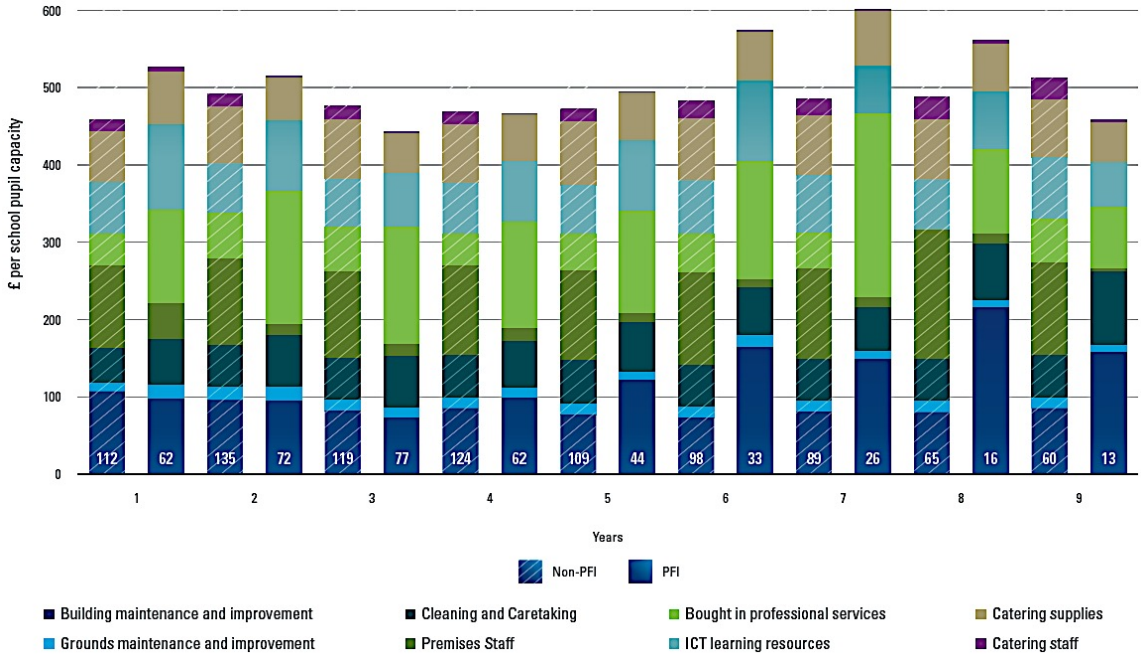


Figure 5-2: Operational expenditure for UK PFI and non-PFI renewed schools (£s per pupil capacity, 2010 constant prices). Source: Author analysis.

Table 5-1: Average operational expenditures for UK non-PFI schools (£s per pupil capacity, 2010 constant prices). Source: Author analysis

Years following renewal	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*9 year*
Sample size	*112*	*135*	*119*	*124*	*109*	*98*	*89*	*65*	*60*	*average*
Building maintenance	*97*	*96*	*82*	*85*	*77*	*73*	*81*	*80*	*85*	*84*
Grounds maintenance	*13*	*16*	*14*	*13*	*14*	*14*	*13*	*14*	*14*	*14*
Cleaning and caretaking	*53*	*55*	*54*	*56*	*56*	*54*	*54*	*55*	*55*	*55*
Premises staff	*107*	*112*	*112*	*116*	*116*	*120*	*118*	*122*	*119*	*116*
Sub total	*270*	*279*	*262*	*270*	*263*	*261*	*266*	*271*	*273*	*269*
Bought in prof. services	*40*	*58*	*58*	*40*	*47*	*49*	*46*	*45*	*57*	*49*
ICT learning resources	*68*	*65*	*62*	*67*	*64*	*70*	*75*	*65*	*80*	*68*
Catering supplies	*65*	*73*	*76*	*75*	*82*	*80*	*77*	*78*	*74*	*76*
Catering staff	*16*	*17*	*18*	*17*	*17*	*23*	*21*	*29*	*29*	*21*
Total	***459***	***493***	***476***	***469***	***473***	***483***	***485***	***489***	***513***	***482***

Table 5-2: Average operational expenditures for UK PFI schools (£s per pupil capacity, 2010 constant prices). Source: Author analysis

Years following renewal	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*9 year*
Sample size	*62*	*72*	*77*	*62*	*44*	*33*	*26*	*16*	*13*	*average*
Building maintenance	*97*	*95*	*73*	*99*	*121*	*164*	*149*	*216*	*157*	*130*
Grounds maintenance	*18*	*17*	*12*	*12*	*11*	*15*	*10*	*9*	*9*	*13*
Cleaning and caretaking	*59*	*67*	*67*	*61*	*64*	*62*	*57*	*73*	*96*	*67*
Premises staff	*47*	*14*	*16*	*16*	*12*	*11*	*12*	*12*	*3*	*16*
Sub total	*221*	*193*	*168*	*188*	*208*	*252*	*228*	*310*	*265*	*226*
Bought in prof. services	*121*	*173*	*152*	*138*	*132*	*153*	*238*	*110*	*80*	*144*
ICT learning resources	*110*	*91*	*69*	*79*	*91*	*103*	*62*	*75*	*58*	*82*
Catering supplies	*68*	*55*	*51*	*60*	*62*	*64*	*70*	*61*	*52*	*60*
Catering staff	*6*	*3*	*3*	*1*	*2*	*2*	*3*	*5*	*4*	*3*
Total	***525***	***516***	***445***	***465***	***494***	***573***	***600***	***561***	***459***	***515***

Analyses comparing the annual comparative total costs of this basket of FM expenditures suggest there is no significant difference between PFI and non-PFI renewed schools. Further, the differences in specifically hard FM expenditures between conventionally procured and operated and PFI schools raises concerns about the accumulation of backlog maintenance in those non-PFI schools. PFI does seem to economise on production cost elements of OPEX, if not the client's transaction costs, given consistently higher BIPS.

5.2.5.2 Refurbishment against rebuild capital works

These samples can then be assembled by capital investment form. On first inspection, figure 5.3 below bears some considerable resemblance to figure 5.2 above, especially in regard to consistently higher *bought in professional services* cost in the rebuilt sample. This results from a high correlation between school facilities being invested in and operated under PFI contracts and their form of capital investment being rebuilt, as opposed to refurbishment type works. Approximately 80% of the rebuilt samples comprise of PFI facilities, yet only 34% of the total sample (rebuild and refurbishment) constitutes PFI facilities. This should be born in mind when considering capital investments of varying motives over A (alteration), B (reducing backlog maintenance) and C (additional capacity) where the clear association of some procurement methods with certain types of capital works, notably PFI for rebuilt / new build.

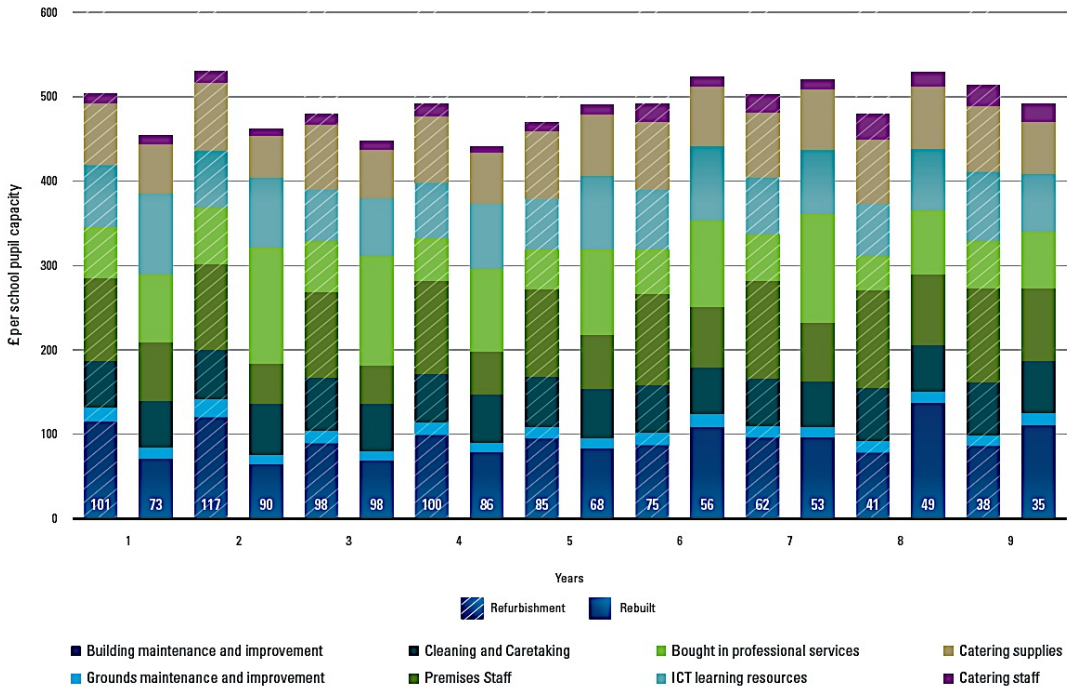


Figure 5-3: Operational expenditure for rebuilt and refurbished UK schools (£s per pupil capacity, 2010 prices). Source: Author analysis

Table 5-3: Average operational expenditures for refurbished schools (£s per pupil capacity, 2010 constant prices). Source: Author analysis

Years following renewal	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*9 year*
Sample size	*101*	*117*	*98*	*100*	*85*	*75*	*62*	*41*	*38*	*average*
Building maintenance	115	120	89	99	95	87	96	78	86	96
Grounds maintenance	16	21	15	14	13	14	13	13	12	15
Cleaning and caretaking	55	58	62	58	59	57	56	63	63	59
Premises staff	98	102	102	110	104	108	116	116	111	108
Sub total	284	301	268	281	271	266	281	270	272	278
Bought in prof. services	61	67	60	51	48	53	55	41	56	55
ICT learning resources	74	68	62	66	60	71	68	62	83	68
Catering supplies	72	80	76	78	79	80	77	76	77	77
Catering staff	13	14	13	15	12	21	22	30	26	18
Total	***504***	***530***	***480***	***491***	***469***	***492***	***504***	***477***	***514***	***496***

Table 5-4: Average operational expenditures for rebuilt schools (£s per pupil capacity, 2010 constant prices). Source: Author analysis

Years following renewal	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*9 year*
Sample size	*73*	*90*	*98*	*86*	*68*	*56*	*53*	*40*	*35*	*average*
Building maintenance	*71*	*64*	*68*	*78*	*83*	*108*	*96*	*137*	*110*	*91*
Grounds maintenance	*13*	*11*	*11*	*11*	*12*	*15*	*12*	*13*	*14*	*12*
Cleaning and caretaking	*55*	*61*	*56*	*57*	*58*	*55*	*54*	*55*	*62*	*57*
Premises staff	*69*	*47*	*46*	*51*	*64*	*72*	*69*	*84*	*86*	*65*
Sub total	*208*	*183*	*181*	*197*	*217*	*250*	*231*	*289*	*272*	*225*
Bought in prof. services	*81*	*138*	*130*	*98*	*101*	*103*	*129*	*76*	*67*	*103*
ICT learning resources	*96*	*82*	*68*	*77*	*87*	*88*	*76*	*72*	*69*	*79*
Catering supplies	*58*	*50*	*57*	*61*	*73*	*70*	*72*	*74*	*62*	*64*
Catering staff	*11*	*9*	*11*	*8*	*12*	*13*	*12*	*18*	*22*	*13*
Total	***454***	***463***	***447***	***441***	***492***	***524***	***520***	***530***	***492***	***485***

5.2.5.3 Aggregate operational costs

Looking at a wider basket of school facility occupancy costs including 4 additional cost concepts to the 8 used above (including Water and sewerage (E15), Energy (E16), Other insurance premiums (E23), Other occupational cost (E18)) we can normalize this broader concept of F by pupil capacity unit (f). Comparing these to the school level costs of their front line staffing (Teaching staff (E01), Supply teacher staff (E02), Education support staff (E03), Administration and clerical staff (E05)) reveals that normalised occupancy costs (f) are typically between one sixth to a fifth that of normalised front line staffing costs (s). Looking at time-series of average f and s over the whole estate of secondary comprehensives (figure 5.4 below) including the majority of the estate that has not undergone significant investment (schools sample circa 3,000), we can see the relative magnitudes of f : s are roughly around 1 : 5. This ratio has increased in the most recent years observed, that is f has increased more than s, with 2012/13 data suggesting a 4% annual rise for *f*, against a 2% reduction in *s*. Comparing the rough ratios for 2002/03 with that of 2012/13 we see that whereas in 2002/03 f of £500 to s of £2800 gives a 1:5.6, the 2012/13 value of f (£700) to s (£3300) gives a 1:4.7 ratio, demonstrating a considerable increased expenditure on occupancy costs relative to staffing.

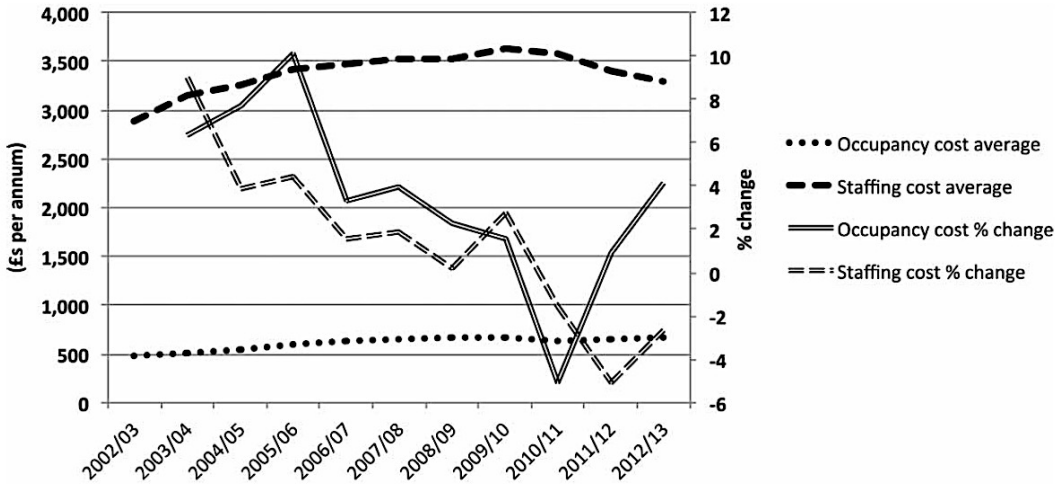


Figure 5-4: Annual average occupancy and front line staffing costs per pupil capacity unit for UK schools 2002/03 - 2012/03, 2009 prices. Source: Ive, Murray and Marsh, 2015, fig. 2.

Despite this short period insight, later analyses assume that over a long enough period, changes in relative factor prices for f and s will be roughly neutral (Chapter 8). Although public sector pay, specifically teachers' pay, has increased at a rate below inflation for the years following the GFC (Cribb et al., 2017), there is insufficient basis in theory of historical trends to assume anything but, in the long run, that teachers' and FM staff pay will both track general levels of inflation.

The relevance of the Baumol's cost disease theory may arise in a scenario where one form of cost (F) may benefit from reductions in labour intensity, which the other cost (S) cannot capture. Baumol put forward the idea that for certain forms of services that have limited ability to substitute capital for labour, they would, over time, witness an inevitable relative inflation in the cost of the labour intensive services. He gave the example of the performing arts (Baumol and Bowen, 1965), where it was 'very difficult to reduce the number of actors necessary for a performance of Henry IV, Part II' (p. 500). This is applicable in the classroom, with reluctance to let class sizes rise above the low 30s, or indeed in healthcare settings with nurse to patient ratios. The displacement of labour elements for F related cost has to be considered across a wide range of functions supplied. Portering services already have advanced robotised competition and advancements in material science is delivering finishes and glass that are resistant to dirt build up, or even self cleaning. In school contexts, the expectation is that other humans are required to provide the educational services we most value has strong resonance, but for the encroachment of technology driven forms of learning. This last point bears on the magnitude of the largest component of WLC for PSAs and

seems to be a highly uncertain prospect which will depend on how standardised national curriculum develop to include the use of technology in learning.

It can be seen from Table (4.6) above that capacity utilization (pupils on roll divided by pupil capacity) has some considerable variability (st. dev. 0.22) about its mean of 0.87. There are seemingly schools that are over-utilised at the upper limit of the distribution (90th percentile - 1.06) and others that are considerably under-utilised (10th percentile - 0.61). These are likely to be the schools driving most of the variance in normalised per pupil construction cost indicators.

5.2.5.4 Backlog maintenance in schools

Data on backlog maintenance in schools has only just been amassed by the DfE and was not accessible for study in this thesis. At March 18th, 2015 Commons Education Select committee heard from Councillor David Simmons, who was also Head of the Local Government Association Children and Young People's Board. He suggested the capitalised backlog maintenance across the schools estate is around £15bn (Simmonds, 2015). Following are some choice extracts from the James review concerning maintenance and the collection of backlog data across the school estate:

> "Maintenance is critical to controlling the lifetime cost of schools and the quality of maintenance across the estate is extremely variable. This is exacerbated by the fact that no good quality data is collected on the condition of the estate." James, 2011, p. 5.

> "Currently there is no explicit obligation to maintain buildings and no agreed standard. Funds are wholly devolved to school level making it impossible for Responsible Bodies to prioritise their needs at a local level."
>
> *ibid,* p. 7.

> "At the moment, the data used by the Department (of Education) to allocate devolved funding is, on the whole, of poor quality – on building condition it is almost non-existent. Once allocated there are no mechanisms in place to track devolved funding and there are no incentives to achieve value for money."
>
> *ibid,* p. 29.

"After 2005, further attempts to collect condition data were abandoned as part of a scheme to reduce the overall data collection burdens on Local Authorities. So, the Department has no data on the condition of the school estate despite spending over £20 billion on the estate in the past three years."

ibid, p. 30.

"while some maintenance is undertaken collectively at Local Authority level, this does not happen systematically, and the Department lacks leverage to do more than encourage cooperation. . . . This means that an estate with a replacement cost of £110 billion has no central professional property maintenance function or strategy akin to that which would exist in the private sector."

ibid, p. 31.

"…capital being allocated in some cases to buildings that did not require it; 'islands' of expenditure across localities in England whilst extremely dilapidated schools in other parts of the country remained untouched; and to over-spend against a 'transformational' agenda which was not realistic or even necessarily desirable."

ibid, p. 44.

"To date, Local Authorities do not appear to have set consistent parameters for the use of the funding available for maintenance at school level. Indeed, there is anecdotal evidence that suggests many schools adopt, at best, a reactive maintenance approach rather than investing more in planned, preventative maintenance. Ultimately this lack of a standard process results in:

• a relatively high funding requirement nationally, with virtually no economies of scale available;

• services of greatly varying quality;

• failure to deliver value for money solutions;

• limited and ultimately ineffective management of the national school estate's maintenance needs, with decay of the estate that eventually needs addressing at higher cost; and

• occasional emergencies, where a building fails or is deemed unsafe, with loss of teaching and learning time."

ibid, p. 61.

These insights from the James review paint a worrying picture of the state of knowledge about current school PSA estates. While recently collected estate data is being used to inform the latest Priority School Building Programme 2, the timeliness of data collection and application is slow to. Data is an asset subject to depreciation at faster rates than other productive assets. It is unsurprising that one of the James reviews recommendations include:

"Recommendation 8: That the Department: gathers all local condition data that currently exists, and implements a central condition database to manage this information; Carries out independent building condition surveys on a rolling 20% sample of the estate each year to provide a credible picture of investment needs, repeating this to develop a full picture of the estate's condition in five years and thereafter."

James, 2011, p. 50.

5.3 Hospitals – method and findings

Moving on to consider the on-going operational cost and performance of hospital PSAs, a similar dearth of analysis by procurement method and form of capital works is evident. However, one 2010 NAO study of the performance and management of PFI hospital contracts, based on data they obtained from SPVs found 'the cost and performance of PFI hotel services are similar to those in Non-PFI hospitals' (NAO, 2010, p. 6).

The following analyses look at two measures of cost (cleaning and catering) and two performance indicators (patient environment and cleanliness). Patient Environment Action Team (PEAT – patient environment and food quality) ratings and NHS National Specifications of Cleanliness scores at facility level over 4 years are compared for samples defined by procurement method. Data on the expenditure on facility maintenance, as a cost indicator for Hard FM and data on the incidence of Backlog maintenance are also examined.

5.3.1 Method

5.3.1.1 Data sources

The main data source for the study was the online NHS Hospital Estates and Facilities Statistics (HEFS) site level reports. The NHS Information Centre hosts this set of data. Collected through the annual Estate Return and Information Collection (ERIC) the HEFS reports provide site-specific annual indicators of various aspects of hospitals' specification and operational performance. However, they do not indicate the procurement route applied for the construction and/or operation of the site. This information was accessed through negotiation with central NHS estate staff. The cost, cleanliness and backlog maintenance data were obtained from the ERIC reports. The remaining site level patient environment and food ratings are publicly available information provided by the National Patient Safety Agency's (NPSA) Patient Environment Action Team (PEAT) assessments. These are reported for calendar years.

The reliability of the ERIC data is supported by detailed definitions of the variables collected. Production of datasets relies on estate managers submitting information that is then collated by the NHS Information Centre for Health and Social Care. Information undergoes an inspection by a Central Returns Steering Committee and is approved by Monitor, the central regulator of NHS Trusts. They provide a single source for high coverage statistics on insights on the NHS estate. During their application for the following analyses, data quality was assessed, with some issues, particularly around information on the backlog maintenance, raised in discussion.

5.3.1.2 Sampling process

The site level HEFS reports formed the basis of the samples. Each year's report was filtered using the following process to produce the study sample. The sampling steps below show how the population of renewed hospitals in 2007/08 is reached:

- The complete 2007/08 HEFS site level report covers 1,965 sites
- Removing all forms of a) aggregated site and b) sites where patients are not both treated and accommodated (including GP properties, Support Facilities, Treatment Centres and Non-hospitals) and c) sites with no data provided for site type, leaves 1,052 hospitals.

These include Community hospitals, General acute hospitals, Long stay hospitals, Multi-service hospitals, Short-term non-acute hospitals and Specialist hospitals.

- In order to focus on cost and performance of renewed hospitals, all sites with any part of the age asset profile dated before 1995 (as well as sites without the data to confirm they have been wholly built after 1994) were removed. This was done using annual ERIC reporting data. This reduced the sample down to 136 hospitals. Age asset profile data was more fully reported in some years than others. As a result, one gets a different number of renewed hospitals between years. Firstly, because the growth in the number of renewed hospitals there actually were, and secondly, based on the varying availability of age asset profile data in any particular year.

- Patient environment and food ratings data were collated by cross matching the 136 hospitals from the previous stage with publicly available PEAT results for hospitals. Facility level *site codes* acted as appropriate unique identifiers for cross matching between datasets.

- Finally, for particular variables, some of this population of 136 renewed hospitals did not have full data available for cost and performance. For example, 4 sites that returned zero results for cost of cleaning or '*No Data Provided*' were removed, leaving 132 renewed hospitals to allocate to either PFI or Non-PFI procurement subsamples.

5.3.1.3 Procurement route

To establish comparative samples of PFI and non-PFI facilities, a comprehensive list of operational PFI hospitals was compiled for the research. This was done in 3 steps. First, by using a list helpfully provided by the NHS Information Centre of hospitals they were aware to have been procured via PFI, with unique identifier site codes. Second, some sites were identified from the HM Treasury list of PFI signed project using facility names. Finally, additional sites were added to this list of PFI hospitals through further desktop research. This research effort was required at the time of analysis, but as of 2016, HEFS now usefully provide a comprehensive list of PFI hospitals available

from their website[20], which will make replication and development of the following analyses more effective.

The PFI sample represents the more recently constructed facilities (the average age of PFI sample is somewhat lower that that of the Non-PFI sample). The Hard FM costs were regarded to be sensitive to age of the hospital. Therefore, the decision was taken to restrict samples for this data to hospitals built since 2000 for cost data for the year 2004/05, and then separately for hospitals built since 2005 for analysis of cost data for 2005/06 onwards. This was an attempt to restrict analysis of these variables to very recently built hospitals.

5.3.2 Variable description

5.3.2.1 Cost of cleaning

This was produced by dividing the HEFS site level 'Cleaning services cost' by 'Occupied floor area' to make an *annual per square metre cost of cleaning* variable. The cost of cleaning is the cost to the NHS trust as reported by that trust in its ERIC report. For outsourced cleaning services this cost refers to the contract price. Cost for in-house cleaning provision refers to material, equipment and staff costs plus on-costs. The cost for cleaning in PFI hospitals is the part of the UCP apportioned to cost of cleaning under the PFI contract. Each year's cost of cleaning at current prices was converted to constant prices of April 2008 using Office of National Statistics RPIX indices to make the years comparable with each other.

5.3.2.2 Patient environment and food ratings

The patient environment ratings are compiled by NPSA teams that assess non-clinical aspects of patient surroundings taking into account the organisation's policy, observed cleanliness in various areas, infection control, general environment and conditions in access/external areas. The food rating is published by the NPSA through a similar assessment of aspects of the quality of patient food provision in hospitals. Given that common teams using standard criteria undertake these assessments they are considered to provide informative ordinal (but not necessarily cardinal)

[20] http://hefs.hscic.gov.uk

assessment of different hospitals. For more effective Chi squared analysis, both the patient environment and food 1 to 5 ratings were reduced to instances of either 5, 4 or 3 and below. In the range 1 to 5, 5 represents excellent, 4 good, 3 acceptable, 2 poor and 1 unacceptable. The rating methodology involves weighting ratings of numerous elements of the environment including perception of cleanliness, décor, signage around the hospitals, external area upkeep etc. Some aspects of the patient environment rating involve assessments of resource availability, for example hands scrubs and washbasins in certain areas. If these requirements have been included in the prescriptive output specification of the PFI contract, the financial penalty for non-provision will promote provision of such resources, in turn contributing to higher patient environment ratings for PFI overall. As such, this rating is taken as a proxy of the operational services and maintenance of the facility, rather than the design of the building itself.

5.3.2.3 Cleanliness

This is a percentage score generated by self-assessment against the National Specification for Cleanliness of the NHS as reported for the site in the HEFS report. The assessment is a pass or fail audit of 49 elements, such as cleanliness of fixtures and fittings and equipment, in the functional areas of the hospital (National Patient Safety Agency, 2007).

5.3.2.4 Cost per patient meal day

This a direct read off of the statistic on the HEFS site level report '*cost of feeding one patient per day (patient meal day) (£)*'. No normalisation was required for this variable. This cost data was converted in the same way as cost of cleaning data to April 2008 prices.

5.3.2.5 Cost of Hard FM

This is the HEFS site level reported 'Building and engineering maintenance cost' normalised by dividing by the 'Gross Internal Site Floor Area' (GIFA). This cost data was not converted to April 2008 prices as other underlying data quality issues hinder comparability.

Table 5-5: Variables and samples for operational renewed hospitals. Source: ERIC, Author analysis.

Units of analysis	*Source*	*Period*	*Sample*			
			Year	*n*		
					Non-PFI n	*PFI n*
Cost of cleaning	*HEFS*	*2004/05 -2007/08*	*04/05*	*122*	*106*	*16*
			05/06	*124*	*103*	*21*
			06/07	*136*	*105*	*31*
			07/08	*132*	*95*	*37*
Cleanliness	*HEFS*	*2004/05 -2007/08*	*04/05*	*79*	*68*	*11*
			05/06	*115*	*96*	*19*
			06/07	*142*	*110*	*32*
			07/08	*135*	*96*	*39*
Patient environment ratings	*PEAT*	*2005-2008*	*2005*	*98*	*83*	*15*
			2006	*113*	*93*	*20*
			2007	*124*	*95*	*29*
			2008	*122*	*85*	*37*
Cost per patient meal day	*HEFS*	*2004/05 -2007/08*	*04/05*	*97*	*83*	*14*
			05/06	*115*	*90*	*20*
			06/07	*126*	*96*	*30*
			07/08	*120*	*84*	*36*
Food ratings	*PEAT*	*2005-2008*	*2005*	*104*	*89*	*15*
			2006	*116*	*96*	*20*
			2007	*124*	*95*	*29*
			2008	*119*	*83*	*36*
Cost of Hard FM	*HEFS*	*2004/05 -2007/08*	*04/05*	*53*	*37*	*16*
			05/06	*11*	*8*	*3*
			06/07	*21*	*13*	*8*
			07/08	*26*	*13*	*13*

The results of statistical tests (independent sample t tests for cost and cleanliness scores data and chi squared tests for patient environment and food ratings) are presented in the proceeding tables. In reporting the independent sample t tests, the 'equal variances not assumed' t-test result is used if Levene's test for equality of variance was statistically significant. In the tables, asterix (*) indicates the presence of significance differences at the 95% confidence level.

5.3.3 Findings

5.3.3.1 Cost of cleaning

Table 5-6: Normalised cost of cleaning by procurement method (£ m^2, 2008 prices). Source: ERIC, Author analysis.

Cost of Cleaning	*Mean*					*t-Test*				
Year	*Group*	*N*	*Mean*	*Std. Dev.*	*Std. error mean*	*t*	*df*	*Sig. 2 tailed*	*Mean diff.*	*Std. error diff.*
2004/05	*Non-PFI*	*106*	*34.72*	*19.43*	*1.89*	*-1.27*	*120*	*0.207*	*-6.55*	*5.16*
	PFI	*16*	*41.27*	*17.71*	*4.43*					
2005/06	*Non-PFI*	*103*	*36.49*	*18.05*	*1.78*	*-1.05*	*122*	*0.294*	*-4.44*	*4.21*
	PFI	*21*	*40.93*	*14.98*	*3.27*					
2006/07	*Non-PFI*	*105*	*37.59*	*20.94*	*2.04*	*0.02*	*134*	*0.983*	*0.08*	*4.08*
	PFI	*31*	*37.50*	*16.14*	*2.89*					
2007/08†	*Non-PFI*	*95*	*40.76*	*19.37*	*1.99*	*1.45*	*96.84*	*0.150*	*4.25*	*2.93*
	PFI	*37*	*36.51*	*13.06*	*2.15*					

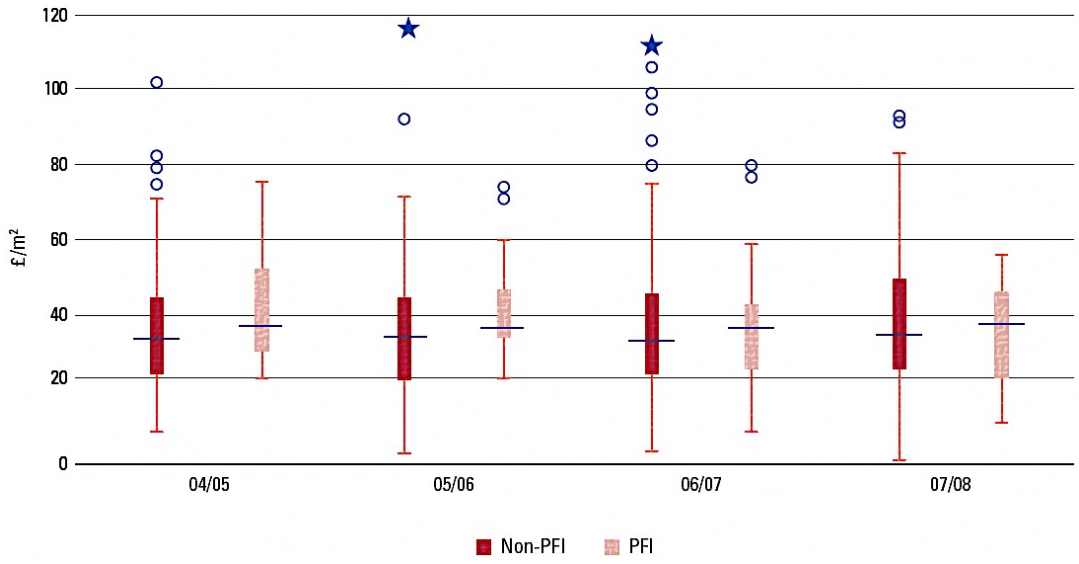


Figure 5-5: Variability of normalised cleaning cost by procurement method (£s m^2 2008 prices). Source: ERIC, Author analysis.

No significant differences in the costs of cleaning by procurement method are observed over the years considered. Consistent inverse trends are seen between the decreasing cost of cleaning in PFI hospitals (reducing £4.76 to £36.51 in 2007/08) and increasing cost of cleaning in Non-PFI hospitals (increasing £6.04 to £40.76 in 2007/08) over the period. The marked increase in Non-PFI cost of cleaning going into 2007/08 may reflect the impact of the implementation of the 'Deep Clean' initiative announced by the government in September 2007 (Dept. of Health, 2008). The corresponding PFI cost would not be expected to increase as the scope of the cleaning services is defined within the contract and not so subject to changing client requirements or centrally mandated *one off* initiatives.

Looking into the variability of the normalised cost of cleaning, the median for PFI is consistently above, if only marginally, that of non-PFI hospitals. Further, it is apparent that PFI cleaning costs are much less variable, despite the overall smaller size of compiled samples. The results for non-PFI exhibit many instances of outliers in the higher expenditures, as well as instances of implausibly small normalised cost indicators, bringing into question the quality of some of the non-PFI data. This leads to questions about the accurate calculation of public sector service costs. Suspicions of poor accounting have previously been raised as an issue, particularly with regard to adequate recognition of full employment on-costs, including pension liabilities. The variability of expenditures for non-PFI will in part be the result of the greater diversity in type of hospitals being operated. Smaller and more complex facilities will understandably cost more to clean on average, resulting from more segmented facility layouts and stricter operational requirements, including secure containment of patients in some mental health facility contexts.

5.3.3.2 Cost per patient meal day

No statistically significant differences are witnessed within the cost per patient meal day results here. Only the final two years come close to statistical significance, with differing effects between procurement methods. Neither PFI or Non-PFI provision appear to cost consistently less over the period.

Table 5-7: Normalised cost of catering (£s per patient meal day, 2008 prices). Source: ERIC, Author analysis

Cost per patient meal day	***Mean***					***t-Test***				
Year	***Group***	***N***	***Mean***	***Std. Dev.***	***Std. error mean***	***t***	***df***	***Sig. 2 tailed***	***Mean diff.***	***Std. error diff.***
2004/05	*Non-PFI*	*83*	*6.87*	*5.10*	*0.56*	*0.19*	*95*	*0.845*	*0.28*	*1.14*
	PFI	*14*	*6.59*	*3.19*	*0.85*					
2005/06	*Non-PFI*	*95*	*7.12*	*3.51*	*0.36*	*-0.00*	*113*	*0.993*	*-0.01*	*0.85*
	PFI	*20*	*7.13*	*3.19*	*0.72*					
2006/07	*Non-PFI*	*96*	*6.99*	*3.59*	*0.37*	*-1.63*	*124*	*0.107*	*-1.44*	*0.88*
	PFI	*30*	*8.43*	*5.83*	*1.06*					
2007/08[†]	*Non-PFI*	*84*	*7.96*	*3.81*	*0.42*	*1.76*	*118*	*0.080*	*1.23*	*0.69*
	PFI	*36*	*6.73*	*2.57*	*0.43*					

[†] - Levene's test for equality of variance was close to significance within this test at 0.55, with a corresponding *equal variances not assumed* p value of 0.043

5.3.3.3 Patient environment ratings

Based on the observation that PFI has higher proportions of each yearly sample in the best rating '5' (excellent) and lower proportions in the worst rating of '3 or below' (acceptable or worse), an interpretation of these results is that if the chi squared result is significant, then PFI samples are from a different (in this case superior) population distribution. As can be seen, there are two strong results in 2006 and 2008 with a borderline result in 2005.

Table 5-8: Patient environment ratings by procurement method. Source: ERIC, Author analysis.

Patient environment ratings	*Contingency table*				*Pearson Chi-Square*			
Year	*Group*	*Ratings*		*Total*	*Value*	*df*		*Asymp. Sig. (2 sided)*
		3 or below	*4*	*5*				
2005	*Non-PFI*	*38 (45.8%)*	*23 (27.7%)*	*22 (26.5%)*	*83*	*5.578*	*2*	*0.061*
	PFI	*2 (13.3%)*	*7 (27.7%)*	*6 (40%)*	*15*			
	Total	*40 (40.8%)*	*30 (30.6%)*	*28 (28.6%)*	*98*			
2006	*Non-PFI*	*27 (29.0%)*	*44 (47.3%)*	*22 (23.7%)*	*93*	*7.889*	*2*	*0.019**
	PFI	*1 (5.0%)*	*9 (45.0%)*	*10 (50.0%)*	*20*			
	Total	*28 (24.8%)*	*53 (46.9%)*	*32 (28.3%)*	*113*			
2007	*Non-PFI*	*31 (32.6%)*	*47 (49.5%)*	*17 (17.9%)*	*95*	*2.452*	*2*	*0.294*
	PFI	*7 (24.1%)*	*13 (44.8%)*	*9 (31.0%)*	*29*			
	Total	*38 (30.7%)*	*60 (48.4%)*	*26 (20.1%)*	*124*			
2008	*Non-PFI*	*22 (25.9%)*	*44 (51.8%)*	*19 (22.4%)*	*85*	*9.460*	*2*	*0.009**
	PFI	*1 (2.7%)*	*23 (62.2%)*	*13 (35.1%)*	*37*			
	Total	*23 (18.9%)*	*67 (54.9%)*	*32 (26.2%)*	*122*			

5.3.3.4 Cleanliness

Table 5-9: Cleanliness score by procurement method (%). Source: ERIC, Author analysis.

Cleanliness	*Mean*					*t-Test*				
Year	*Group*	*N*	*Mean*	*Std. Dev.*	*Std. error mean*	*t*	*df*	*Sig. 2 tailed*	*Mean diff.*	*Std. error diff.*
2004/05	*Non-PFI*	*68*	*89.68*	*8.01*	*0.97*	*-0.68*	*77*	*0.493*	*-1.82*	*2.65*
	PFI	*11*	*91.50*	*8.95*	*2.69*					
2005/06[†]	*Non-PFI*	*96*	*89.80*	*8.85*	*0.90*	*-2.17*	*47.23*	*0.034**	*-3.08*	*1.41*
	PFI	*19*	*92.87*	*4.73*	*1.09*					
2006/07	*Non-PFI*	*110*	*89.09*	*7.95*	*0.76*	*-1.99*	*140*	*0.048**	*-3.01*	*1.51*
	PFI	*32*	*92.10*	*5.88*	*1.03*					
2007/08	*Non-PFI*	*96*	*91.31*	*6.16*	*0.63*	*-1.95*	*133*	*0.54*	*-2.16*	*1.11*
	PFI	*39*	*93.48*	*5.03*	*0.80*					

[†] - Levene's test of equality of variance showed statistical significance at 0.027; *equal variances not assumed* test results are presented

Another indicator of facility output performance, cleanliness scores provide a proxy indicator of the performance of cleaning FM services. The PFI subset average is higher in each year of the study period, with 2 years where the result is statistically significant (2005/6 and 2006/07). The variability

in scores within the samples changes between years, but PFI tends to have lower variability overall, suggesting a more consistent quality of provision between these facilities. The lack of statistical significance in 2004/05 is in part down to a lower differential and PFI's notably higher standard deviation, in part down to the lower sample size in that year, at a point when fewer PFI hospitals were operational.

5.3.3.5 Food ratings

Table 5-10: Food rating by procurement method for UK renewed hospitals. Source: ERIC, author analysis.

Food ratings	*Contingency table*					*Pearson Chi-Square*		
Year	*Group*	*Ratings*			*Total*	*Value*	*df*	*Asymp. Sig. (2 sided)*
		3 or below	*4*	*5*				
2005	*Non-PFI*	*14 (15.7%)*	*46 (51.7%)*	*29 (35.6%)*	*89*	*1.134*	*2*	*0.567*
	PFI	*2 (13.3%)*	*6 (40.0%)*	*7 (46.7%)*	*15*			
	Total	*16 (15.4%)*	*52 (50.0%)*	*36 (34.6%)*	*104*			
2006	*Non-PFI*	*11 (11.5%)*	*59 (61.5%)*	*26 (27.1%)*	*96*	*7.101*	*2*	*0.029**
	PFI	*0 (0.0%)*	*9 (45.0%)*	*11 (55.0%)*	*20*			
	Total	*11 (9.5%)*	*68 (58.6%)*	*37 (31.9%)*	*116*			
2007	*Non-PFI*	*9 (9.5%)*	*40 (42.1%)*	*46[†] (48.4%)*	*95*	*7.574*	*2*	*0.023**
	PFI	*0 (0.0%)*	*20 (69.9%)*	*9 (31.0%)*	*29*			
	Total	*9 (7.3%)*	*60 (48.4%)*	*55 (44.4%)*	*124*			
2008	*Non-PFI*	*4 (4.8%)*	*33 (39.8%)*	*46 (55.4%)*	*83*	*2.132*	*2*	*0.344*
	PFI	*0 (0.0%)*	*13 (36.1%)*	*23 (63.9%)*	*36*			
	Total	*4 (3.4%)*	*46 (38.7%)*	*69 (57.9%)*	*119*			

[†] - notable result as the only instance where Non-PFI has a higher proportion of the Non-PFI subset sample total in the excellent rating than the corresponding PFI result

As can be observed, PFI generally shows a more negatively skewed distribution with typically higher ratings. An exception to this includes 2007 where Non-PFI has a higher proportion of facilities in the 'excellent' band, while PFI has a much higher proportion in the mid range with none in the lowest band of '3 or below' (acceptable or worse). Significant differences are observed in 2006 and 2007. The 2007 result is more difficult to interpret; the non-PFI sample has higher proportions in both the top (5 'excellent') and bottom (3 and below 'acceptable and worse') categories. The 2006 result has a clear interpretation; in that year PFI hospitals have better food ratings than Non-PFI hospitals.

The provision of pre-prepared catering services lends itself to outsourcing as a non-core clinical service considered on the periphery of NHS trust's competence. Insight on the extent of in-house catering within the NHS can be gained from looking at data from Patient Environment Action Team datasets (National Paitent Safety Agency, 2010). Analysing this data, we see of the 1,232 facilities surveyed approximately 57% of facilities record catering as provided in-house (Table 5.12 below) and 43% as privately provided. This underestimates the extent of private catering by number of meals in the NHS, as many of the newest PFI facilities are the largest general acute hospitals, with many times more beds and patients than other smaller facilities where catering is in-house.

Table 5-11: Procurement of catering services for all UK hospitals. Source: PEAT, Author analysis

	Catering service			
Catering provision	**Cook-Serve**	**Delivered Meals**	**On-Site Central Production**	**Total**
Contracted[21]	185	225	70	480
In-House	292	213	198	703
Mixed	18	22	7	47
Total	**495**	**460**	**275**	**1230**

One can also see there is a higher prevalence of the catering services being provided as *delivered meals* when it is contracted (225 / 480: 47%) compared to when it is in-house (213 / 703: 30%). This might imply the quality of contracted catering services is inferior (if onsite provision is thought to be associated with higher quality), though the prior PEAT analyses suggest that catering is an area where private provision is able to reduce costs, without reductions in the quality of service.

Additional data is available within PEAT surveys on whether procurement of catering services involves in-house or outsourced providers. This allows an additional level of detail in comparing catering service cost and performance for renewed hospitals. This controls for the portion of PFI facilities that retained some core FM functions such as catering under in-house forms of provision. Analysis revealed little difference in the cost and performance of PFI and separately outsourced provision and hence, they have been combined to produce a pure public versus private provision comparisons below.

[21] Includes facilities where catering is provided within the scope of the PFI contract

Analysis of the performance indicators reveals that private provision is associated with marginally better levels of service (though not statistically significantly different given the limited sample sizes, 0.332).

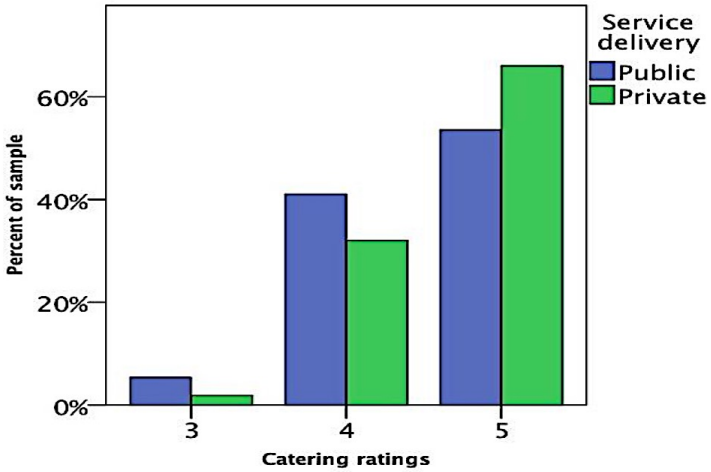


Figure 5-6: Distribution of hospital catering ratings (2008) by procurement method. Source: ERIC, PEAT, Author analysis.

Table 5-12: Hospital catering ratings for 2008 by procurement methods. Source: ERIC, PEAT, Author analysis.

Catering ratings	Public (% of n)	Private (% of n)
Excellent – 5	53.6	66.0
Good – 4	41.1	32.1
Acceptable 3 or below	5.4	1.9
Sample size	56	53

Analysis of the cost of catering shows that private provision of catering is delivered at far lower cost, suggesting better VfM can be gained with outsourcing or integrating catering services with contracts with the private sector. This difference is strongly statistically significant (0.001).

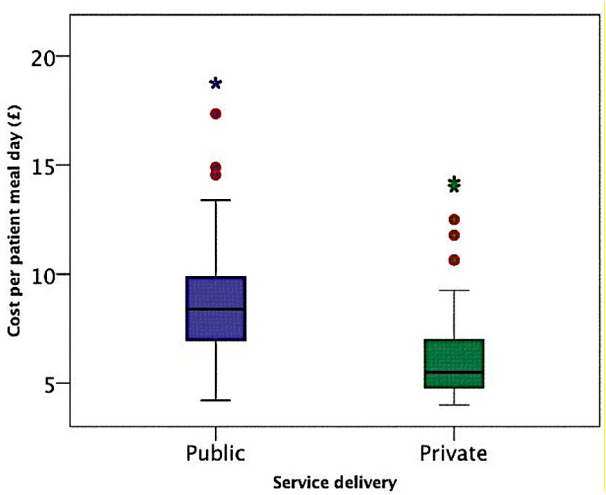


Figure 5-7: Hospital catering cost per patient meal day (2008, £s) by procurement method. Source: PEAT, ERIC, Author analysis.

Table 5-13: Hospital catering cost per patient meal day (2008, £s) by procurement method. Source: PEAT, ERIC, Author analysis.

Catering cost (£ per patient meal day	Public (% of n)	Private (% of n)
Average	8.81	6.55
St. dev	3.77	3.01
Sample size	54	49

There has been little empirical comparisons published about the results of in-house provision compared with outsourcing or integrated provision as part of a PFI type contracts. These results suggest that for some soft FM services, improvement in quality can be gained along with significant reductions in costs. Nevertheless, for the forming of the PF2 policy the government adopted the view that soft FM would only be incorporated into future deal where there was a significant case for integration of soft FM services within the contract. In light of the above analysis, and the fundamental basis of private finance forms of procurement to internalise the WLC of wide sets of services, this decision to remove all soft FM services from PF2 seems questionable. The separate outsourcing of such services would entailed additional transaction costs and create an interface between the PF2 builder and operator of the facility, and the separate catering provider (or cleaning, security, portering etc).

5.3.3.6 Hard FM costs

Table 5-14: Hard FM costs in less than 4 year old renewed UK hospitals (£ m^2, 2008 prices) Source: ERIC, Author analysis

Hard FM cost	*Mean*					*t-Test*				
Year	*Group*	*N*	*Mean*	*Std. Dev.*	*Std. error mean*	*t*	*df*	*Sig. 2 tailed*	*Mean diff.*	*Std. error diff.*
*2004/05***	*Non-PFI*	*37*	*12.59*	*10.00*	*1.64*	*-1.25*	*15.19*	*0.231*	*-25.39*	*20.33*
	PFI	*16*	*37.97*	*81.06*	*20.26*					
2005/06	*Non-PFI*	*8*	*16.88*	*17.95*	*6.35*	*0.34*	*9*	*0.744*	*3.78*	*11.22*
	PFI	*3*	*13.10*	*10.37*	*5.99*					
2006/07	*Non-PFI*	*13*	*10.54*	*13.56*	*3.76*	*-0.32*	*19*	*0.755*	*-1.72*	*5.44*
	PFI	*8*	*12.26*	*9.07*	*3.21*					
2007/08	*Non-PFI*	*13*	*17.17*	*19.60*	*5.44*	*-0.68*	*24*	*0.502*	*-9.45*	*13.86*
	PFI	*13*	*26.62*	*45.99*	*12.76*					

† - Levene's test of equality of variance showed statistical significance at 0.14 for 2004/05; *equal variances not assumed* test results are presented

** - Note on samples: 2004/05 (all hospitals constructed since 2000); 2005/06 onwards (all hospitals constructed since 2005)

5.3.3.7 Data quality

These Hard FM results are presented to demonstrate the data availability. Quality issues also need to be questioned, especially in the area of asset information within the NHS. While it is commendable that there is data available on the above aspects of cleaning and catering service cost and performance, the particular lack of good data on asset condition and backlog maintenance of public sector estates is not surprising. It is this lack of consideration about the maintenance of buildings that forms a cornerstone of the PFI case, and one that is evidently still an issue. This lack of focus across the public sector on facility maintenance no doubt leads to sub optimal allocation of resource on built assets. These can be considered as decisions made about forms of capital investment, between new build versus refurbishment, and about the resources dedicated to maintaining facilities during operations, as the associated life cycle, which can extend asset lives and reliability. The optimal choice for both of the above aspects should be closely aligned with the requirements of the processes, and resulting services, such facilities accommodate.

5.4 Allocation of OPEX and asset data by mode of operation

A Public Accounts Committee hearing provides a unique insight into this with the insistence from a senior NHS Commercial Director that "costing data in ERIC can be a combination of that relating to PFI and non-PFI. No data on the split between them is collected by ERIC or is available from other sources." (PAC, 2010). The collation of a list of PFI hospitals was a research challenge at this time. The HM Treasury PFI signed projects list provided a comprehensive record of the PFI contracts commissioned by the Department of Health and devolved NHS bodies. One difficulty here was that this source presents data at the contract (project) level, rather than at the facility level, relevant where many facilities, including legacy and new build, may be operated under a single PFI contract. Other data sources at the facility level were sought. The most useful source to begin compiling this list of PFI hospitals was a bespoke report provided by the NHS Information Centre. They maintain a facility level database (collatable with ERIC data) including a PFI marker for facilities they know are operated under PFI contracts. Other material also added to the list, with reference to the PFI signed contracts list and desk based research.

5.5 Full scope F and S for hospitals

The task of generating a full scoped concept for hospitals for F or S requires additional work. The following table suggest sources for the equivalent concepts used in schools. Some data on hospitals gives more aggregated cost indicators

Table 5-15: Potential sources for full scope F in hospitals

Cost concept (schools)	Potential source (hospitals)	Required adjustment
Premises staff (E04)	Trust accounts on cost of staff employment	Detailed breakdown of aggregate building maintenance expenditure to staff and additional supplies / services
Building maintenance (E12)	ERIC data on building maintenance expenditure	More complete and accurate reporting of maintenance expenditures
Grounds maintenance (E13)	Trust accounts on cost of staff employment	
Cleaning and caretaking (E14)	ERIC data	Normalisation to facility / per patient level
Catering staff (E06)	HEFS ERIC data on cost per patient meal day	Require break down of staff and separate catering suppliers

Catering supplies (E25)	HEFS ERIC data on cost per patient meal day	Require break down of staff and separate catering suppliers
Water and sewerage (E15)	HEFS ERIC data	Normalisation to facility / per patient level
Energy (E16)	Display Energy Certificate (DEC) data or meter readings of facilities	Tariff data may be required to convert energy used into costs
Other insurance premiums (E23)	Insurance providers quotes and data on policies taken out by NHS Trusts	Trusts likely have insurance over many facilitates. A facility level policy and associated premiums would be required
Other occupational cost (E18)	Healthcare consultants	Full range of costs not elsewhere covered required
ICT learning resources (E20)	Healthcare equipment suppliers	Detailed specification of typical facility provisions and costings
Bought in professional services (E28)	Trust accounts on external advice procured	This may be volatile between trusts so large sample needed to be representative

5.5.1 Full S concept measurement in hospitals

5.5.2 Trust level accounts:

Given the focus of ERIC on the estate of Trust rather than on the front line staffing cost of clinical employees (nurses and doctors principally), alternative sources of data are required to build a WLC concepts for S in hospitals.

Table 5-16: Potential sources for full scope S in hospitals

Cost concept (schools)	Potential source (hospitals)	Required adjustment
Teaching staff (E01)	Clinical staff expenditure from Trust level accounts	Disaggregation of trust level expenditures to particular facilities
Supply teacher staff (E02)	Locum medical staff expenditure from Trust level accounts	Attribute to facility
Education support staff (E03)	Medical support staff	As above
Administration and clerical staff (E05)	Trust level administration and overhead staff expenditure	These may be averaged out of trust faciltities given that clinical staff expenditure will greatly outweight this portion of staff costs

The hospital is not necessarily the accounting unit for trusts as departments may span a number of facilities. If trust data makes attribution of staffing costs to facilities difficult, then an alternative approach to WLC ratios would be produce them for a particular trust that might be considered typical of the standard. This would be a move away from the idea of WLC ratios for particular facilities and rather an attempt to look at the WLC of organisations operations over parts of large national estates. In seeking out NHS trusts for further work, focusing on those with a single large type of facility (such as acute hospitals) would seem a sensible approach.

5.6 Chapter summary

This chapter has presented a range of analyses on the operational cost of schools by both procurement methods and form of capital works. A general finding in school PSAs is the prevalence for f costs to increase more than S costs in the wider estate over the period. This demonstrates recent years of austerity with regard to funding of front line staff in education PSAs. Further, headline comparison of a basket of FM cost for procurement defined samples reveals PFI is no more expensive than conventionally procured and operated facilities, but also no less expensive. This suggests savings from investment in operation are minimal.

The hospital level analysis of some FM related service costs and performance reveal that PFI is not consistently more or less expensive than conventionally procured and operated PSAs, with instances of higher quality provision in terms of patient environment ratings and cleanliness scores. Catering is shown to be an area where private provision can reduce normalised cost and improve performance.

Chapter 6 Whole life cost

Having considered the costs of construction and operations (both facility and front line staffing) in the previous two chapters, it is now possible to place these findings together and consider WLC as a measured concept. Given the paucity of available data on the facility level construction costs of hospitals, and the lack of a full scope F or staffing costs (S), commentary will focus on what new knowledge has been established for school's WLC. Given the requirement to study recently renewed schools to establish values for C, this limits out ability to comment on the WLC of schools across the estate (as C is not observable), but insights are available on the aggregate level of spending on F and S generally. The key question posed earlier in this thesis concerns the potential factor substitution between C and F, and the possibility that WLC can be reduced with *investment in operations.* This lies at the heart of the business case for privately financed forms of PSA capital investment.

An additional comparison looking at the on-going operational costs of the recently renewed estate against that of the non-renewed estate is possible, but has not been pursued as yet given limited life cycle data for renewed assets. This might be achieved by collating CFR data for the sample of schools analysed above along side similar data for the rest of the estate, but will require significant resources for collation and computation of benchmarks given the number of data points and time periods available.

6.1 Comparing school operating costs before and after renewal

For WLC ratio analyses, three years' post renewal data for F and S were sampled for a subset of schools from those identified as renewed according to the SBS 2011. These were averaged over the ex ante and ex post periods to produce annual cash flow estimates. They then became the predicted constant price cash flows for each of the 60 years of assumed asset lives of the renewed schools. Discounted at both 3.5% (social time preference) and 7% (alternative discount rate allowing like-for-like comparison with commercial offices), we see that the stylised WLC ratios for schools under a 3.5% discount rate are roughly 1 / 1 / 5, changing to 1 / 0.5 / 2.5 under a 7% discount rate.

The lower ratio of (F + S)/C in schools (5.3/1 when discounted at 3.5%; 3/1 when discounted at 7%)

compared with offices (16.5/1 – Ive, 2006) implies that, overall and on average, it will be even more difficult than in offices to design schools projects so that they can achieve savings on F and S (in rebuilt schools in comparison with non-rebuilt) to cover the additional cost of investing in C, the cost of construction. This is apparent despite using a longer assumed asset life for schools (60 years) compared with offices (20 years).

Table 9 Cost ratios *c*, *f* and *s* (normalized)

Present value (PV) cost per pupil capacity	**(£)**	
c	20 497	
SD	6383	
n	166	
Discount rate	3.5%	7.0%
f	16 380	9219
SD	5841	3288
n	97	97
s	91 088	51 266
SD	19 402	10 919
n	97	97

Figure 6-1: WLC ratios for c, f and s (normalised by pupil capacity). Source: Ive, Murray and Marsh (2015) Tab. 9.

Whilst it is still the less well understood and less predictable relationships between spending on C and consequent savings in S that could be crucial (where environments are able to enhance the productivity of front line staff), rather than the relationship between spending on C and potential savings on F, the former relationships may well be relatively more important in school settings given the constrained budgets for additional teaching staff.

6.2 Capacity available versus utilisation

In the past, the central planning system for ensuring sufficient capacity of schools places could meet demand was led by local authorities who tried to ensure that they were not over providing

against population estimates. Given the changing landscape of school provision with academies and free schools, it is conceivable that the capacity utilisation of established schools could vary considerably if pupils are attracted to attend new, local alternative schools. This has implications for the ability to fund under utilised capacity, especially given the fixed cost overhead nature of some facility operation and maintenance costs.

The first effect of having spare capacity for pupils for which you are not receiving per pupil based funding may include schools facing challenges to maintain a full range of curriculum. This will likely bring pressures to reduce staff expenditures. Any on-going allocations to fund previous capital investments may also come under strain unless pupil numbers can be maintained in the face of increasing competition. In this sense, assumptions about future capacity utilisation rates (and the resulting funding streams) may have been affected by optimism bias within capital project business cases. These issues are returned to in recommendations for further research.

The preceding analyses have a common form of normalising headline school costs using pupil capacity unit provided in the Edubase dataset, the number of pupils a school is able to accommodate. Appendix 9 provides the government guidance for school size based on phases (Design guidance 98), information applied in the estimation of school construction cost in the previous chapter. This common means of normalising cost, while convenient, will hide one important determinant of operational cost, that of actual capacity utilisation. If a facility is used more intensively than comparative facilities, it is reasonable to predict higher resources cost must be expended to maintain the standard of facility provision. One feasible scenario includes ensuring communal halls are of sufficient capacity to accommodate whole school assemblies (increasing CAPEX) or from the increased energy and water costs of more intense use (increasing F). While there is good data on pupils on roll, the data on school capacity is available from the Edubase dataset, a dynamic dataset updating values over time. Hence, it does not provide a good basis for times series data on the capacity of schools, required to assess the capacity benefits of capital investment in schools.

Knowledge of capacity utilisation at the facility level is of core concern, especially for the operation of intensively used, and hence, more critical assets. This may arise from a sudden need to change operational regimes in a way not considered ex ante, for example in achieving new legislative

requirements for adherence to energy efficiency in public buildings or the sudden requirement to decant facilities and house pupils temporarily elsewhere.

6.3 Discount rate

The long lives of PSA assets demand that consideration of the discount rate (and the form of the period cash flows) is considered with care. The Treasury Green Book (only mandatory for central government departments and agencies, but recommended to local authorities and other public bodies) lays down a 3.5% real discount rate to reflect social time preference, with additional adjustment to the cash flows rather than to the discount rate to offset optimism bias in forecasts of cash flows. It also lays down that: 'The valuation of costs or benefits should be expressed in "real terms" or "constant prices" (i.e. at "today's" general price level), as opposed to "nominal terms" or "current prices"' (section 5.42). 'Where particular prices are expected to increase at significantly higher or lower rate than general inflation, this relative price change should be calculated'. This latter point is of upmost importance as if expectations about where longer term prices changes for key cash flows can be made explicit, these might shape the decisions concerning the capital investment to focus on minimising WLC.

The 7% discount rate was applied also to allow for comparison with previous studies (Ive, 2006), but as table 2.3 earlier demonstrates, the variety of discount rates and asset lives applied in the range of WLC studies to date, makes wider comparisons difficult.

The discount rate should reflect the risk of the particular category of the investment being pursued. Given the similarity in the riskiness of construction of schools and hospitals (figure 4-1 above) and the similar contexts in which they are commissioned and operated, there seem little case to suggest different discount rates to be applied.

Of course, beside the discount rate there are a set of key sensitivities that drive the out turn WLC of facilities, not least how inflation is incorporated into future cash flows, the majority of which constituted wages and salaries for the delivery of FM PSA management and front line public services. Inflation may be factored into the discount rate if cash flows remain nominal (as was pursued here), or lower nominal discount rates used for real cash flows. The reality is, given the difficulty with predicting headline inflation in even recent years, let alone how wages will adjust to

this in public sector settings, analysis of sensitivities for WLC settings requires better historic information on the profiles of costs against recorded inflation to inform input distribution parameters.

6.4 Asset life

The asset lives of PSAs are an uncertain and understudied area. As is apparent from data on the age asset profile of both the school and hospital PSA estates, there are in operation now assets over and above 80 years, though of course these have likely had significant remedial works to ensure fitness for purpose.

WLC estimations will of course be sensitive to the actual life of the asset reached, and while there is fairly good knowledge about how assets deteriorate over time, what is uncertain is whether the location or specification of a building will be suitable for long term service. Historically, school location have not been sensitive to the underlying value of the land they are built on, given the legislative requirement for local authorities to provide school place within given localities. The asset life of a high end London base office can be reasonably assumed to average around 20 years (Ive, 2006), given the reality that after some considerable years of operations, regardless of the suitable condition of the asset for means of accommodating future tenants, the rental yield amenable to a *tired* building may require that significant works be undertaken to be attractive to higher yielding tenants (Barras, 2009). This pursuit of yield on PSA sites is not an over riding factor in determining asset lives which are arguably more a function of the affordability to renew, rather than the functional life of as built assets.

If obsolescence was to determine the asset lives of PSAs strictly, this might be at odds with the reality that well over 10% of the estate originates from pre 1919 (higher in hospitals). What has driven the creation and management of the estate has been a need to expand provision (motive C) and hence facilities originating from various periods, with quite different needs for investment have emerged. In a monopoly context, economic theory suggests the operator would keep operating assets until the ownership cost is more than the cost of replacement (this is clearly not the case if the above results are to be believed). In a more competitive regime, where *market* forces are at play in attracting parents to choose particular schools, operators may be forced to abandon particular assets for which they cannot attract sufficient pupils (and associated revenues)

for covering fixed costs. This may turnout to be sub optimal policy outcomes if those abandoned PSAs later require re-establishment as part of future school estates.

6.5 WLC as a tool for allocating resources

WLC approaches provide a framework within which potentially superior decision about long term budgeting can be made. As the above analyses have shown, the magnitudes of headline WLC metrics vary considerably within and between different types of facilities. This alone allows the decision maker to contextualize their allocation decisions for capital and operational investment to one more specific to the setting such as a school. It is apparent from table 6.1 above for schools that additional expenditures on C in pursuit of savings in F will be particularly hard to achieve given their relative magnitudes, while marginal expenditure on C that can reduce S (staffing costs) by similar amount may be possible in pursuit of lower WLC. This would require fundamental re-allocation of funding for school PSAs as well as considerable finance to cover the period between investment in the asset (occurring upfront) and on-going asset life long lower streams of expenditure on S. The profile of saving on S would be pertinent in assessing the NPV of the *investment,* defining the PV saving against increase C against the perceived discount rate.

The allocations of capital grants between sectors within the scope of government provision are subject to highly centralised HM Treasury negotiation and sign off. In austere times, there is a risk that biased allocations will be made for programmes that involve lower first costs, excluding capital programmes that might otherwise pose credible investments in pursuit of WLC savings. Better understanding of the WLC involved with owning and operating long term PSAs may serve to counter myopia in the allocation of public funds in pursuit of economies, resulting from greater transparency about the long-term commitments (and options for current costs). Further, WLC frameworks offer another perspective on the trade offs inherent within investments in specific assets (idiosyncratic), that even well considered discount rate assessment never will (as the systematic perspective of the asset). Further, WLC perspectives help understanding the trade off between mutually exclusive options given real budgetary constraint. In the decision to subsidise investment in high speed broadband, the government (and private investors) understand well that once ducting and cabling has been installed, ongoing maintenance on modern fibre optic cable is relatively low, so C will be somewhat higher than both F and S combined. On the other hand,

additional school capacity operated under normal regimes will entail longer-term commitments to S some times large than the PV of C.

The growth in the popularity of WLC frameworks suggests an increasing appreciation for the longer-term cost of facility operation. The commitment to spend on C mandates a minimum commitment to F and S, with the risk that failure to acknowledge this at the outset will lead to over investment in C for assets that later turn out to be economically unviable. A classic example of this in the context of PSAs includes Sure Start centres of the New Labour administration, which has received significant budget cuts in recent years demanding re-purposing of the PSAs that under pinned the programme. The reality that no government can tie the budgetary hands of later administrations means that even with perfect WLC information, less than optimal decisions concerning maintenance and investment in PSA estate will always be subject to wider contextual factors. One notable exception includes PFI contracts, where future government commitments to WLC maintenance are mandated (else incur prohibitive contractual compensation clauses). This swing from a focus to budgeting for S to F (in the case of PFI) has lead to situation where S had become a residual concern once contracted payments have been paid.

6.5.1 Life cycle allocations

Lifecycle allocations exist to provide for on-going capital maintenance and replacement. They are built into the UCP. The relative size of life cycle allocations will be of considerable importance to achieving lower WLC. A more intensively used facility, such as a school undergoing significant wear and tear, will require a higher proportion of it's WLC allocated to life cycle replacement. This will ensure the building is maintained adequately and does not lead to increased risk of unavailability due to asset failure. The intended timing of those life cycle expenditures will bear on the sculpting of the profiles of UCPs and thus on the project's NPV in VfM assessments. Further, when in reality those expenditures are incurred will bear on the on-going profitability of the SPV. If the SPV feels they are able to take the risk of deferring lifecycle expenditures, and hence accept the possible resulting unavailability if the asset deteriorates, then they will make additional unanticipated ex post returns in the form of interest on unspent funds. There has been increasing pressure for public clients to share in these savings, as many early projects were considered to have over allocated resources to these life cycle funds (HM Treasury, 2012).

6.6 Chapter summary

This chapter has presented summary findings on the cost of PSA construction and operation, including the staffing costs of schools. A central finding concerns that for schools, for each £1 spent on construction, approximately £1 is spent on facility operation and £5 spent on staffing (mainly teaching staff) over a 60 years asset life (discounted at 3.5%). This ratio becomes closer to 1:0.5:2.5 when discounted at 7%. The lower discount rate amenable to publicly financed investment when compared to privately financed investment, including PFI, necessarily means the present value of WLC savings from investment in operations will be greater when pursued with public finance, if only the incentives or policies for their pursuit could be instilled without the use of private finance forms of procurement.

Chapter 7 Outcomes

Having considered the costs and facility performance aspects of capital investment and on-going operation, this chapter provides insight as to the effect investment in a facility can have on the users. The term *outcomes* is commonly used to consider the benefits of policy interventions and fits within the framework applied in the Green Book (HM Treasury, 2011). The Green Book (HM Treasury, 2011, p. 14) provides a range of examples of the difference between outputs and outcomes, as illustrated in Table 7.1.

Table 7-1: Examples of outputs and outcomes. Source: HM Treasury, 2011, Table 3

Table 3 Examples of outputs and outcomes

Policy area	Outputs	Outcomes
Job search/job matching	Number of job seekers assisted	Value in extra output or improvement in efficiency of job search
Development of skills	Number of training places and/or numbers completing training	Value of extra human capital and/or earnings capacity
Social outputs: schools; health centres	Examination results (schools); people treated (health centres)	Improvement in human capital (schools); measures of health gain (health centres)
Environmental improvement	Hectares of derelict land freed of pollution	Improvements in the productivity of the land

Increased focus on outcomes in policy settings of investment and procurement form an attempt to move away from the notion that dedicating more resources to a particular project or programme automatically improves the achievement of the ultimate objective of PSA, that of facilitating the provision of public services and the benefits they bring. In the recent years of austerity in public budgets, *more for less* has become a strap line for policy interventions that aim to deliver greater benefit for less cost (Barber, 2017).

A key difference between outputs and outcomes is that outcomes seek to place a valuation (with some concept of unit value) on the improvement in user performance (or facility operation in the case of assessing non-user WLC benefits of capital investment), rather than merely quantifying the actual improved output. The following chapter presents the development of a method for valuing outcomes from school capital investments. While such a method can not be developed for hospital facilities given current data on the cost and benefits of capital investment on healthcare outcomes, discussion focuses on what steps are required to replicate the advancements made in schools capital investment scenarios.

7.1 Educational attainment as an outcome

In the context of schools, educational attainment (EA) becomes a tangible and well-measured form of outcome that has been at the fore of policy interventions in recent years. To provide some context on the *as usual* national average attainment at the end of compulsory secondary education to age 16, below is the recent time series performance of national attainment of 5 A* - C GCSE[22] as the main NQF (National Qualifications Framework) level 2 assessment objective. As is apparent, over time there has tended to be improvement in national average attainment, that is, on average, schools tend to witness a higher proportion of students attaining this target level of achievement. There is of course considerable variance between schools and indeed within schools. It is notable that as EA attainment has increased over time, the standard deviation within comprehensive schools has reduced significantly, in part down to the upwardly constrained variability in this measure of EA. This is indicated by the skew of the distribution, progressively more negative after 2008. This coincides with a progressive increase in the kurtosis of the EA distribution, in line with the trend of reducing standard deviation.

[22] General Certificate of Secondary Education

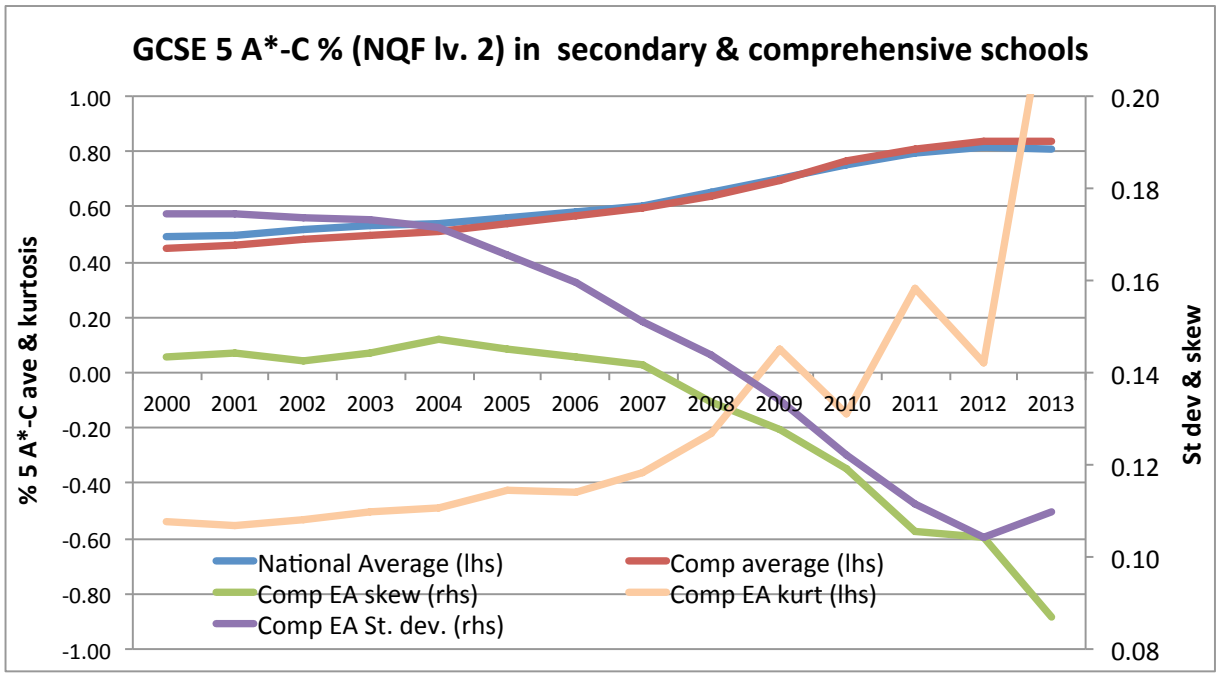


Figure 7-1: Average, skew and kurtosis of EA (5 x GCSE A* - C) across secondary schools (n > 2,500) 2000 - 2013. Source: Attainment tables, Author analysis.

It is notable that comprehensive schools seem to outperform the national average for all secondary schools towards the end of the period. This is verified by looking at official attainment data (Dept. for Education, 2014b) and is in part due to the low performance of special schools, where pupils with special educational need are taught.

One commonly cited source of superior outcomes for schools is of course the variance in a range of socio demographic factors of the pupils attending the school. A 2010 study applying multilevel modelling approaches in attributing the variance in EA found that the vast bulk of variance in educational attainment was attributable to factors linked to the child and the child's family context, rather than factors at the local education authority, primary or secondary schools, or indeed neighbourhood factors.

> "Differing LEA policies and practices might also lead to differences in child outcomes. However, these studies tend to find neighbourhood and LEA effects to be small in comparison to the effects of schools."
>
> Leckie et al., 2010, p 68.

This study uses highly innovative sampling methodologies (as well as advanced multi level modelling approaches) for the identification of twins from pupil level data to allow for controlling of family contexts in studying EA. Pupil data is understandably highly cleaned of personal details, demanding the use of anonymised birth date and post-code data. Similar methods might be used on large-scale datasets over the estate to identify schools that are potentially more susceptible to capital interventions in pursuit of improved outcomes (motive A). Given that most future capital works in this sector will constitute motives B (backlog maintenance) and C (capacity adding), any capital investment in pursuit of outcomes in line with motive A should be highly focused in it's allocation with an evidence base rooted in comparison with other schools.

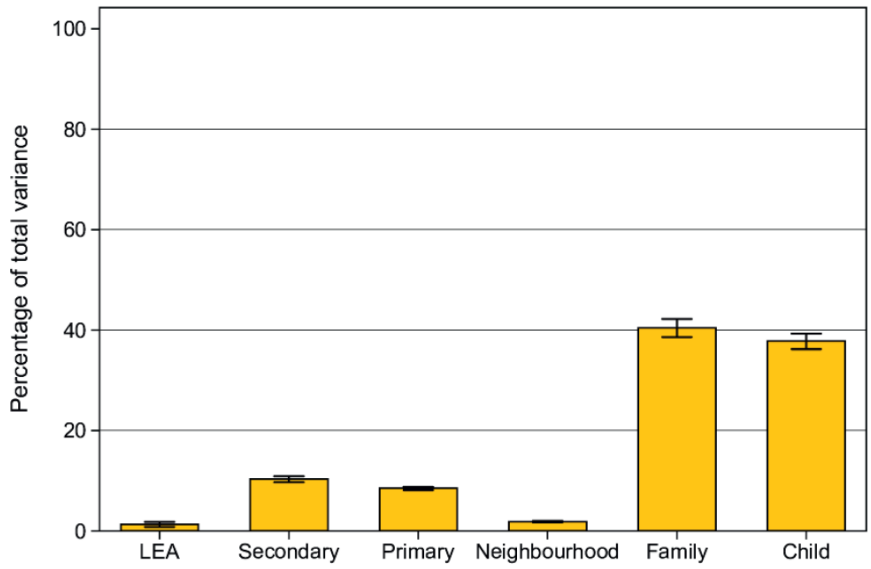


Figure 3. Variance decomposition results for the unified model with 95% credible intervals

Figure 7-2: Sources of variance in EA. Source: Leckie et al., 2010, fig. 3.

It was partly in recognition of these contextual determinants of EA that the New Labour government sought not to compare schools based on raw EA, but rather to use contextualised value added (CVA – a form of multi level model) approaches to assessing the effectiveness of schools in improving EA (Dept. for Education, 2010). In 2005, the then government began piloting of CVA measures that sought to use national data on a range of child level characteristics[23] to control for the make up of school cohorts. This approach lost favour with the incoming coalition

[23] Including 8 factors e.g. ethnicity, deprivation, English as 2nd lang., free school meals amongst others.

government in 2010 who instead reverted back to comparing schools on more raw bases (Leckie and Goldstein, 2016).

The political sensitivities of academic progression across sections of society, along with increasingly sophisticated data and modelling approaches, have made this area of policy a fertile ground for research in recent years. However, the long time horizons involved in time series studies is, an albeit temporary, barrier to more detailed analysis of policy interventions. The following analyses seek to provide specific insight into the associated change in outcomes from recent capital investment in English secondary comprehensives.

The role of good-quality school buildings in determining the outcomes of children's education was asserted as the rationale for much of the BSF capital programme (Crace, 2010; Dept. for Education and Employment, 2001; House of Commons Education and Skills Committee, 2007). What 'good' means in this sense is, however, yet to be comprehensively understood (Barrett et al., 2013). The investment case for the BSF programme was based on some evidence (PricewaterhouseCoopers LLP., 2003) of a positive relationship between money spent on rebuilding and improved educational outcomes.

With BSF cancelled as of 2010, public investment in the school estate has become more devolved, though not necessarily to local authorities, most evident with the controversial academies and free schools policies. These policies circumvent the local authority as the local provider of education (including both the building and their staffing). A recent NAO report (2016) provides a useful summary of the lines of responsibility and reporting within the education sector (Appendix 7). As is clear, academies are completely separate from the maintained sector. It is interesting to note that while all schools are accountable to the Department for Education for aspects of educational performance, schools are accountable to the non-departmental and independent Education Funding Agency for financial aspects of their operation. It seems the decision-making concerning the allocation of budgets for inputs (costs) is intentionally separate from the authority responsible for the outcomes (EA) of the facilities in use. Further discussions of issues that may arise from this are included in the closing chapter.

The need to continually maintain and, when appropriate, rebuild school buildings remains, whether that responsibility is taken on by central / local authority or, as is increasingly the case, quasi-independent schools (academies and free schools).

The following exercise relates however to capital investments made in the period from 1997 – 2012. For these investments the principal aims are to:

(1) observe the variance in outcomes associated with from capital investment, to assess the challenge of predicting returns from a school building project at the individual level
(2) address the lack of clear method in programmes of projects for policy-makers to set measurable objectives, evaluate outcomes and rates of return

Commentary attempts to describe a situation in which the recent national evidence base on costs and consequences of rebuilding English schools was necessarily thin ex ante, because few English schools had been rebuilt in the preceding period. Further, it deals with a situation in which even the limited potentially available data set was incomplete, unconsolidated and little analysed prior to launch of capital programmes. Given the considerable freedom concerning the wider provision of education academies are afforded, academies are not considered in the following analyses in attempt to focus on those schools that received capital allocations under BSF.

7.2 Investing in school rebuilding

The research concerning the mechanisms for improvement of EA resulting from superior learning environments remains an emerging field. A notable recent contribution in this area, begins to break down the mechanism with a theoretical framework and extensive literature review provided in the *Clever Classrooms* report on the Holistic Evidence and Design (Barrett et al., 2015). The figure below serves as a useful framework from which to draw reasoned argument for the benefits of better learning environments, achievable via appropriate capital investment in existing PSAs and for new capacity. The separation of the built environment factors across three aspects of naturalness, individualism and level of stimulation, within and outside of classrooms, does well to break down the complex relationships between the elements of users performance and physical environments. While this study undertook its main analyses in primary school settings, findings

included significant association between EA and optimum light and air conditions. There is little reason to suppose the effectiveness of such optimum conditions for older pupils in secondary comprehensive settings are any less important.

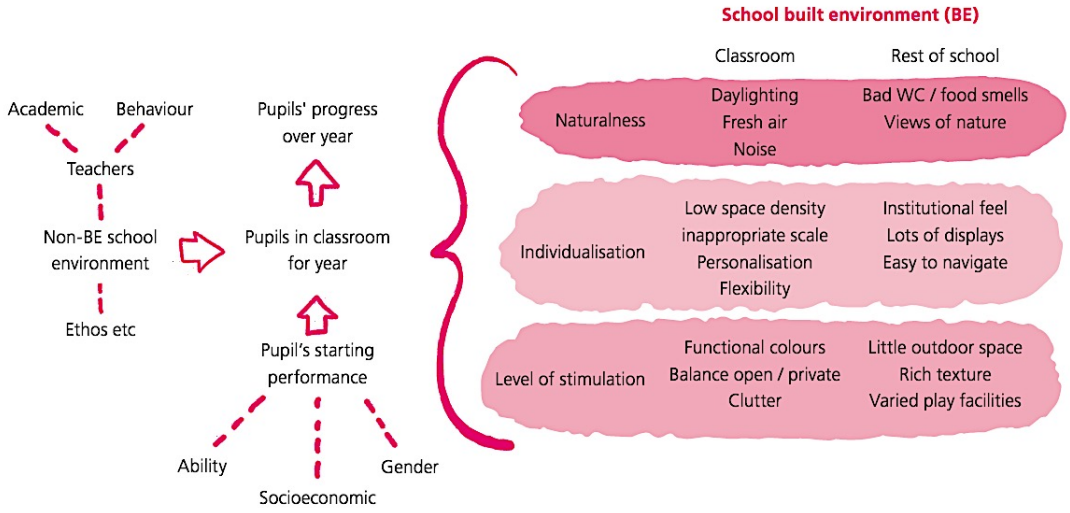


Figure 7-3: Educational attainment conceptual model. Source: Barrett et al., 2015.

Earlier work in this area of study provided a basis for much of the more recent capital investment and sought to define the relationships between school level factors and EA (PriceWaterhouseCoopers LLP, 2001).

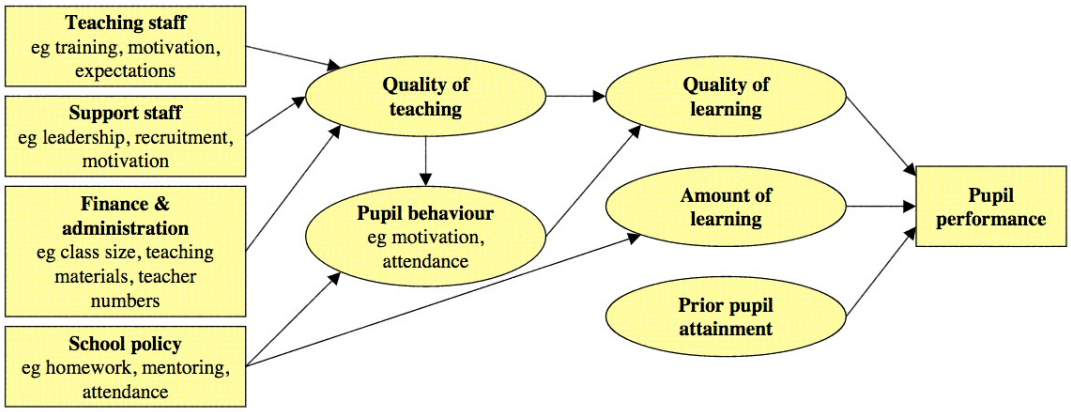


Figure 7-4: Framework for understanding the factors in pupil attainment. Source: PWC, 2001.

While this framework focuses on school level characteristics, it is notable how it concurs with the Barrett et al. analysis in terms of highlighting pupil behaviour as a relevant factor, while lacking the

sophistication to consider socioeconomic factors other than how they might form the basis of prior attainment. Many of the factors considered here remain elusive from deeper measurement and modeling, though as data emerges and is able to be combined, there is increasing opportunity to investigate proxy indicators of *good* and *bad* physical environments (see further research). It was seemingly in light of the above earlier work that the then Prime Minister Tony Blair was quoted as suggesting:

> "A good education depends on many things: teachers, parents, standard, discipline and motivation. But good facilities where young people can learn and grow are a vital foundation."
>
> Dept. for Education and Skills, 2007, p. 4.

7.3 Ex-post EA performance

Out of previous research (Durbin and Yeshanew, 2010; KPMG, 2010b; PricewaterhouseCoopers LLP., 2003; Rintala et al., 2008; Rintala, K., 2009; Williams et al., 2014; Wing Yin, 2008) a method has developed for measuring the impact of rebuilding schools on EA.

Durbin and Yeshanew (2010) attempted to compare average levels of examination attainment after rebuilding in rebuilt (BSF) schools with those in non-rebuilt schools. The problem with this approach is that schools were selected for inclusion in the early rounds of BSF precisely because the prior levels of attainment of these schools were relatively low. Adjusting for pupil's prior attainment (at primary school) fails to deal with this problem.

This method was developed to undertake the analysis for another study of recently renewed schools and found the average effect of rebuilding on educational performance in the years immediately following rebuilding to be statistically significant and positive (KPMG, 2010b). This is measured by the annual rate of improvement relative to national average in the proportion of pupils obtaining five or more A* – Cs. The method developed in this latter work did not seek to control for the characteristics of cohort but compared improvement in those schools to have received capital works against the national average rate of improvement in GCSE results overall.

This was then taken as a moving benchmark, with the implication that it was the rate of improvement that would be expected of a large sample of schools in the absence of a capital works intervention. Actual improvement in the sample of rebuilt schools was then measured relative to this national rate (for each school in each year performance was measured as 'x' percentage points above or below the national average for that year, where what was measured in percentage points was the proportion of all pupils, nationally or in the school, achieving five or more A* – C GCSEs). For each school, construction works was attributed to the single most appropriate year according to centrally provided data (SBSs, Partnerships for Schools, 2009). Change in GCSE performance was then measured for three years before and three years after the year of renewal. To produce the comparative sample for type of capital works, the 395 schools were divided into 193 rebuilt and 202 refurbished schools with reference to SBS. For these comparisons, rebuilt refers to facilities listed within the SBS's as either 'new build' or 're-build', and refurbished refers to schools listed as either '80% - 100% refurbishment' or '50% - 80% refurbishment'.

The test for positive effect was whether the sample moving average performance in the post-renewal period was statistically significantly higher than in the pre-renewal period. The positive effect in the subsample of rebuilt schools (68 schools) was significantly different, though not in the subsample of refurbished schools (83 schools). This suggests that the effect of refurbishment on EA is less than where the school is rebuilt or a new build facility.

Table 7-2: Before versus after capital investment EA against national average for renewed schools (percentage points, n=151). Source: KPMG, 2010. Author analysis.

	Before			Excluded	After		
	-4	-3	-2	-1	1	2	3
Renewed schools	-12.16	-10.45	-10.07	-10.93	-9.47	-9.28	-8.42
Three year average		-10.90				-9.06	
Before vs. after improvement				1.84			
Annual improvement				0.46			

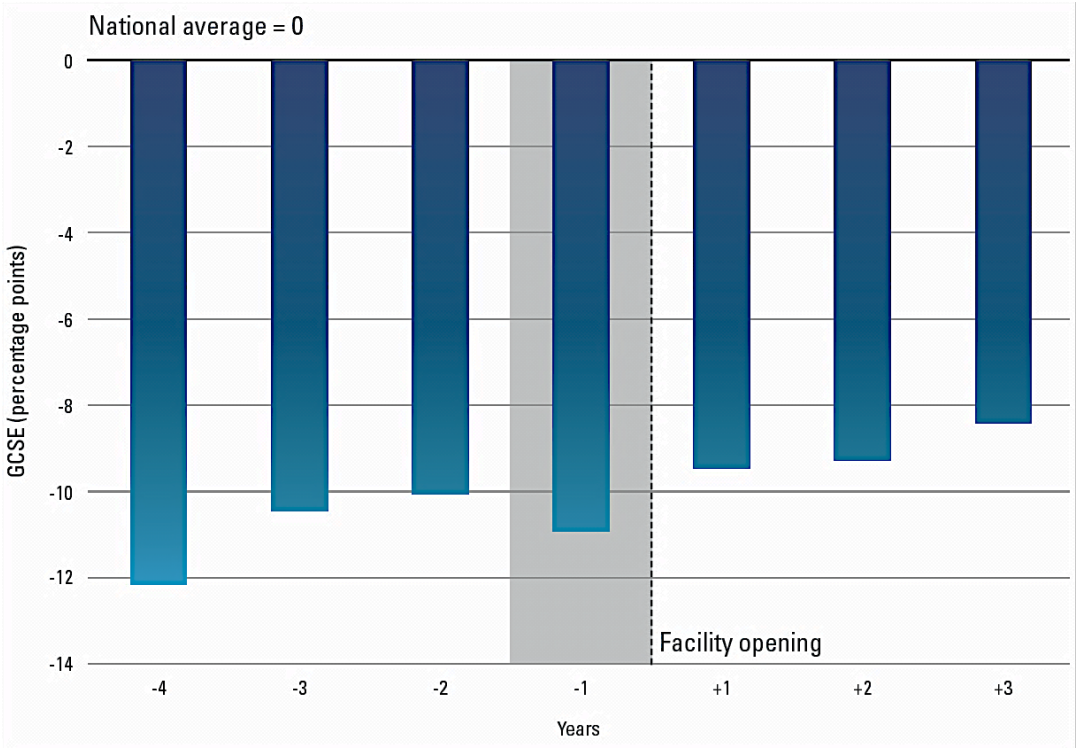


Figure 7-5: Before versus after capital investment EA against national average for renewed schools (n=151). Source: KPMG, 2010. Author analysis.

The average annual rate of improvement relative to benchmark in 151 renewed schools was found to be 1.86 percentage points over the period, averaging to a 0.46 percentage points per annum increase over in effect four years (the two moving averages being anchored respectively on two years before and two years after the year of renewal). All of the secondary schools in this study were renewed in or prior to 2006, given the requirement for at least 3 years post renewal EA data at the time of analysis. If rebuilding had no effect on attainment (as the null hypothesis), then the measured annual average rate of improvement relative to benchmark in the sample of rebuilt schools would either reflect only noise (and a false positive finding), or that the sample was not a random one, since the change in the benchmark indicates the mean rate of improvement to be expected in any large random sample of schools.

Table 7-3: Before versus after capital investment EA against national average for refurbished schools (percentage points, n=83). Source: KPMG, 2010. Author analysis.

	Before			Excluded	After		
	-4	-3	-2	-1	1	2	3
Renewed schools	-9.26	-7.1	-7.07	-8.01	-6.66	-7.29	-7.27
Three year average		-8.01				-7.08	
Before vs. after improvement				0.94			
Annual improvement				0.23			

Table 7-4: Before versus after capital investment EA against national average for rebuilt schools (percentage points, n=68). Source: KPMG, 2010. Author analysis.

	Before			Excluded	After		
	-4	-3	-2	-1	1	2	3
Renewed schools	-15.70	-13.80	-13.74	-14.49	-12.90	-11.71	-9.83
Three year average		-14.41				-11.48	
Before vs. after improvement				2.93			
Annual improvement				0.73			

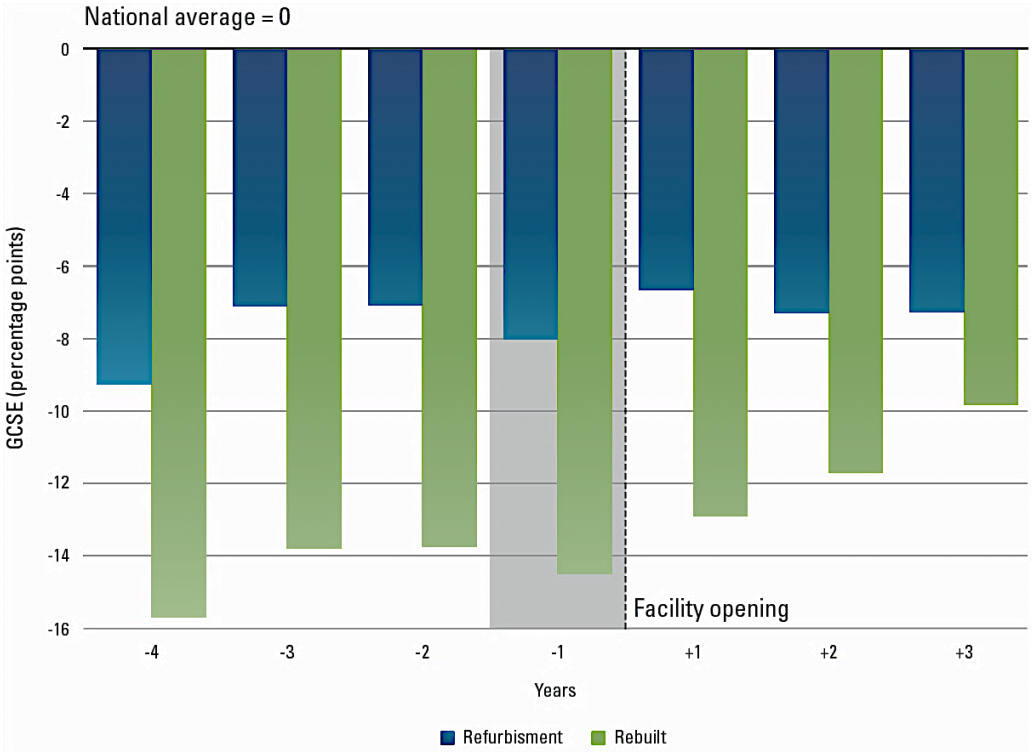


Figure 7-6: Before versus after capital investment EA against national average for renewed schools by form of capital works (n=151). Source: KPMG, 2010. Author analysis.

In assessing the role of capital investment on educational attainment, the question becomes whether this null hypothesis of no association can be rejected? The problem is that that the

average attainment of the sample of renewed schools started considerably below the national average, and there may be some general regression to the mean at work over time in the relative performance of schools. The magnitude of any EA effect of renewal is likely to be, at least in part, dependent on the school's position within the initial population of non-renewed schools. For example, there is likely to be some diminishing return to the positive effect on EA from rebuilding when choosing to renew schools with higher levels of EA relative to the national average.

In this earlier research, no data were analysed measuring construction cost, and thus no measure of rate of return on investment could be attempted. Nor was it possible to see whether the amount of construction expenditure correlated with the amount of EA improvement, other than by the crude division of the sample into 'rebuilt' versus 'refurbished'. This found, unlike either the rebuilt schools or the renewed schools as a whole, no statistically significant improvement in performance in refurbished schools, in which, presumably, construction expenditure had been on average smaller. The previous chapters have presented the results of incorporating cost data, firstly construction cost but also facility and staffing cost, the obvious requirement to take this approach a crucial step further.

Both this earlier research and the present chapter use five or more A* – C GCSEs as the sole measure of EA. The primary rationale for this is that this was the performance measure favoured by the government of the day, and therefore the presumed favoured objective and measure of impact of the BSF programme. The secondary reason is the supporting evidence for the idea that this level of GCSE performance constitutes an important *hurdle* for the *life chances* and future earnings of pupils, since there is observed to be a huge difference in the probabilities of going on to achieve degree-level qualification between those who do and those who do not jump over this hurdle. The third reason is its availability as a measure for each secondary school in the country throughout the period analysed (whereas, for example, no single national table shows grade point averages for all schools).

7.4 Procurement and outcomes

When this set of 151 renewed schools analysed in the KPMG study is divided into those that receive their capital investment via PFI or more conventional means of procurement (non-PFI), we see there is little difference from the results presented for the refurbishment versus rebuild analysis. This is because of the strong tendency for PFI procured facilities to be rebuilding projects, given the aversion of PFI investors to the risks posed by refurbishment projects. This is an important finding highlighting the correlations between important characteristics of capital investment and the procurement method. This requires that for like for like comparison, these differences should be accounted for if there are to be strong conclusions on the suitability of different procurement methods in pursuit of improved outcomes.

Table 7-5: Before versus after capital investment EA against national average for non-PFI schools (percentage points, n=79). Source: KPMG, 2010. Author analysis.

	Before			Excluded	After		
	-4	-3	-2	-1	1	2	3
Renewed schools	-9.34	-7.55	-6.74	-7.69	-6.27	-6.70	-6.44
Three year average		-7.88				-6.47	
Before vs. after improvement				1.41			
Annual improvement				0.35			

Table 7-6: Before versus after capital investment EA against national average for PFI renewed schools (percentage points, n=72). Source: KPMG, 2010. Author analysis.

	Before			Excluded	After		
	-4	-3	-2	-1	1	2	3
Renewed schools	-15.25	-13.64	-13.73	-14.48	-12.99	-12.11	-10.61
Three year average		-14.21				-11.90	
Before vs. after improvement				2.30			
Annual improvement				0.58			

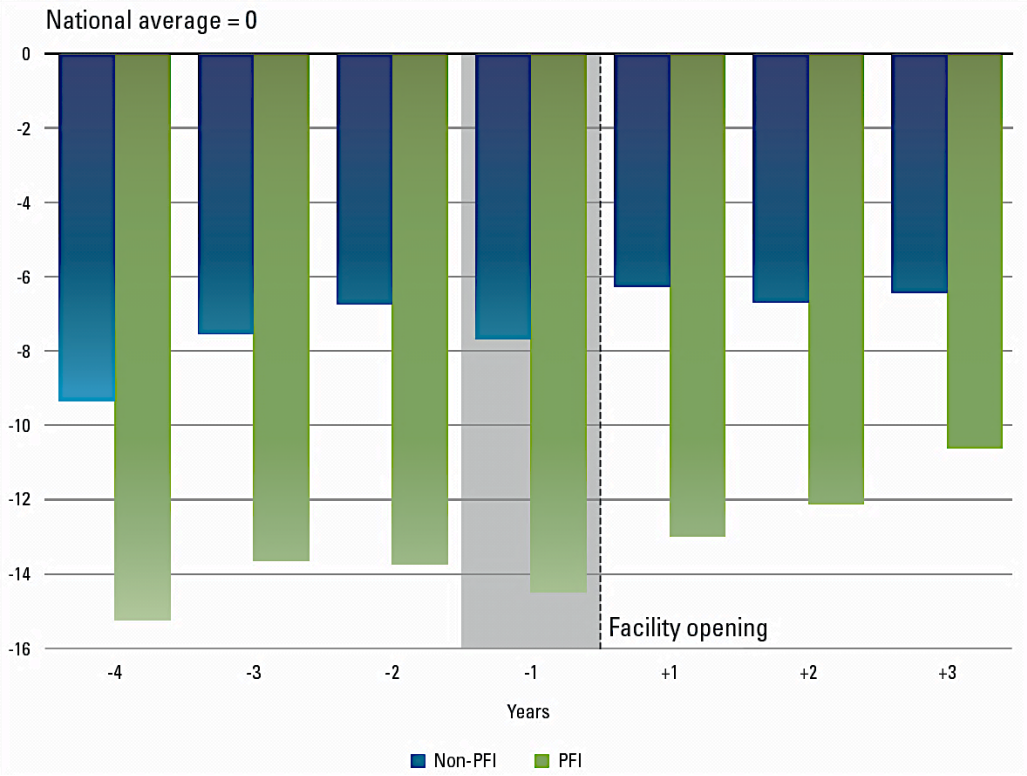


Figure 7-7: Before versus capital investment EA against national average by procurement method (n=151). Source: KPMG, 2010. Author analysis.

7.5 Measuring and valuing outcomes of investment in school buildings

While the above analyses demonstrate the development of methods to observe changes in EA following capital investment, further modelling is required to go the extra step of estimating the value of these changes. At the simplest conceptual level one can think of EA change as addition (or subtraction in the case of decreases) to the stock of human capital in terms of the number (quantity) of pupils a level of EA. The next challenge is to conceive the factor prices that this stock of human capital can attract, such that an overall valuation of net changes is the result of change in quantity multiplied by a price.

7.5.1 Valuing improved educational attainment as Q times P

Equation 3 below lays out the approach to valuing outcomes as the core purpose of this chapter. The next chapter will then present the approach for valuing returns, taking into account the capital investment associated with the changing levels of EA.

This equation breaks down the valuation of changes in EA into 2 parts (quantity and prices). The first set of square of brackets produces the quantity concepts by using three core concepts. The first is the school level pupil capacity (SPC). With the reasonable assumption that schools operate at, or near enough to, full capacity utilisation, this can be used as the basis for calculating the number of pupils raised above a particular EA threshold from changes in EA. The second concept is the change in EA itself (EAΔ) measured as relative to national averages. The third concept is the assumed decay function of the change in EA (DFR). Without empirical basis for a better-informed function, after a 3-year application of actual observed EA change, this is assumed to reduce on a straight-line basis to zero after 20 years. This factor is discussed further below.

The second set of square brackets applied attempts to attached a weighted average price to additional units of human capital drawing on evidence (see later commentary) as to both the additional incomes from higher levels of education relative to NQF level 1 (wage uplifts, WU, for level 2, 3 and 4,), as well as the incidence of individuals going on to achieve those higher levels of education (W for NQF levels 2, 3 and 4).

Equation 3: Calculation of cash flow to value outcome V in time t

$$V_t = \left\{ \left[SPC \times EA\Delta \times DFR \right] \times \left[\left(WU_{lv2-lv1} \times W_2 \right) + \left(WU_{lv3-lv1} \times W_3 \right) + \left(WU_{lv4-lv1} \times W_4 \right) \right] \right\}$$

Where:
- SPC - School pupil capacity
- EAΔ - Educational attainment change
- DFR - Decay function in EA following investment
- WU - Wage uplift (NQF Lv 2, Lv 3, Lv 4)
- W - Weights – proportions moving on to higher levels of education

7.5.2 Valuing improved attainment

The benefits of improved educational attainment are undeniably diverse and complex. For means of modeling their value to allow ex post assessment of pay offs, it is argued here that the final outcome of investment in a school is not a flow of consumption goods or services, but rather an enhanced stock of 'human capital'. In this context, a school is analogous to a capital goods factory producing as its output an annual flow of fixed capital equipment. If this capital (of any variety) is not sold at a market price by its producer, then each unit of this output in turn needs to be valued

based on the discounted value of its expected future net returns. If labour market wage differentials allow the recipient of an investment in human capital to capture for themselves, and fully, the returns from that investment, then the excess of wage *with* that investment in their education over their wage as it would have been *without* it may be used to measure the *market value of education*. Of course, this narrow definition cannot fully capture individual enrichment as a quality of life issue, as socialisation and as contributing to *good citizenship*. However, it may be used as a meaningful metric for the assessment against stated policy goals in terms of achieving higher labour productivity from statutory education. Further, it may also be used to model the fiscal returns back to the funder in the form of increased tax revenues from higher incomes.

In practice, impatience to estimate returns, and the absence of a *futures market* in the value of human capital, means that public providers of education look for a measure of outcomes that will be available more quickly than the outcome increment to lifetime earnings of students. The proxy measure most commonly used is enhancement of examination results. This constitutes observation of a *signal* (examination result) rather than for the thing thus imperfectly *signalled* (knowledge, learning, development) (Akerlof, 1970). However, it is true that most school leavers do successfully use their examination results to signal the latter less-observable attributes to others.

7.5.3 Number of additional qualified individuals (Q)

The increase in the number of qualified persons in the workforce results from improved levels of educational attainment can be considered as the change resulting from levels of education attainment that have arisen from interventions that would not have occurred without it. At the time of the BSF programme, the measure of examination results favoured by government was the proportion of pupils in a school obtaining at least five GCSE grades A∗ – C. To use this as the only measure of output is to assume in effect that schools are *gaming the system* by which they are held to account by government, and that change in pupil attainment is concentrated upon *marginal cases* of pupils lifted over this particular threshold, because this is where many schools will focus their marginal efforts. A less cynical view would be that an increase in the five or more A* – C proportion is merely an imperfect signal of a general average improvement in attainment across all pupils (including, for example, the turning of C grade results into A and B grades, and of Bs into As and As into A*s). If this is the case, then using the five or more A* – C proportion to measure the improvement in human capital will produce a serious underestimate. However, not only are there

no readily available, in a single national table, school-by-school data on weighted average grade results, but also the *threshold* approach to increments in qualifications achieved has a certain appeal and logic. Crossing a threshold opens up an *option* to move on to the next level of education, an option that pupils may or may not take. The greatest returns in terms of increments to lifetime earnings come for those who cross a succession of thresholds (at ages 16 and 18), take up the resulting options, and end with university honours degrees or above (level 4 or higher in the National Qualification Framework).

7.5.4 Price of human capital (P)

The value of EA at a rudimentary level can be considered as the additional income the more qualified worker can attract, as a signal of their greater productivity. Since it is known from recent studies (Higher Education Funding Council for England and Wales, 2010; Organisation for Economic Co-operation and Development, 2011) what proportion of the age cohort nationally end up with university degrees, and what proportion end with NQF level 3 (A-levels or their vocational or other equivalent) as their highest qualification, and what proportion end with NQF level 2 (five or more A∗ – C GCSE or vocational equivalents) as their highest qualification, it is then only necessary to assume that the extra pupils crossing the level 2 threshold are subsequently *typical* of the average of all pupils crossing that threshold in order to be able to estimate the value of outcomes. Of every 100 school pupils, *x* fail to cross the level 2 threshold. Of the 100 – x crossing the level 2 threshold, *y* obtain no further qualification. Of the 100 – x – y who proceed to level 3, *z* stop at level 3, leaving 100 – x – y – z to proceed to level 4 or higher. National qualification statistics enable a direct observation of the following:

- 100 – x – y – z: numbers and proportion of age group obtaining degrees (31.9%; OECD, 2011).
- 100 – x – y: numbers and proportion of the age group obtaining A-levels or equivalent (37.2%; DfE, 2012).
- 100 – x: numbers and proportion of the age group obtaining five or more A∗ – C GCSEs (62.8%; DfE, 2013).

From these observed proportions, the values of y (25.6%) and z (5.3%) can be deduced. It can then be assumed that for each extra 62.8 pupils crossing the level 2 threshold, 25.6 stop there (62.8 – 37.2), 5.3 go on to A-levels but then stop there (37.2 – 31.9), and 31.9 go on to get degrees. These

can be converted into percentages summing to 100, and thus into weights. These weights therefore are (see equation 3 below) 0.408 (W2), 0.084 (W3) and 0.508 (W4).

Lifetime earning increments for each level of qualification achieved are available, produced by comparing earnings of each level of highest qualification with earnings of those with only level 1 qualifications (Walker and Zhu, 2013), that of a minimum 5 A* – G GCSEs. The proportions then become the three *weights* used to obtain a weighted average uplift in the lifetime earnings of each marginal 100 pupils, as compared with what they would have been, had all 100 obtained only level 1 qualifications.

Table 7-7: Gross weekly pay by qualification, UK, 2002-2008. Source: UK Commission for Employment and Skills, 2010, Table 5.1.

Gross weekly pay by qualification, UK, 2002-2008

	£ GBP			
	2002	2005	2008	2008 (100 = UK)
Level 5	608.5	653.68	702.46	164.11
Level 4	475.37	508.46	559.76	130.78
Level 3	334.39	360.93	390.7	91.28
Level 2	287.39	315.69	341.01	79.67
Level 1	267.73	293.66	328.16	76.67
No qualifications	209.89	303.77	265.37	62.0
UK Average	345.82	387.09	428.03	100

Source(s): Annual Population Survey (APS).
Sourcelink: https://www.nomisweb.co.uk/
Datalink: https://almanac09.ukces.org.uk/Skills/D5/D5.4_Weekly_Pay_by_Qualification_Level_(Region_and_Nation).xls

Table 7-8: Average aggregate and disaggregate returns by gender. Source: Dickerson and Vignoles, 2007.

5: Average aggregate and disaggregate returns by gender

	MALE			FEMALE		
	Aggregate	Disaggregate quals		Aggregate	Disaggregate quals	
NQF level:	quals	Academic	Vocational	quals	Academic	Vocational
level1	-0.9%	1.3%	-3.8%	-1.4%	0.5%	-1.1%
level2	16.1%	19.6%	-3.4%	15.8%	18.6%	-5.2%
level3	15.3%	16.3%	6.5%	13.1%	14.4%	2.4%
level4	28.1%	24.3%	14.5%	31.2%	24.4%	17.3%
level5	24.0%	17.0%	27.6%	23.2%	18.3%	21.7%
N	69,562	69,562		44,817	44,817	
R^2	0.400	0.404		0.411	0.417	

Notes

1. Source: LFS 2000-2004, pooled, wave 1 observations only.
2. Sample: full-time employees of working age (men 16-64 and women 16-59 inclusive).
3. Controls are age, age squared, ethnicity (6 categories), region of work (21 categories), public sector, firm size (6 categories), apprenticeship, other qualifications; year dummies.
4. Rates of return are calculated as {exp(β)-1}×100%.
5. Given that indicators of all qualifications levels are included in the earnings functions, these estimated rates of return can be cumulated. Thus, for example, a woman with level 3 and level 4 qualifications can expect to earn approximately (13.1%+31.2%=) 44% more per hour than an otherwise identical women (in terms of her age, ethnicity etc) with only a level 2 qualification but no more. This cumulative calculation ignores the potential interactions among qualifications, but to the extent that higher level qualifications are frequently only obtained after lower and intermediate level pre-requisites are completed, this illustrative computation is probably not inappropriate.

Factors affecting the uncertain nature of this value of outcome:

- school-to-school variance in the amount of construction expenditure and in the immediate impact on educational performance
- the uncertain rate at which this impact will persist / decay over time (the DFR co-efficient in the above equation)
- degree of confidence held in the validity of the assumption that past correlations between crossing the five or more GCSE A∗ – C threshold and highest qualification eventually obtained, and then between marginal increments in level of highest qualification held and lifetime earnings levels will persist into the future

7.5.5 Tax as a measure of economic benefit

Further, a financial perspective is considered for the benefits to the government as the PSA investor in terms of increased tax receipts (T) resulting from those potential higher earnings. The financial benefit, T (for tax revenue), to the Treasury as the potential investor facing affordability

constraints, as well as a choice of investing in a myriad of competing capital projects, has been estimated by multiplying the economic benefit by a notional tax rate of 0.4 (a rough estimate for longer-term tax revenue as a percentage of national income). The resulting values of V and T should be interpreted within the context of the assumptions used within the analysis, given the potential for key determinants to change. One scenario was modeled for the calculation of values for V and T involving a range of assumptions to be explained below. These assumptions lead to a single estimation of V. Different scenarios would produce different estimates of V.

In equation 3 above, the first pair of brackets gives the number of pupils affected (the change in *productivity* of the school in assisting pupil attain higher levels of NFQ level 2 attainment). The decay of the educational benefit associated with the rebuilding is assumed such that after 20 years of operation its effect is zero. That is, over years t4–t20, any change in educational outcomes (and their effect on the cohorts of students graduating from the school) returns to zero on a straight-line basis. The assumed decay of this effect will be a key sensitivity in the determination of V.

It is assumed that the effect of school investment on improving educational attainment starts to decay after three years have elapsed, decaying to zero over 17 more years (i.e. 20 years after capital investment), and at a rate of 1/17th per annum. This is an assumption, rather than estimation based on any actual observed long-term information (see recommendations for further research, Chapter 9). If improved facilities had their effect on attainment in isolation from other factors affecting EA, this assumption might be right. However, it seems more likely that complex relationships (with factors such as school intake, leadership, organizational culture, public perceptions and morale) are at work, meaning that some rebuilt schools are significantly *transformed* whilst others are not.

An assumed 40-year working life of former pupils is used, such that in year t41, the first cohort of students to benefit from the renewed asset (t1) will retire, and hence their contribution to the cash flows becomes zero, and so forth for later cohorts.

These cash flows are again discounted at 3.5% for economic and financial benefit analysis.

7.5.6 Assumptions and estimation: problems in measuring and valuing outcomes

Table 7.9 summarises the reasons why estimations of outcome values might differ from that which will actually be. These are broken down by whether reasons might lead to over or underestimation, as well as their source in terms of either being purely the consequence of unavoidable Keynesian uncertainty, those for which better data would assist, and those that are the consequence of the particular method used here, of valuing the effect of pupils crossing a qualification threshold.

Table 7-9: Reasons for possible over and under estimation of outcome value. Source: Ive, Murray and Marsh, 2015, tab. 4.

Table 4 Summary of reasons for possible over/underestimation of project value

Direction	Source	Cause
Underestimation	Particular method	Improvements in educational attainment that do not move 16 year olds over the level 2 threshold
Underestimation	Keynesian uncertainty	Higher lifetime wages may not capture full benefits to the economy of having more highly skilled labour
Underestimation	Lack of data	Uncertain decay of the effect on educational attainment
Overestimation	Keynesian uncertainty	Earning premiums associated with certain qualifications in the past may be quite different in the future
Overestimation	Lack of data	Marginal cost of further education has been ignored
Overestimation	Lack of data and particular method	Overstatement of the number of marginal students actually going on to higher education
Overestimation	Particular method	Role of vocational qualifications not incorporated into the analysis
Overestimation	Lack of data and particular method	Flattening out of the lifetime earning premiums rather than being sensitive to stage of career

7.5.7 Underestimation

There are a range of factors which may lead to underestimation of V. These include improvements in educational attainment that do not move 16-year-old pupils over the level 2 thresholds (which have not been considered here). Further, there may be increases in lifetime earnings of those obtaining qualifications who themselves do not fully capture the economic benefits resulting from an economy having a more highly qualified workforce. There may be benefits captured by employers, and/or important spillover benefits, captured by others. Additional reason for under estimation include:

7.5.7.1 School transformation

Physical renewal of buildings may work by increasing the possibility for a positive transformation to occur, without even being a necessary, still less a sufficient, condition for radical transformation. In the transformed schools, positive cumulative causation may occur (virtuous circles), so that rather than beginning to decay after three years (as the facility deteriorates), the effects on attainment continue to become stronger as time passes. Unfortunately, because the majority of the renewals for which there are data occurred relatively recently, there are not (yet) sufficient data on ex post attainment after, say, 10 elapsed years on enough schools to observe the patterns of the longer-term trends. Instead data for three elapsed years were chosen as the period to measure change in attainment in order to balance between data availability and coverage constraints. Thus, if positive cumulative causation occurs frequently, the method adopted will underestimate total benefits.

7.5.7.2 Additional levels of education

There is also the possibility of underestimation from the method not including additional pursuit of post-graduate degrees beyond level 4. The reality for many professional careers now is that post-graduate degrees (NQF level 5 and higher) are more commonly required for some professions, where the wage uplift effects are greatest. By not including an estimate of the additional value of this on those marginal students, the estimation will tend to under value the improved outcome associated with capital investment.

7.5.8 Overestimation

A similar range of factors may lead to overestimation of V, including:

7.5.8.1 Wage uplifts

Lifetime earning increments are measured using historic data, and are thus reported at the levels they have been observed at over the last several decades. This includes those reaching 16 in, say, 1960 and retiring in, say, 2010. There are some plausible reasons to think that the increments that will be obtained by those reaching 16 in say 2010 may be significantly lower than in the past (before the financial crisis). These reasons revolve around the notion that future UK economic growth may be slower than it has been, and that it is growth that creates skill shortages and raises

wage premiums for possessing qualifications. Further, the wage premium data refer to a period when a much smaller proportion of the workforce possessed university undergraduate degrees (NQF level 4). Conversely, there are also reasons to see stronger forces in the future than in the past tending to hold down the rate of increase of earnings for those without qualifications, and thus, perhaps, its level relative to the earnings of those with qualifications. It must be remembered that recent past period witnessed the introduction of the national minimum wage, and we are soon approaching an increase to minimum wages via the *living wage* policy.

7.5.8.2 Pupil homogeneity

The threshold-and-national-average method may overstate the likely actual proportion of pupils raised above the level 2 threshold who will go on to obtain degrees. That is, what holds for those students achieving five or more A* – C GCSEs without capital investment may not hold for the *marginal* pupils, who may be raised just above the GCSE threshold but may have a below average A level achievement.

7.5.8.3 Vocational qualifications

The role of vocational qualifications is not incorporated into the analysis, in part due to complications raised by their existence parallel to academic ones. Separate findings do exist that show lower lifetime earnings uplifts for those with each level of vocational rather than academic qualifications. Since a far from negligible proportion of students at each level do in fact obtain the vocational qualifications, this creates a problem. However, the method of deducing y and z required introduction of this oversimplification. It is difficult to deduce what separate proportions of students with vocational and academic level 2 stop at that level, stop at level 3 or go on to level 4. Thus, the analysis for earnings uplifts at present applies to all students the uplifts found for those (the great majority) pursuing academic qualifications.

7.5.8.4 Life time earning profiles

Flattening out the actually crescent-shaped profile of lifetime earnings premiums (the area between life time earning curves for unqualified and qualified workers, Walker and Zhu, 2013) will tend to overestimate the early year additional incomes. To simplify, estimation of *cash flows* average premiums over working lives are applied to all ages. It is in fact known in general terms

that premiums reach their maximum for workers aged around 40 years. For younger workers, and to some degree older ones, they are somewhat less (see figure 7-8 below). This simplification therefore overstates actual *cash flow* benefits in the first 20 and last 5 years (over the 40 year working lives of cohorts) after the investment in school renewal and understates benefits in the middle years. When discounted, therefore, the PV of the total sum of benefit flows appears somewhat greater than it would if reflecting annual wage uplift curves sensitive to the age of the worker. The fact that the discount rate in this case is only 3.5% (STPR) partially moderates the size of this overestimation (higher discount rates would make the greater value of early additional incomes more influential on PV estimates of V). For further research, it would be desirable to input alternative assumptions about the equation to model the crescent profile of life time earnings to explore the sensitivity of estimates of V. Overall, at present, it is only possible to take the somewhat heroic view that perhaps the two sets of factors leading to over and under estimation roughly balance out.

Figure 7.8 below shows lifetime earning profiles based on empirical observations. As is apparent, the premium earned for having degree is considerable, the vertical axis being compressed here as a logged presentation. The higher hourly earning earned by males against females is also apparent, and while male earning continue to increase into the later 30s, female earnings seem to level out some years earlier.

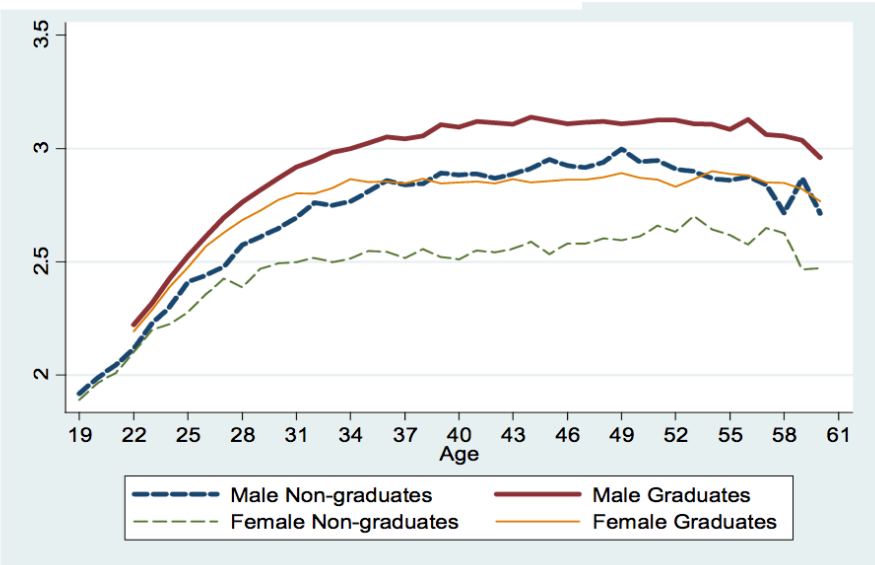


Figure 7-8: Log hourly earning and age: by degree. Source: Walker and Zhu, 2013, fig. 5.

7.5.9 Hawthorne effect

The Hawthorne effect is a well documented phenomena in wider research and specifically in educational research (Cook, 1962). The following definition helps clarify the problems its presence brings:

> "The Hawthorne effect is a phenomenon characterized by an awareness on the part of the subjects of special treatment created by artificial experimental conditions. This awareness becomes confounded with the independent variable under study, with a subsequent facilitating effect on the dependent variable, thus leading to ambiguous results."
>
> Cook, 1962, p. 118.

In the context of capital investment in schools, we can consider the *experiment* the capital investment made in the schools studied here, with the control group consisting of those schools not receiving renewal (driving the national average benchmark). The psychological impact of school

management being told (and announcing to staff and pupils) that they have been allocated capital funds for investment in the building is a credible yet under analysed phenomena. While this effect is usually considered within a purer controlled experimental setting, it should not be under played that such an effect exists in this less contained setting of schools being allocated *limited* capital grants. Further, the Hawthorne effect is typically associated with *test subjects* being aware of them being tested. In this context, it is less credible that pupils would feel that they are being observed as a result of the capital investment, leading to an expectation that any Hawthorne effect in this context would be limited. From this perspective, one might consider any ex ante improvement in EA associated with capital investment not as a conventional Hawthorne effect, but rather an actual additional benefit of awarding particular schools capital grants.

There is no obvious *placebo* for capital investment in a school to help control for any possible Hawthorne effects. If there were, it might resemble a light refurbishment, where the learning environment receives relatively little modification and a fraction of expenditure is incurred relative to a more intensive rebuild / new build investment.

Looking at the distributions of annual change in EA relative to national average in the years leading up to capital investment for the 90 schools analysed above, we see that year -3 to -2 witnesses an average increase in EA of 2.6%, while the proceeding years see much lower changes leading up to capital investment. This hints at a possible Hawthorne effect, except inspection of the distribution of this annual change reveals that the median effect is close to 0 at 0.5%, although some schools in the upper quintile do seem to improve EA quite drastically. This opens up a further complication in controlling for the Hawthorne effect if its apparent incidence is itself dependent on contravening factors, rendering some schools more susceptible to this effect than others.

Table 7-10: Pre-renewal EA change (n=90). Source: SBS, Attainment tables. Author Analysis.

_	Yr-2 - yr-3	Yr-1 - yr-2	Yr+1 - yr-
Average	0.026	-0.002	0.016
Count	90	90	90
St Dev	0.137	0.100	0.105
Kurt	16.543	14.430	16.571
Skew	2.819	2.769	2.885
Min	-0.355	-0.185	-0.166
Max	0.875	0.604	0.674
Median	0.005	-0.016	0.004
Decile 1	-0.098	-0.098	-0.096
Decile 2	-0.046	-0.067	-0.056
Decile 3	-0.029	-0.047	-0.037
Decile 4	-0.008	-0.032	-0.012
Decile 5	0.005	-0.016	0.004
Decile 6	0.032	0.003	0.027
Decile 7	0.045	0.024	0.044
Decile 8	0.086	0.055	0.072
Decile 9	0.145	0.085	0.114
Decile 10	0.875	0.604	0.674

Further research on the outcomes associated with capital investment in time might clarify the impact of the Hawthorne effect in this particular setting and seek to develop more subtle methods for controlling for it. Development in the understanding of Hawthorne effects in educational research continue (Adair, 1984). New methods should seek to take in the findings of both educational research and wider experimental research. Further, better time series will amass over time and the opportunity to study these effects in greater detail will continue to emerge with larger sample sizes and collation of wider scoped datasets (including school and pupil level socio-demographic data).

7.5.10 Uncertainty of benefits

Compared with most investment in physical tangible assets, the returns expected from renewing schools continue exceptionally far into the future. If effects on pupil GCSE attainment persist for 20 years (as assumed here) and those pupils on leaving school then work for 40 years, then the effects on productivity, and on GDP, output and earnings will be supposed to continue for 60 years post-investment. Thus Keynes' dictum applies with particular force, especially if schools no longer operate as monopolies but face competition from other schools:

> "Our knowledge of the factors which will govern the yield of an investment some years hence is usually very slight and often negligible. If we speak frankly, we have to admit that our basis of knowledge for estimating the yield ten years hence of a railway, a copper mine [. . .], the goodwill of a patent medicine [. . .], a building in the City of London amounts to very little and sometimes to nothing [. . . and] if we exclude the exploitation of natural resources and monopolies, it is probable that the actual average results of investments, even during periods of progress and prosperity, have disappointed the hopes which prompted them. [. . .] If human nature felt no temptation to take a chance, no satisfaction (profit apart) in constructing [. . .] there might not be much investment merely as a result of cold calculation."
>
> Keynes, 1936, ch. 12.

To this, if the *public choice theory* observation is added that in the case of the schools programme, those making the decision to invest are not investing and risking their own money, but that of the taxpayers, it might then not be surprising that there does not appear to exist any clear basis for confident calculation of returns to investment in schools, but that such investment nonetheless occurs.

7.6 Schools analysis and findings

Below is presented the single scenario for estimation of V in figure 7.9, for the distribution of the estimated cash flows associated with the 90 schools with sufficient data to observe EA before and after capital investment. As is evident, the median cash flow is only marginally positive, showing that nearly half of the schools witnessed a reduction in EA relative to the national average following renewal (as the sole source of variance in this analysis (other co-efficients having fixed effects here).

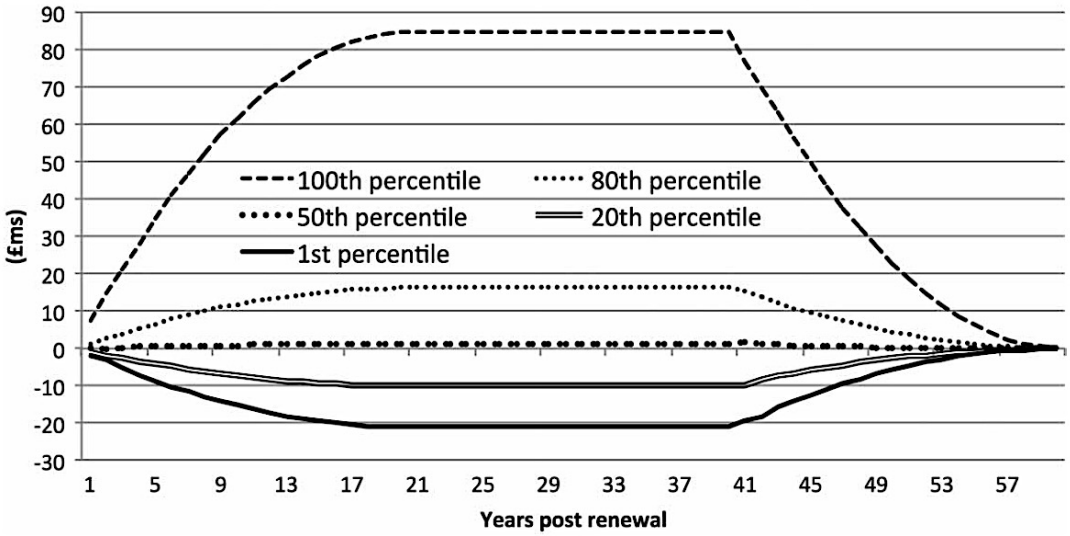


Figure 7-9: Distribution of estimated cash flows resulting from changes in EA following capital investment. Source: Ive, Murray and Marsh, 2015, fig. 3. Author analysis.

In this sense, the distribution of V as the value of improvement in human capital is far less certain than might be expected of the return from commercial ventures into fixed capital formation. It is expected that such ventures would tend to be more consistently positive, if not as variable.

More interestingly, it would seem that a small minority of schools (the top quintile) provide the near entirety of overall net benefit. In this sense, attempts to achieve drastic improvements in EA in schools may be analogous with prospecting for oil rather than a less speculative, more common pursuit of risk adjusted investment return from investment. This parallel can be taken further to consider investment allocation approaches to undertaking such investment. An oil prospector is careful to invest time and money into surveys of the potential drilling sites. Expert geotechnical engineers are employed to survey and test drill numerous plots. In light of these results, it seems only appropriate that in a time of acute austerity, fiscal resources could be allocated in a similar fashion if the intended policy goal is improvement in EA from capital investment.

The risk in the cash flows here is predominantly the unique risk in which school EA is achieved. This belies the somewhat partial reality that pursuit of EA by particular schools is a zero sum game. That is, some schools can benefit from attracting higher ability intake cohorts at the expense of competitor schools. This element is a systematic characteristic of the *market* for attracting pupil cohorts, and as an increasingly relevant factor, should be born in mind for assessing investment in

pursuit of improved EA. As ever, a principal consideration for assessing the prospects for returns from financial modeling approaches include the allocation of unique and systematic risks. The former should be applied to the cash flows (for example adjusting the weights to be more representative of actual schools cohort progression into higher levels of EA), and the latter built into the discount rate (for example accounting for the uncertainty within future expected wage uplifts). The Green Book approach is to worry about unique risks and adjust the cash flows and leave the discount rate. This approach is relevant when looking at individual projects, but the larger the capital investment programme is, the greater the relevance of systematic (market) risks. If all government projects assessed against common discount rate (3.5%) then projects facing greater market risk may well be preferred due to the use of lower than otherwise discount rates.

As ever, one should remember that correlation (or its absence in this case) is not causality and beware of the post hoc fallacy here. While these results regarding average return on investment may be regarded as justification of the BSF programme (given the net benefit from the *portfolio* of investments made), another interpretation of the findings may equally be regarded as ammunition for its critics. They show that almost all the benefits will flow from just one-fifth of schools included in the programme and thus from a fraction of the total expenditure.

The value of the school level cash flow per annum depends upon the key variable (EA change following capital investment) multiplied by a constant (value put on a unit of improvement). Figure 7.11 above reflects this and shows that there was no observed improvement in exam results (deducting national average trends) in the three years post construction in half of all the renewed schools. Indeed, there are many schools for which capital investment is associated with reduced EA.

7.6.1 NQF level 2 including English and Maths

Looking at a subset of the 90 schools studied above, 63 provide consistent data for their achievement of NQF level 2 (5 GCSEs A* – C) including English and Maths. As is apparent in other samples, we witness a considerable increase in EA prior to the capital investment as a potential Hawthorne effect. There is also a momentary dip in EA during construction works (year -1) followed by a noteworthy increase in EA immediately after the investment. It is hard to see how this

improved EA could result from any cohort effect (given the immediacy of the change) or from regression to the national average performance level, which would tend to show a more gradual regression to 0 (as the national average).

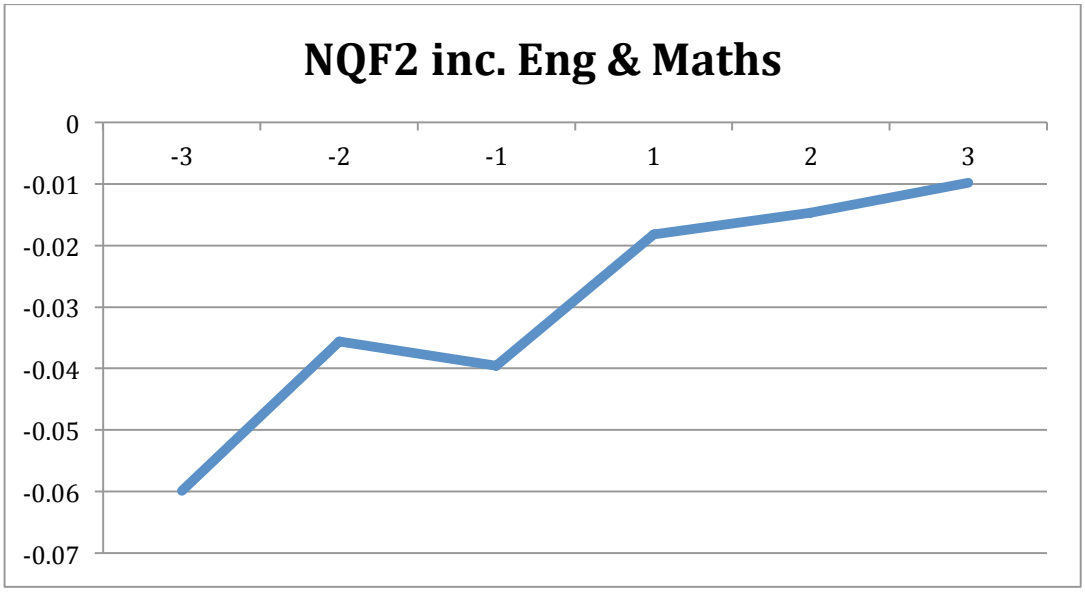
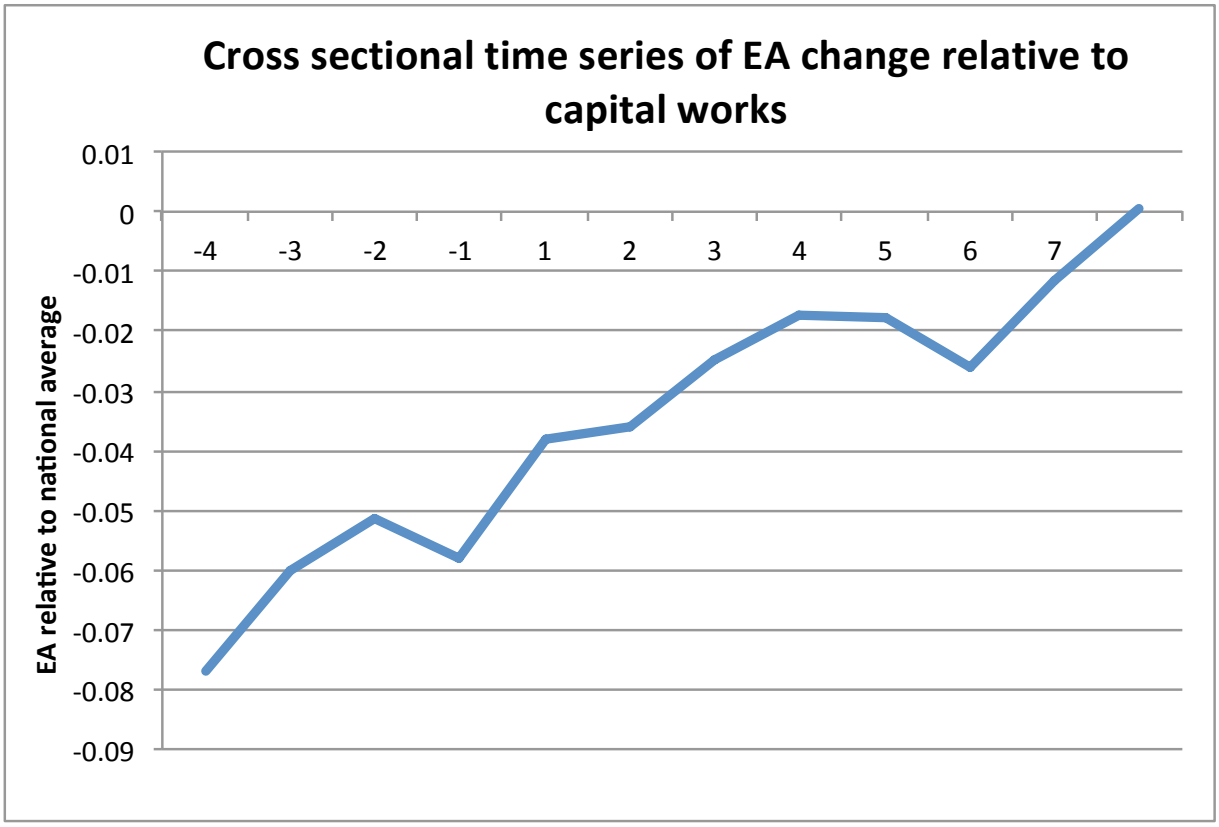


Figure 7-10: Before and after capital investment in NQF level 2 including English and Maths for renewed schools (n=63 as subset of 90 with required data).

A cross sectional approach to observing EA change allows for a longer times series of EA change relative to capital works to be observed. Figure 7-11 below presents the path of average EA performance relative to national average from 4 years before to 8 years afterwards. What is clear is that of those schools that were allocated capital grants for works, were seemingly already improving relative to national averages trends. While capital works is followed by a general increase in EA performance following works, years 5 and 6 following works suggest a drop in performance on average. This implies the presence of cohort effects with uncertain causal mechanisms, which warrant further study. These results should bear in mind the changing context in the schools that make up the average, but never the less this approach may offer more timely evidence base for the decay function of EA change following capital work.



Year	-4	-3	-2	-1	1	2	3	4	5	6	7	8
Sample size	37	63	77	87	89	89	90	90	49	24	13	3

Figure 7-11: Cross sectional time series of EA change relative to capital works. Source: SBS, Attainment tables. Author analysis.

7.6.2 Cumulative causation and cohort effects

Schools are independent from one another in most regards except their intake, where one school can benefit at the expense of another in achieving higher raw attainment by attracting pupils with higher prior attainment. It may be that the schools that have seen the greatest improvement in attainment are those that were able to benefit from the capital investment by being perceived as more *attractive* by the parent who then choose (or at least strongly influence) the school their children attends. This type of activity may lead to cumulative causation along vicious and virtuous circles if trends in EA then re-enforce parental decisions to prefer (or avoid) particular schools for their off spring.

Central government may have believed more strongly in the role of capital investment for *educational transformation* than did local authorities. This may have lead to allocation of capital

grants by LAs that did not distribute funds for capital investment on any basis that was prioritising investment most likely to achieve the stated policy goal. The James review supports the view that capital allocations were made driven more by which local authorities were most prompt in their pursuit, and readiness for receipt of, capital allocations.

7.7 Healthcare outcomes

Outcomes may be measured by metrics on re-admission rates following treatments, incidence of infections and their control as well as more subjective assessments of patient well-being. Investigations of the outcomes of patients in hospitals procured and operated via different procurement methods has been attempted (Wang, 2008). Looking at clinical indicators of outcomes including MRSA, C-Diff and patient experience indicators between PFI and non-PFI hospitals, this paper presents similar findings to many in this field, that procurement and operating method has seemingly little systematic effect and that PFI is no worse or better assessed against conventionally procured and operated facilities. Data remains an issue, as acknowledge by Wang (2008), with many metrics reported at the trust level, rather than facility. This precludes deeper analysis of the effects of procurement and facility operation. This includes data available from the Care Quality Commission, as the central regulator of the healthcare sector.

Looking at the business case behind what was to become 2 separate PFI contracts for the provision of a large acute hospital (1,231 beds) as well as a mental hospital facility in Birmingham, we see that one of the anticipated improvements resulting from investment in a consolidated estate included:

> "Improved efficiency, improved discharge planning reducing ALOS (average length of stay) and a reduction in inappropriate admissions. The introduction of an inpatient care pathway will result in better clinical outcomes, which is calculated as being between 5% to a maximum of 10%."
>
> University Hospital Birmingham NHS Foundation Trust, 2006, p. 91.

Codinhoto et al. (2008) provide a comprehensive review of the literature and theories concerning how physical environments might influence healthcare outcomes, finding little agreement on the

casual mechanisms underpinning observed associations. This work presents an alternative theoretical framework to that in school settings above. The study draws out numerous literatures commenting on the relevance of optimal ventilation and lighting conditions for patient well-being. Further, it asserts the difficulty of empirical research in this area given paucity of data and the lack of deductive models for testable propositions. Where inductive methods show promise, approaches based on falsification are put forward as alternatives to positivist methods on affirming relationships between physical factors and patient outcomes.

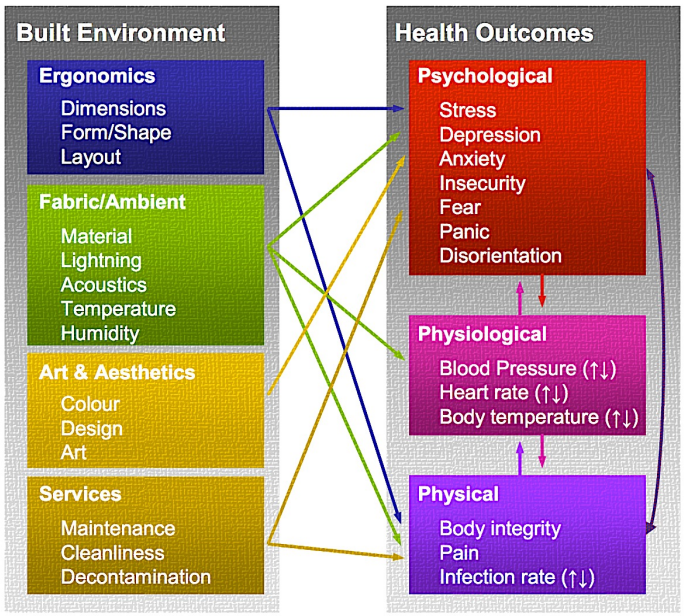


Figure 2. Knowledge areas and health outcomes framework

Figure 7-12: Knowledge areas and health outcomes framework. Source: Codinhoto et al., 2008, fig. 2.

The above framework suggests causal mechanisms between broad aspects of the BE on the psychological, physiological and physical healthcare outcomes of patients. The difficulty of amassing sufficient data on both perspectives (BE characteristics and healthcare outcomes) around discrete units of analysis remains a challenge.

While this investigation has been unable to gather the required data to comment on outcomes for renewed healthcare facilities as it has for EA in schools, the approach and methods applied above may be adapted to assess the value of changing levels of healthcare outcomes following facility investment. In light of the findings of Wang (2008) and those on the change in EA relative to national average, it should be borne in mind that investment in PSAs may lead to reduced

performance in terms of outcomes, though may still be justified on the basis of operational cost savings (motive B) or the addition of critical capacity (motive C).

To undertake a similar analysis for healthcare facilities, the following types of information would be required:

- Data about the change in outcomes on prominent healthcare procedures and treatments. Given the diversity of healthcare provided across the various types of hospital, analysis may focus on more standard and common forms of treatment e.g. hip replacement, hernia treatments. This might be considered as an equivalent to ΔEA in equation 3 above.
- Data about the lost income of patients from sustained convalescence or longer-term disability resulting from complications during surgery or treatment. This is equivalent, somewhat reversed, to the wage uplift co-efficients in equation 3 above. Data on the sums awarded from instances of medical negligence may serve as a suitable source for indicators metrics.
- Data about the increased capacity from healthcare facility investments included details on how one facilities growth may have replaced or displace the contribution of other facilities to providing treatments.

7.8 Chapter summary

The preceding chapter has presented a range of analyses on the educational outcomes witnessed in secondary comprehensives and shows that while capital investment is associated with improvements in EA, the effect is by no means positive for all schools and indeed, is uncorrelated with amount spent per pupil capacity unit. Sociodemographic contextual characteristics were shown to explain most of the variance in EA, with school level associated factors explain a lower levels of EA variance in previous studies.

The change in EA associated with rebuilding was calculated based on the observed difference in school reported achievement at NQF level 2 relative to national average benchmarks. This was then used to estimate the effects on lifetime earnings based on two key concepts. The first is the proportion of students obtaining five or more A∗ – C GCSEs going on to higher levels of qualifications (Higher Education Funding Council for England and Wales, 2010; Organisation for Economic Co-operation and Development, 2011). The second is the associated earning differentials

for individuals obtaining those levels of academic qualifications (Dickerson and Vignoles, 2007; Garrett and Mason, 2010). For the estimation of future cash flows based on changes in EA, the three years following rebuilding were used to generate the first three years of cash flows, with the remaining 57 years (60 years in total) based on using a decay function on an average difference in the first three years after construction works compared with the three years beforehand. Findings suggest that capital investment in schools is associated with improved EA in subsets of the samples investigated, if not all schools to receive investment. The longer-term effects are uncertain without long-term times series studies.

Insights on healthcare outcomes associated with capital investment have been elusive. Opportunities have been highlighted for better collation between public databases to enable similar advancement to those demonstrated for educational PSA settings. In the development of methods for the valuation of outcomes, one should bear in mind the importance of more direct human determinants beyond those associated with capital investment and physical environment factors.

Chapter 8 Returns on investment – risk and uncertainty

The penultimate chapter of this thesis, before conclusions and recommendations, considers issues of investment return, risk and uncertainty associated with the benefits from capital investment in PSAs. Returns from capital investment should be considered as the *benefits* achieved from investment as a ratio to the sums (costs) invested. In this chapter, operational cost savings resulting from capital investment will be treated as a form of benefit within WLC frameworks.

School-by-school findings are applied in an attempt to estimate what might be the real net present value (NPV) of each separate investment in schools to generate programme benefit to cost ratios. Benefits are measured as (1) benefit of additional output for which enhancement in lifetime earnings per former pupil, multiplied by the increment in number of pupils achieving five or more A∗ – C GCSEs, used as a proxy for enhanced productivity and output, and (2) as any savings in cost of facility management or staffing resulting from rebuilding and observed with the set of renewed schools.

8.1 NPV in WLC and value terms

To calculate the present value of capital investments in PSAs, we can draw on conventional appraisal techniques with use of NPV calculations. These have been specified within the concepts used above, those of f (facility operation cost), s (staffing costs) and v (value of outcomes). The value of cost savings from investment in operations can be considered as the PV of the lower cash flows over the life of the asset, estimated by deducting the cost in presence of investment ($f_{i,}$ s_i) from the cost in the absence of investment ($f_{a,}$ s_a). The direction of the net effect of change in v following investment is opposite to that the cost items of f and s. This reflects the presumption that capital investments would hope to achieve cost savings or increased benefits, such that the benefits are higher in the presence of investment (v_i) than without (v_a). To subtract the v in the presence of investment from that without would deliver a negative value and reduce the overall NPV, though one may reflect on the above results concerning the negative results for change in EA from many school investments. The addition of a terminal value concept (TV) is include for completeness and would require further reflection in the context of PSAs, as to what the value of a dilapidated school or hospital might be.

Equation 4: NPV of WL(C & V) investment

$$NPV\ of\ WL(C\ \&\ V)\ investment = -c_{t1} + \frac{(f_a - f_i)_t + (s_a - s_i)_t + (v_i - v_a)_t}{(1+r)^t} + \frac{TV_t}{(1+r)^t}$$

c = construction / investment cost

f_a = operating cost in absence of investment

f_i = operating cost with investment

s_a = staffing cost in absence of investment

s_i = staffing cost with investment

v_a = value of outcomes in absence of investment

v_i = value of outcomes with investment

r = discount rate

TV = terminal value

Given the durable long-term nature of built assets operating over many years and delivering benefits over many more, assessment of returns must take a very long-term view, for example in the case of school PSAs with assumed 60 year asset lives and 40 year working lives of the beneficiaries of education. The variance in outcomes witnessed (figure 7.9 above) is also pertinent, especially the evidence that there is no positive, indeed negative change in outcomes following investment, in around half of the schools analysed. This makes clear that there is limited evidence base on which to predict, probabilistically, the eventual effect on outcomes from capital investment.

This requirement to consider the very long term is no doubt one of the challenges for better appraisal of potential, and even evaluation of historic, capital investment in PSAs. The long-term horizon required for fuller appreciation of WLC and value brings to the fore the relevance of considering uncertainty into the medium and long run. Uncertainty as an aspect of public capital investment appraisal appears to be increasingly acknowledged by central government (HM Treasury, 2015b). The Aqua Book has sought to improve the quality of modelling undertaken by government in recent years, following the worrying observations of poor practice uncovered by the MacPherson review (2013). The Aqua Book has much to say about risk and uncertainty, though at times seems to miss the fundamental economic distinction between these concepts by suggesting aspects of uncertainty can be modelled probabilistically.

> "To select the best option, decision - makers need to take account of the range of outcomes that may occur for each option and their *relative likelihoods*. In other words, they need information on uncertainty."
>
> HM Treasury, 2015b, sec. 5.7.

The ambiguity with the suggestions of *relative likelihood*s (probabilities) next to *information on uncertainty* here hints towards the Shacklian conception of potential surprise based upon pure uncertainty, about which one can not gather information (else it could be considered risky). The following section continues this mistaken conceptualisation of uncertainty as something that can be quantified and modelled probabilistically.

> "The impact of individual uncertainties on the analysis outcome may be quantified by sensitivity analysis or probabilistic modelling.
>
> Ranges or alternative point estimates representing a range of alternative values or scenarios may be propagated by simply repeating the calculation with each estimate in turn. This is a simple form of sensitivity analysis.
>
> Distributions may be propagated by repeating the calculation many times, sampling different values from the distributions each time: often referred to as stochastic or probabilistic modelling. This is often done by Monte Carlo simulation.
>
> If the form of a parameter distribution is uncertain, the impact of this can be quantified either by repeating the analysis with alternative distributions or by using imprecise probability approaches such as probability boxes, which envelope sets of potentially relevant distributions."
>
> *ibid*, sec 8.29.

8.2 Adjusting for optimism bias

The notion of optimism bias is well documented phenomenon (HM Treasury, 2011) . The best way to counter the effect of under valuing construction cost or indeed over valuing anticipated benefits (resulting in higher NPVs and acceptance of investments which may turn out to have benefit to cost ratios lower than expected), is good quality, reliable and bespoke data on incidence of cost and benefits of similar historic capital projects. Such data should form the basis on which project appraisers adjust their expectations to align with experience and recent practice.

The above analyses show that the overwhelming source of positive NPV (at least in schools) come from improvements to outcomes (given the highly variable and on average near zero change in F and S). As such, in improving the empirical basis for the values of cost and benefits in minimising optimism bias, additional focus is warranted on the benefits of capital investments, rather than over emphasis on the modelling of input costs.

8.2.1 Appropriate discount rates for schools projects

We return to the Green Book for guidance on the discount rate for projects with very long-term cash flows.

> "For projects with very long-term impacts, over thirty years, a declining schedule of discount rates should be used rather than the standard discount rate (section 5.51)."
>
> HM Treasury, p. 27, 2011.

It cites Weitzman (1998) and (Gollier, 2002) and their findings on the effect of uncertainty as its authorities for this declining rate. This analysis applies Green Book guidance on discount rate, except in respect of the declining long-term rate. Here, because the change would only be from 3.5% to 3.0% for years 30 to 60, it was simpler to apply 3.5% throughout.

8.3 Schools investment returns

The estimations of returns from investment in school PSAs requires the specification of a benefit derived from investment, divided by the cost of the investment. As explored above, the benefits can be considered as the cost savings in f and s, as well as improvement in outcomes v. Given that these benefit occur over time, they should be presented in PV form, while the capital investment principally occurs in the near term, and so does not require discounting. Equation 6 below presents the form of return measure on investment based on the c, f, s and v concepts applied above.

Equation 5: Return on WL(C & V)

$$\text{Return on } WL(C \& V) \text{ investment} = \frac{PV\ \Delta f + \Delta s + \Delta v}{\Delta c}$$

This conception of return is closely linked to the concept of a cost benefit ratio. The principal benefit of applying this includes the ability for commissioners to rank potential investments based upon the value of benefits (savings on f and s, and high v) relative to costs (c). Beside the separate calculation of cost ratios and outcomes presented above, a key intention of this analysis is to bring these together to provide some indication of the returns to investing in school PSAs. This is in an attempt to inform the future investment policies of those involved in capital expenditure in such facilities. Figure 8.1 below shows the average values of change (delta Δ) observed in c, f, s and v resulting from investment in renewal. That is, the change associated with renewing relative to not renewing, rather than absolute magnitude (presented in table 6.1 above).

Present value (PV) per pupil capacity	£
Δc	−20 497
SD	6383
n	166
Discount rate	3.5%
Δf	−189
SD	2914
n	56
Δs	−840
SD	6961
n	54
Δv	73 323
SD	272 024
N	90
Δt ($v \times$ tax rate[a])	29 329
SD	108 809
n	90

Note: [a]Tax rate = 0.4.

Figure 8-1: Present values from school investment - change in annual cash flows of renewal against non-renewal. Source: Ive, Murray and Marsh, 2015, table 13. Author analysis.

Table 8-1: Rate of return on school PSA investment

PV change per pupil capacity	Value £s
Δ c	20,497
Δ f	-189
Δ s	-840
Δ v	73,323
Rate of return	3.53
Return to HM T	1.41

8.3.1 Whole life cost

It is relevant to restate that the estimation of Δf and Δs requires additional data to that for Δc, and as such they represent subsamples of C:166. The observed Δc above remains the value presented earlier (as c is zero in the case of non-renewal), while the PV of Δf and Δs in Table 8.1 is estimated

from 3-years pre and post renewal data (extrapolating changes out over the assumed life of the asset). As can be seen, even with 60 years of estimated cash flows, the difference in f and s relative to the pre-renewal cash flows for these schools is apparently negative on average (additional cost), though negligible and highly variable. This suggests that, overall, renewal has little discernible effect on ongoing expenditures on f and s in the schools for which data was available. This is no doubt a simplification of the real long-term impact of renewal on these expenditures, as this is based on only 3 years pre and post-renewal expenditure data. Both Δf and Δs is negative (indicating an additional cost on f and s following renewal, rather than saving), that is F and S are slightly higher after renewal than they would have been without renewal.

8.3.2 Whole life value

Using the method for estimation of monetary value for the outcomes resulting from improved net EA explained earlier, cash flows for Δv were generated and have been used to evaluate the PV of outcomes. As can be seen from Table 8.1 above, the estimated value of additional earnings to be accrued over the lifetime of those beneficiaries of net improved EA witnessed across the sample of schools is around £73,300 on a per pupil capacity basis. This value is of course based on the particular scenario modeled. This cash flow dwarfs the circa £21,500 per pupil upfront capital investment and minor additional costs on f and s associated with renewal, giving an estimated return of 353%. Using this increased earning cash flow over the pupils future working lives and an assumption that 40% of that additional earning will return back to fiscal authorities (t), as the basis for a return to the Exchequer (as the financier of the investment), this suggests an overall net gain to the public purse on the investment of 1.41 (PV of Δt) to 1 (PV of Δc). These values are of course subject to considerable risk in the medium term (rate of change in the annual impact on EA following investment) and further, inherent uncertainty into the long run, given the nature of the underlying factors.

8.3.3 Capital investment policy relevance and sensitivities

The high level of standard deviation in the value of Δv should be borne in mind, along with the reality that median effects on educational attainment are close to zero in the schools observed. Thus, the return on individual investments is highly uncertain.

The returns from the programme of investment depend on the actual future in which those gaining level 2 qualifications will go on to live and work. This future may turn out to have very different wage uplifts from those referenced in this analysis. Consideration of this point is fundamental to the application of these findings in policy settings in terms of designing public capital investment programmes. If policy-makers have reason to believe that key assumptions regarding the links between qualifications and lifetime earnings will be different in the future than they have been in the recent past, they can take explicit account of this (see recommendations).

The sensitivities in the above analysis of WLC and value for schools are many and influential. While some factors will have relatively small influence on v, and thus on the returns from investment. These relatively low influence factors include the assumed working life of former pupils and the proportion of schools leavers stopping at NQF level 2 or 3 (schools or college leavers, given the lower wage uplift associated with these levels of EA). Other factors will have much greater influence, especially the proportion of schools leavers going on to NQF level 4 (university degrees) and the wage uplift associated with attaining this level of EA (given the considerable increase in life time wages associated with this level). It is proposed that a useful framework to break down these factors for means of policy design includes classifying them as high or low influence, as well as whether their incidence (in terms of risk if not uncertainty) can or can not be influenced by public capital investment (and wider) policy decisions. That is to say, the factors should be considered as endogenous, within the internal control of the policy, or exogenous, outside the control of the policy. The likelihood is however that the complexity of the relationships within and between these factors makes them highly interdependent and difficult to consider as either purely internal or external.

8.3.3.1 In domain of *internal* control

- **Average of initial and subsequent EA change following capital investment -** the change in EA following capital investment is no doubt an uncertain prospect in a particular school, but potentially not so when considering a programme of capital investments. As is apparent in the above study, a small proportion of schools drive the net positive change in EA. Further work is needed to understand if particular schools present more favorable likelihoods for improvement in EA from capital investment. It seems unreasonable to suggest that capital investment can only be a positive driver of change in outcomes, given

that just under half the schools for which data was available showed a reduction in outcomes following capital investment. Isolating the factors behind this variance in EA change will require a major programme of multi disciplinary research. Success in this research would help move from uncertainty to risk with better understanding of the context for the determination of outcomes.

- **Proportion going on to higher levels of education –** the proportion of those progressing to level 4 may reduce with increased tuition fees

8.3.3.2 Outside the domain of control:

- **Working life –** the length of the working life for future workers is no doubt an uncertain prospect. With increases in the UK pensionable age and increasing life expectancies, it is possible many will be required to work longer. An additional 5 years of working life will not make a significant difference as these later cash flows will be subject to the greatest degree of discounting. A key benefit from HE seems to be the much lower levels of inactivity, with those that have undertaken NQF level 4 qualifications around half as likely not to be in work.
- **Wage uplifts** – the determinants of wage uplifts are subject to how markets value the skills and knowledge of the future work force and are beyond school capital investment influence. More recent work re-affirms that attaining HE qualifications (NQF level 4) still pays in terms of higher wage uplifts, but variation in graduate outcomes has increased, with notable difference by institution, subject and degree classification as important factors (Britton et al., 2016). The below figure demonstrates some of these findings while the paper's approach to using administrative tax and student loans records demonstrates a clear potential method for deeper analysis of the working life outcomes of educational interventions.

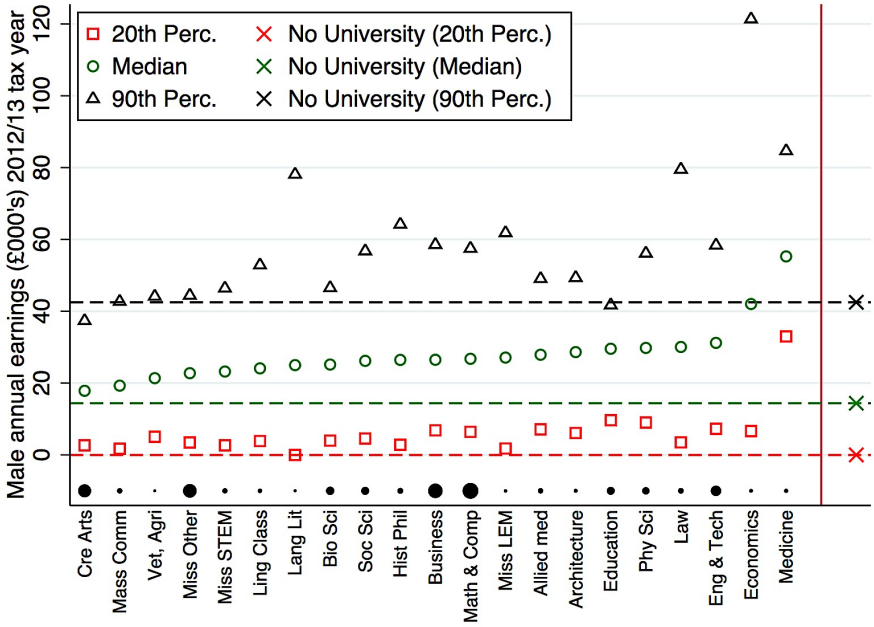


Figure 8-2: Male annual earning (£000's) 2012/13 tax year by degree topic. Source: Britton et al., 2016, fig. 4.

Table 8-2: Factors within (internal) and outside (external) domain of control of DfE in influencing V

	Internal	**External**
High influence	1) Average size of EA uplift across schools 2) Decay function	1) WU3-4
Low influence	1) Proportion of those with lv 2 encouraged or allowed to enter 16-18 education 2) Proportion of those with lv 3 encouraged or allowed to enter 18+ education	1) WU2-3 2) Working life

As a means to focus policy efforts, it is proposed public clients might concentrate efforts on those factors that can be classified as highly influential and within the internal domain of control. The distribution of EA change following capital investment is classified as highly influential and within the internal domain of control for government. This is based on the reality that government chooses the schools to receive capital investment and may, with improved understanding of the incidence of *educational transformation,* better focus the application of limited capital funds to those schools exhibiting similarities with schools that tend to improve EA the most following capital

investment. The classification of WU3-4 as a highly influential yet external factor in determining V is based on the premise that while *government* can influence the pursuit of higher education, the value of the WU is fundamentally determined by how markets in the economy value the skills and knowledge of university graduates.

8.3.4 EA as a function of CAPEX

Looking at EA change as a function of construction cost per pupil capacity unit for the schools for which there is sufficient data available reveals a remarkably uncorrelated relationship in either new / rebuild or refurbished schools. Where there is a relationship (albeit based on quite small sample sizes), refurbishments seem to offer marginally greater increase from additional CAPEX per pupil, where as more expensive new build has weak negative effect on outcomes. As suggested in figure 7.9 (cash flows) above, this affirms that while renewal is associated with improved EA on average, the effect is by no means evenly distributed across all schools. Overall, net improvements in EA are driven by a minority of schools with a median effects close to 0.

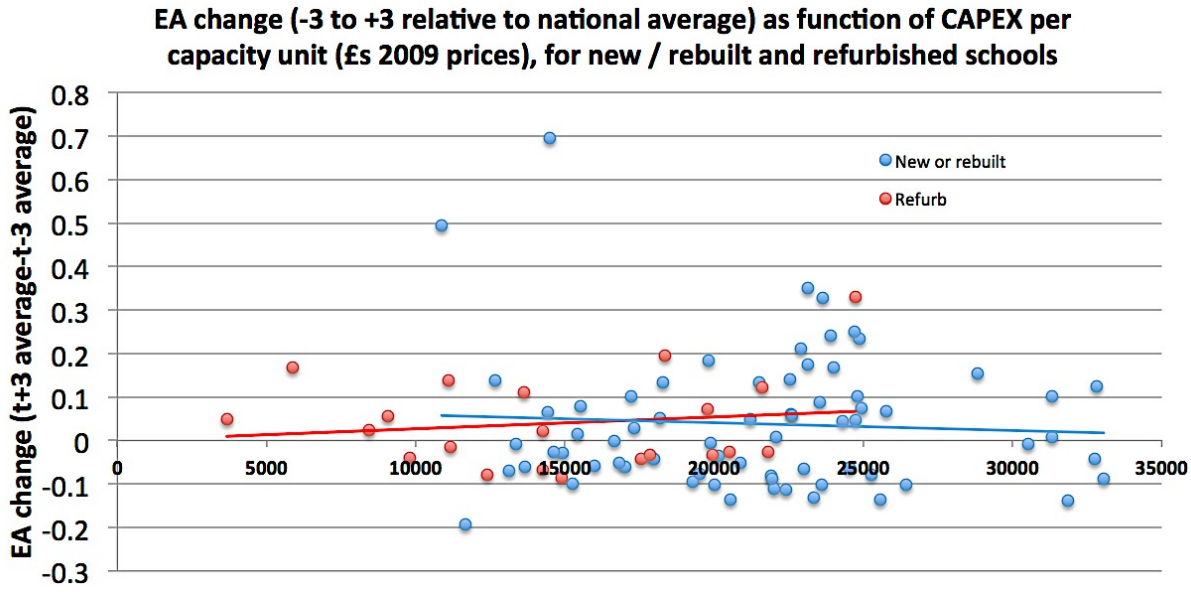


Figure 8-3: EA change as a function of CAPEX per pupil capacity unit, for new / rebuilt and refurbished schools. Source: SBS, Attainment tables, Author analysis.

Earlier research on the links between capital investment and change in EA at earlier stages of education shows similar result in term of the distribution of EA change following capital

investment. Key stage 3 covers the period where pupils are aged 11-14, the preceding stage to key stage 4 analysed above. What is notable is the less than rare incidence of negative changes in educational outcomes, as observed in the above analysis of investment in secondary school buildings.

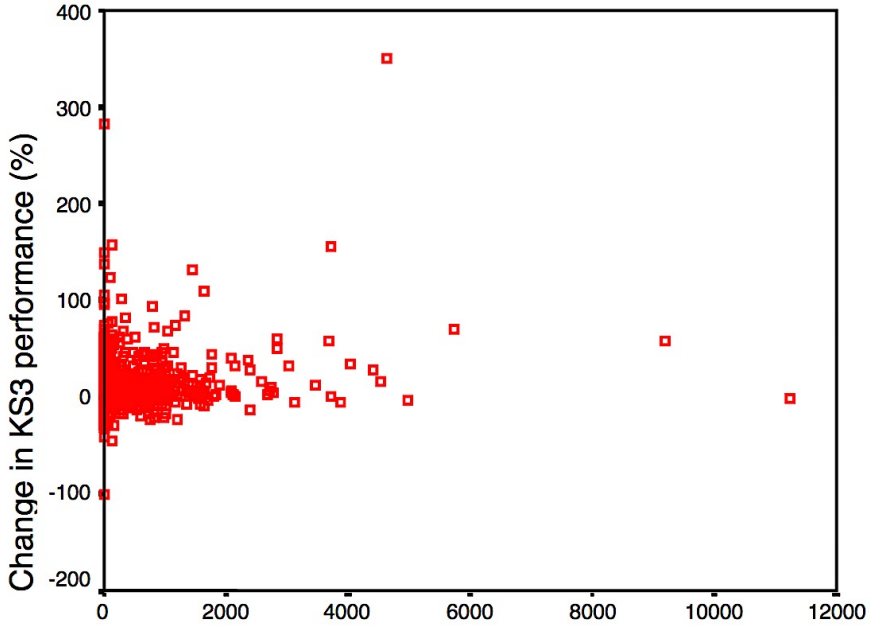


Figure 8-4: Correlation between capital spend and change in KS3 performance. Source: PriceWaterhouseCoopers LLP, 2001, fig. 5.

8.3.5 Information from previous investments: public versus private capital allocation

The comparable findings above on changes in EA from the earlier study by PWC and the original analysis presented here both demonstrate that consistently positive improvement in outcomes do not prevail is fundamental to decisions around future investments in pursuit of improved outcomes. The presumption of improvements in outcomes from investment is a major barrier to actual ex post return from capital investment. About half of returns are actually negative (figure 8-3 above) with the mode also being marginally negative and the median marginally positive median. This eludes to the notion of black swans and fat tails put forward by Taleb (2007), where by the estimation of the tails of distributions is underestimated by a bias towards predicting higher densities at the central sections of the distribution.

Comparing with the prospects of private investments, public investment in PSAs face greater uncertainty with regards to their achievement, in part because the benefits are not revealed via market transactions (and as such are harder to target and verify), nor do they accrue sufficiently quickly to allow them to be attributed to the investment that brought them about. Further, where as in private investment, there are mechanisms by which investors can undergo information searches at earlier stages to inform latter commitments on capital, no on-going information search is apparent for large programmes of public investment. An obvious example here includes the surveying and exploration of potential gold mines and oil wells, the results of which go on to guide where additional capital is allocated between numerous potential mines and oil fields. Rarely is timely evaluation of public investment programmes undertaken to guide later phases of investment.

One can treat previous investment programmes as forms of exploration, except that these investment in PSAs are rarely formed and iterated based on emerging information as to their potential for return (based on reduced cost or improved benefits). This is especially the case when programmes are infrequent and intensive, as is the case in recent programmes in social infrastructure up to 2010 (figure 4-5). With these forms of programmes where investment quickly ramps up without the application of emerging information as to efficacy of early investments, the risk of *white elephants* increases, as the absence of information to prioritise capital allocations necessarily means investors face unknown risks that might otherwise be avoided with the application of information.

The prospect for improved outcomes in schools can be compared to oil exploration, pharmaceutical research in drug development and even venture capitalists allocation of capital to high growth start-ups. While the prospects are similar to these contexts, the processes for deciding where to invest are fundamentally different. While venture capitalists know the majority of their returns will come from a small proportion of their investments, they still undergo arduous activities to appraise the prospects for return from each individual investment with the view that selection can improve portfolio returns, else they would simply spread their capital amongst all potential high growth firms. This scenario of spreading capital regardless of potential returns is closer to what seems to be the norm in public sector PSA investment, evident in the BSF policy intention to

renew *all* schools rather than to select those schools where investment need was greatest and most urgent.

This comparison of PSA investment with private investment has its limits. For one, investment in private enterprise provides the option to scale up in time if and when positive returns become more likely. This is not the case with public investment in social infrastructure, where allocation resembles a more 1 stage investment. The option to scale up in private contexts is based on a notion that the market can be captured and gains can be made against the competition. In social infrastructure contexts, the notion of competition is not applicable given that, at least in the UK, a monopoly form of provision prevails. Attempt to introduce contestability into public provision complicates this, except that responsibility for delivery will always fall back on government if providers become *uncompetitive.* In this sense, parallels between public and private investment should use private monopolies as the benchmark.

A private investor would not choose to invest in schools that are underperforming if the measure of success is absolute EA, rather than improvement in EA. This is because schools that underperform ex ante, in the main due to factors outside of the control of providers (see figure 7-2 above), will be unable to *compete* on absolute EA. For the public sector investor, improvements in those worst performers has considerable value whereby maximising outcomes is not the optimal basis for capital allocation, but rather minimising underperformance. This is evident in the prevailing allocation of investment focused on those schools with below national average levels of attainment.

8.4 Shacklian relevance for public investment and procurement decisions

Public procurement decisions increasingly involve more complex financial considerations with the use of private capital, and as such can be considered critical decisions by 2 fundamental criteria, both as capital intensive investments and as decisions involving complex financial aspects (Crocco, 2002). PSAs have large excesses in value in their intended use over their value in alternative use, resulting from their highly specific nature as assets (Williamson, 1979). The resulting high *sunk cost* makes investment decision about PSA more critical because of their relative irreversibility and difficulty in adapting for alternative use.

The efficacy of these commitments is subject to a range of risky future states of world and inherent uncertainties into the long run. The results of these capital investments, at least in terms of outcomes, are difficult to predict with anything but a small degree of confidence. Further, there are a range of occurrences that may be classified as beyond the realms of *expectation*. In terms of achieving stated policy goals, an example would include the observation that half of those educational PSAs that received capital investment exhibit improvements in outcomes, while the other half see no change or negative outcomes on change in EA.

For means of improving allocation of capital resources, frameworks that incorporate risk and uncertainty are put forward as useful to improve allocation. The work of Shackle (1938) provides such a framework, and while typically being applied to the context of private entrepreneurs with an Austrian school leaning (having been a student of Hayek), there is value to be had from his classification of decision making under uncertainty for PSA capital investments. The decision to invest or not in PSAs will always involve, implicitly or otherwise, an act of *imagination* about the future, as the key source of informing scenario analysis. Investment decisions involve dealing with high levels of risk and uncertainty, more specifically about the underlying determinants of cost and sources of value (benefits) into the long run.

Alternative procurement methods exist as socially constructed institutional mechanisms for transferring and managing risks for management under residual property rights, with PFI seen as a mechanism for tempering client exposures to construction cost overrun and longer-term operational cost risks. It is notable that there are few contractual mechanisms for the incentivisation of private providers to pursue delivery of outcomes, given the paucity of understanding on the mechanisms that bring them about. Contracted providers (and private financiers) are comfortable in the realms of bounded risk, not so in contexts of unbounded uncertainty. This is pertinent in considering the development of payment mechanisms that incentivises the delivery of outcomes, in contrast to the outputs that forms the basis of PFI payment mechanisms.

8.4.1.1 Time and ergodicity

Shackle writes about the relationship between time and knowledge. While more philosophical aspects of his work on the non-ergodic nature of economic progress are of course important, the

appropriate focus here is on his conceptualisation of the decision process. More precisely this relates to the forming of expectations about the future, in which decision makers can only credibly claim to have some probable knowledge (in the face of probabilistic risk). Time periods should be born in mind here, given the very long-term nature of procurements, not least the long-term nature of any PSA or indeed the outcomes that flow from their use. Knight's view that 'the existence of a problem of knowledge depends on the future being different from the past, while the possibility of the solution to the problem depends on the future being like the past' (1921, p. 313) is pertinent in the prospective efficacy of public capital investment. It is either the future not being like the past, or an ignorance of the past, which bring about what Shackle referred to as *potential surprise.* The notion is that decision makers (investors in PSAs in this case) are faced with having to accept that their preconceived expectation about the future will never come to complete fruition. Instead of seeing uncertainty as a problem to be overcome, Shackle embraces a quintessential Austrian view of uncertainty as the fundamental source for competition. It is differing imaginations of how the future will unfold that forms the basis of commercial decision-making. He concedes that unbounded uncertainty can stifle action, supporting that 'the boundedness of uncertainty is essential to the possibility of decision'.

8.4.2 Potential surprise

Shacklian theory goes against the notion that risk can be considered on a continuous scale, and rather that the decision making process under risky (and even uncertain) future states of world entails more *imagination* of mutually exclusive potential scenarios. As such, considering risk as additive (to unity) across the realms of possibilities is misleading. Blatt (1983) goes on to develop the notion of a *safety net* approach to investment appraisal, suggesting that the first stage should include the identification of investments with imaginable excessive losses, beyond that acceptable. Earl describes Blatt's approach as involving 2 stages:

> "…first, exclude projects with an excessive probability of disaster: second (and here the returns to the additive methodology), rank non-excluded projects in terms of their expected returns. This approach is akin to a characteristic filtering/additive differences hybrid procedure…, except that it all takes place with respect to a single characteristic axis."
>
> Earl, 1995, p. 112.

The Shacklian iso-ascending curve concept draws out his more binomial conceptualisation of risk (and return), given this questioning of its continuous nature. The central curve (Y) in figure 8.3 below shows how the bounds of imagination are confined by realms of expectation that are suitability unanticipated that they constitute outcomes of *potential surprise* or astonishment. The sections of this curve that run along realms of unsurprising prospect (lower horizontal axis) are what Shackle terms neutral outcomes. This is not with respect to their utility (given the variance in gains and losses) but rather the extent to which their occurrence may bring about surprise. This view of future states of worlds naturally steers appraisal of investments to involve scenario planning exercises against which to estimate pay offs, rather than attempting to find the *maximum* probability *median* scenarios between two mutually exclusive states of world.

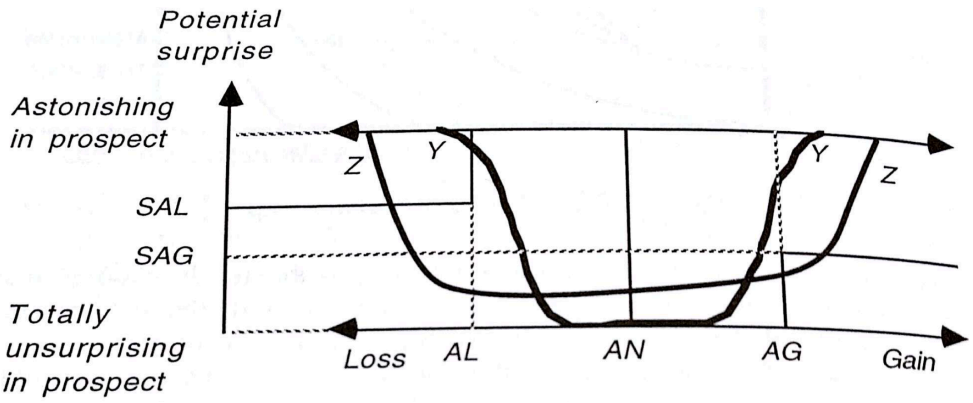


Figure 8-5: Focus loss and focus gain. Source: Earl, 1995, fig. 5.8

Contestability in the delivery of PSAs and public services is increasing with a trend to devolve decisions about procurement and spending down to more local commissioners. In so far that commissioners are monopolies (mainly aligned with locality), they are able to diversify away the unique risks associated with any one particular function. A limit to this is the portfolio under management, with central government having the largest *portfolio* of functions. At a local level, there are risks that monopolies might over or under invest resulting from the incumbent benefits of inheriting PSA estates. The focus gain in these rivalrous scenarios of public service provision might include capturing the market and even *take overs* of other *failing* public sector providers (most applicable in an NHS Trust context where financial unsustainable Trusts can be merged with more successful *neighboring* Trusts). This scenario is also pertinent in the rolling out of school academy status and the growth of Academy super chains, with the prospect of considerable

concentration in the *market* for *independent* (non-public) provision for state education an emerging reality.

The opportunities for potential surprise in the direction of state education is, as ever, defined by the political context in which decisions are made. The prospect of a competing political party gaining power and reversing the decisions of their predecessors is always a credible, or *neutral* in Shacklian terms, occurrence.

8.4.3 Focus loss and focus gain in public investment

The relevance on Shacklian perspectives on decisions making are arguably limited in the context of public investment decision making, given their rooting in the commercial habits of merchants and private entrepreneurs. It is arguable that political decisions makers and civil servants have limited liability for their bad decisions (certainly more limited than that of an at risk merchant), Shacklian perspectives have an uneasy application to the public investment setting. The uniting link is based on the assets that both private firms and public authorities must invest in to deliver services, and the common economic characteristics that each exhibit, particularly concerning the asset specificities that are inherent with schools and hospitals. With this in mind, the following section attempts to contribute to methods of theorising about investment in social PSAs in their specific contexts by highlighting the emerging sources of uncertainty from recent capital programmes.

In a public investment setting, this framework can be applied to consider the scenarios for alternative forms of on-going provision for PSAs and the services they provide. The introduction of PFI forms of procurement provides opportunity for applied consideration of this framework. Focus loss in PFI is not necessarily about the higher costs involved, as these are reasonably well known beforehand (so do not pose significant sources of potential surprise). Rather in PFI, potential surprise may include the undervaluing of flexibility against the fixed price (and service specification) of PFI as long-term contracts. In austere fiscal times following the GFC, there are some PFI commissioners that have a level of regret regarding their *lock in* with PFI contracts. Some may be re-assessing the appropriateness of the assets they have invested in against emerging scenarios that require estate re-configuration, especially in community healthcare provision. In this sense the choice of procurement method became the *crucial decision*, rather than the actual choice to invest

in a similar asset and service with greater flexibility attached to it via conventional procurement. If PFI had been 'the only game in town' for some public investment as evidence suggests, this necessarily changed the credible sources of potential surprise in the ex ante period, regardless of whether this was acknowledged by commissioners or not.

Beside the lack of on-going flexibility within PFI contracts, the relative cost of capital between private and public source may also serve as an example here. It is doubtful that even if PSCs assessment had considered the long-term trend in public costs of capital, they would have done well to predict the medium term reductions to historic level following the GFC. This is understandable given the qualitative difference between theorising about the future and describing past occurrences. In line with Shackle's model above, possibleness is categorical. Further, focus loss may include the possibility of having to close a facility, either because it is not fit for purpose or because it no longer proves affordable. The worst loss imaginable financially, involves having to reinvest to provide the services that are required by legislation in alternative ways than how previous investments allowed.

The level of risk aversion is pertinent in considering Shacklian frameworks. The more risk averse you are the more one would weight on focus loss. This may go far to explain why public sector capital programmes have tendencies to go over budget, than if the process behind their development and allocation is more risk preferring. This would tend to make the decision maker emphasise the focus gain. This fits with the observations of the business cases behind BSF projects and the programme, with aspiration goals around educational *transformation* (the focus gain) and less regard to the actual returns on investment in school PSAs. This emphasis of focus gain on ill-defined yet valuable outcomes represents a form of optimism bias in light of limited historic evidence to support claims of achieving such benefits.

Given the stronger fiscal constraint and lower level of diversification in costs and revenues, local public authorities might be expected to be less risk averse than central government. While this may lead them to make more balanced assessments of the cases for capital investment, the *grant* nature of centrally allocated capital funds dilutes this aspect from local appraisal. Although one would have expected that the use PFI would have tempered this behavior, with clear on-going liabilities for LAs. Given it's novelty as a emerging alternative to conventional procurement, it

seems many LAs did not appreciate their future fiscal commitments under this form of procurement.

While LAs have been allocated devolved maintenance budgets, the variability in how effective these monies have been spent is questionable (given the condition of legacy estates is still emerging). While central government has continued to prefer that LAs allocate these monies, given their better position to assess and meet local need, there are increasing tendencies for central government to seek greater transparency on how these funds are spent (Laws, 2015).

> "Uncertainty about the future would be far less of a problem for decisions–makers if the commitments they make today could easily be reversed if they seem poorly matched to the state of world that subsequently materializes. In an ideal world, a mistaken investment decision would be overturned simply by firing or redeploying workers and selling physical assets for their new prices less an amount that reflected their physical depreciation. …
>
> … mistaken decisions may still be expensive depending on 1) the degree of specificity and immobility of the item that needs to be sold, 2) how hard it is for prospective buyers to judge it's condition, and 3) the haste to which ones tries to find a buyer."
>
> Earl, 1995, p. 119.

The real challenge for applying Shacklian thinking to evaluation of public sector capital investments is the untimely nature of outcomes, which tend to reveal themselves over many years (at least in the case of EA). This requires a continuing commitment to monitoring and presents challenges for isolating the effects of investment on users of PSAs. It also renders attempts to make the Minister of the day accountable for present day revelations hard to justify, being as they are, the benefactor or victim of good and bad decisions made by their predecessors.

8.5 Flexibility as a means of bounding uncertainty's effects

The exposure to uncertainty in long-term investment and management of PSAs by public authorities is unavoidable, while the value of flexibility to adapt to emerging changes in the underlying factors of cost and value are seldom acknowledged. This flexibility is traded off under the inflexible governance structures of PFI procurement methods. For the case of potential surprise, we might consider the scenario that emerged following the GFC in terms of austere fiscal budgets along with historically low government borrowing costs. If government clients had known that their revenue budgets would be so considerably reduced and that lower cost of capital would soon be achievable via public financing, might this have impacted on the use of this policy for long-term private financing? The *surprise* here is not necessarily the eventual cost of capital incurred for private financing, but rather the value of the flexibility traded off for more certain cost exposure (and the associated output specification) inherent in PFI.

Shackle focuses on the process of decision making more than attempting to attach probabilities to risky outcomes. In contrast to the view of the general theory of equilibrium as abstracted from the passing of time, he takes a typically Austrian view of the dynamic nature of equilibrium. In this sense the allocation of scarce capital resource for public investment is in a constant state of flux. In preventing this dynamism in the unfolding future in which the value of PSAs are determined from paralysing decision making, careful consideration of the range of past data may be used by a decision maker to give themself greater confidence in making decisions for uncertain futures. They do this by lengthening the period of the evidence base upon which such crucial decisions are then made. The extent to which eventualities are ergodic or not much depends on the period of observation considered by the decision maker.

8.6 Hospital investment returns

A lack of data across the WLC and value concepts for hospitals analogous to that explored in schools limits empirical estimation of stylised ratios, or of the returns from capital investment in healthcare PSAs. Instead, attention is given to how advancing the application of the WLC and value frameworks to hospitals might best be achieved, with the view that in time, empirical data or appropriate proxies might be amassed. Even before this evidence base is developed, consideration

of the equivalent factors for healthcare WLC and value is warranted, with view that it might guide the accumulation of data to better inform future capital investments.

8.6.1 Value of healthcare

The value of healthcare is a multifaceted and complex domain. Beside increased longevity and quality of life, there are numerous economic sources of value from improved health in the wider population. The classification of these sources of benefits, along with attempts to estimate their incidence and value is required if equivalent proxies to *change in EA* can be developed. Data for such events will be for sets of specific patients treated by particular facilities, except with the added complication that patients are potentially treated at numerous healthcare PSAs as part of their overall treatment. This need not happen within close geographic proximity, if the treatment is of a specialist nature. This makes the attribution of potential change in outcome levels to any one PSA difficult, without detailed information on the process of care provided to the patient. Such information would be highly sensitive to the extent this would be barrier to collation and application. This is a primary barrier in the application of the above developed evaluation methodology in healthcare settings. The choice of outcome or treatment for evaluation should seek to control for the complexity of other forms of treatment.

Another difficulty with the application of the above evaluation method for schools in hospital PSAs is the prior state of patients undergoing treatment. In schools, children have much less history that may lead to particular educational outcomes. Conversely, adult patients have history (smoking status) and pre-existing conditions that greatly influence the outcomes they achieve, regardless of the state of the healthcare PSA or quality of treatment. Such patient characteristics would need to be known to control for their influence on outcomes to assess the separate contribution of better quality PSAs. An alternative approach may include the development of healthcare indices for broad classes of people against which patient receiving treatments could be assessed.

Developing an equivalent value of healthcare to that provided for education by EA may will require accounting for the greater diversity in the forms of healthcare services provided by hospitals when compared to education, and the convenient signal of quality provided by GCSE examination results.

The following are potentially useful sources of data from which to construct a value concept for healthcare provision:

- Actuarial data on expected life by area – this is an equivalent to the working life concept applied in the above considerations of EA outcome values. Essentially, a quantity measure of mortality in local areas.
- Quality of life indicators, sourced potentially from General Practitioners – this would be a superior indicator to the above as quality indicator (rather than just a measure of reduced mortality resulting from investment in healthcare PSAs)

The above concepts might then form the basis of a healthcare index amenable to geographies, against which investments in local healthcare PSAs could be evaluated. General Practitioners hold detailed records on the treatments of their patients, and are increasingly more responsible for the choice of healthcare provider in their role as Clinical Commissioning Groups in primary care settings. The decisions of CCGs to change healthcare provider may also provide important signals to the quality of service being provided by primary care and hospitals. Opportunities for accessing this data may be available through consultation with individual CCGs for case study research.

Just as one considers the systematic effects of EA in school settings, such as cohort effects and displacement of student between schools, these are also important in healthcare PSA contexts. The reality is that certain hospitals gain a reputation for the quality of healthcare in particular forms of treatment and attract funding to resource specialists in certain areas (e.g. Royal Brompton for hearts and Royal Marsden for cancer). Patients with particularly difficult cases to treat are often sent to these facilities to benefit from their specialism. This limits the extent to which the above method can be applied to healthcare PSAs as the above practice of allocating patients for treatment will lead to expert centres having lower levels of outcomes associated with it, attributable to the difficulty of illnesses being treated. It is worth returning to mention the value of the contextual value added measures of EA trialed in 2005 and published until 2010. This measure sought to account for the prior attainment of children from earlier stages of education (primary) in assessing their progress associated with the school they attend. The development of an equivalent set of measures for adult patients would no doubt be more complex, but goes some way to the application of similar methods to those applied to schools above.

Mortality data for particular hospitals was collated and made available by the leading private healthcare data consultant Dr. Foster up until 2013 drawing on a Hospital Standardised Mortality Ratio (HSMR). This measure factors in 12 different characteristics of patients who die in hospital to calculate an actual against expected mortality rate and is only designed to be applicable in acute hospitals, not community facilities. Despite advances made by Dr. Foster on the measurement of hospital level statistics, a short extract from a description of their HSMR method reveals the on-going difficulty of data aggregated at the Trust level:

> "in ***some*** cases, where the hospital trust runs more than one acute site, we have then also looked at the acute sites separately to see if they have different mortality rates."
>
> Doctor Foster, 2013, p. 25.

In assessing the value of healthcare, one alternative approach to that applied above in looking at EA is to consider healthcare more as a consumption good rather than an investment good (from improvement in human capital). This sits well with the fact that healthcare services are more intensively used later in life, so rather than increasing one's productivity in the work place, healthcare services add to the enjoyment and quality of life for those that receive it. Reflecting on this, one might adapt the approach applied above.

For hospitals, the basis for capital investment (and indeed other policy interventions) should focus on outcomes and the VfM basis of these as an effective focus to align the complex co-ordination of service delivery between varying functions (Porter and Thomas, 2013). Porter highlights the potential for bundling payments for healthcare provisions as a means to move away from charging for distinct disjointed healthcare provision through the *care cycle.* This work also places patients at the core of the cost (inputs) and value (outputs and more so outcomes) recording framework (rather than department or indeed facilities), in line with the above exploration of cost and value *per pupil* in school settings.

> "Indeed, rigorous measurement of value (outcomes and costs) is perhaps the single most important step in improving health care. Wherever we see

> systematic measurement of results in health care—no matter what the country—we see those results improve.
>
> By failing to consistently measure the outcomes that matter, we lose perhaps our most powerful lever for cost reduction.
>
> Just as railroads converged on standard track widths and the telecommunications industry on standards to allow data exchange, health care providers globally should consistently measure outcomes by condition to enable universal comparison and stimulate rapid improvement."
>
> Porter and Thomas, 2013.

The relevance of discussing the above under a section on risk and uncertainty relates to the lack of systematic and comparable data on the incidence of outcomes. In line with the views above, the measurement of outcomes should be the basis for assessing efficacy of capital investment, and alternative delivery mechanisms for investment, even if a focus on outcomes precludes use of outsourcing and private investment. If the difference between risk and uncertainty is the ability to attach estimations of incidence (probability) and impact (cost / value on occurrence) in line with the Knightian definition (2009), then displacing uncertainty with risk to better inform decisions requires that data is actually collected, collated and interrogated.

8.7 Risk and uncertainty in WLC and value

In an attempt to bring together the frameworks of WLC and value with that of risk and uncertainty, the figure below summarises the knowledge held about the determinants of costs (inputs: c, f, and s) with the performance of facility (outputs), the outcomes of users and the wider impacts of provisions and investment of PSAs. The proposed schematic draws on the results from both investigations into the change in EA following capital investment (itself a function of the method for estimating school level cash flows) as well as the findings on school WLC ratios. With regard to costs, risk and uncertainty are curtailed by the amassed knowledge of how construction and operational cost are determined and managed, hence the domain of known knowns (KKs) prevails.

As one moves through the concepts towards the performance of built assets (outputs) and the users of PSAs (outcomes), risk and uncertainty begin to dominate.

Given the observation that half of the schools observed reductions in EA following investment, there is reason to consider that capital investment interventions can have significant negative as well as positive effects (vertical axis). The causal pathways are undoubtedly more complex in determining outcomes. Further, the estimated v cash flows are of considerable value, some 3 times larger based on the findings in table 8.1 above. This supports the horizontal axes relevance suggesting that as one moves through the less tangible benefits of PSA operations (outcomes and outputs), the magnitude of the value increases relative to the initial input costs. The goals of future research should be to improve our understanding of the causal mechanisms for outcomes, to reduce the prevalence of uncertainty in their determination. This would assist the investment decision maker by guiding investment to bring about what commissioners of PSAs care most about.

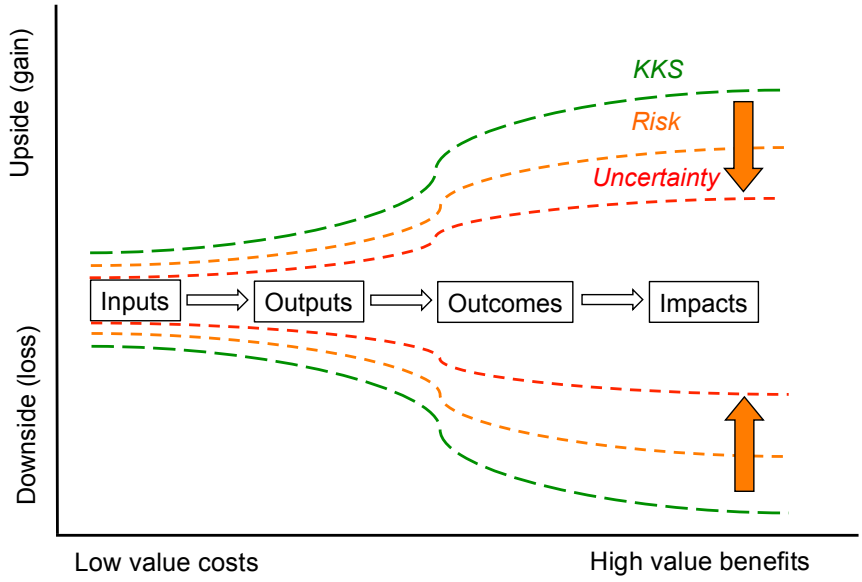


Figure 8-6: Knowledge, risk and uncertainty in the WLC and value of PSA operations

8.8 Chapter summary

This chapter explored the returns on capital investments in schools using the methods laid down earlier in the thesis. Results suggest that for the schools for which complete data was available, and using observed EA change as a basis for predicting the wider economic benefits of improved human

capital, investment will pay for itself over the long run at the programme level. However, in line with the EA change observed earlier, the net positive returns from capital investment are driven by a small minority of schools exhibiting very high improvements in EA. No savings on operational cost were observed suggesting that schools to have received capital investment incur similar on-going operational cost than before investment. There were only a small number of PFI schools within this sample, hence conclusive findings on the returns from investment from integrated contracts remains elusive.

Further commentary focused on the role of Shacklian discourse on decision-making under uncertainty. The contributions of focus loss and focus gain are explored in the context of investment in PSAs, with focus gains identified as the potential for educational *transformation* from investment in school PSAs, and focus losses including the failure to sufficiently value flexibility in on-going PSA operations with the use PFI contracts.

Chapter 9 Conclusions and recommendations

The first part of this chapter will summarise the headline findings from this thesis and highlight the contributions made to the advancement of knowledge. The second part seeks to place findings within the context of emerging policy themes to give some forward-looking considerations. The third and final part will deal with specific recommendations for better evaluation of past capital investment programmes, as well as how these lessons might inform appraisals of future potential investment programmes.

9.1 Conclusions

9.1.1 Business cases and WLC

The actual underlying business cases of programmes of capital investment have been shown to focus on the more aspirational benefits in forms of outcomes from capital expenditure. The underlying justification of the BSF programme was a pursuit of *educational transformation* without clarity on what this is, the mechanisms through which improving school buildings might bring this about or indeed how it might be measured and evaluated. The paucity of evidence at the time to support this claim illustrates the questionable grounds behind this capital programme of uniquely ambitious scale. The key finding that half of the schools analysed actually witnessed decreased educational attainment following capital works (against national average trends) suggests greater skepticism of outcome based programme goals is warranted. This finding should be considered in light of the particular measurement method applied.

Ideal business cases would be more descriptive of the mechanisms through which they intend capital investment will contribute towards the delivery of intended saving on operating cost or improved outputs and outcomes. While the pursuit of operational costs savings within WLC framework remains a compelling basis for capital investment in PSAs, lack of common and formalised WLC methodologies holds back their application in the appraisal of investment in operations.

Given the vast estates of PSAs and increasing coverage data on their operations, it will be possible to identify those PSAs operating at greatest normalised cost (f), and so might be most worthy of

capital allocations in pursuit of WLC savings. *Stylised* cost ratios are just that, *averages* for a *type* of building – they are not definitive indicators at the single facility level. They should be used in the context in which they are estimated, over large numbers of facilities as proportions of diverse and complex estates delivering similar services. For hospitals, the present aggregation of many cost and performance data to the trust level (rather than facility) precludes PSA and estate level analysis across the range of WLC and value concepts.

The propositions made about WLC savings achievable through the substitutability of C, F and S were not supported by the empirical analysis of schools. While returns from *investment in operations* do not seem to bear out at the programme level, there are instances where operational cost has reduced significantly following investment, given the high variance of Δf. Case study research on individual facilities that witness reductions in *f* following higher than average *c* would be valuable. This research would be able to focus on facilities that could be characterised by potential for returns from *investment in operations*.

9.1.2 CAPEX per capacity unit

The average capital expenditure per pupil capacity unit value is £19,883 (for the n=90 sample above). There is considerable standard deviation about this mean (£6,123). Higher capital expenditure is not associated with higher levels of EA, or indeed more systematically positive change in EA. This suggests the premise of higher CAPEX in pursuit of better outcomes is harder to justify. This begs further work to understand where capital works may have had traceable causal effect on attainment other than in their magnitude, but rather other qualities. This finding bears upon the decision to concentrate limited capital funding to fewer schools, or to distribute to many more schools in the form of lower cost refurbishment capital investments. Given this lack of association between CAPEX and EA, and despite the lack of reduction in operating cost following capital investment, the need for some capital investment remains in attempting to reduce operational cost in facilities of higher than average *f*. In light of this, the more recent general direction of current schools capital programmes to spread capital grants on the existing estate for refurbishment seems sensible.

9.1.3 Procurement

The main finding on procurement in regards to WLC concepts concerns the lack of consistently lower operational in PFI against facilities, against the expectation thee might be achieved from investment in operations. Based on the analysis in figure 5.2, PFI provision is not markedly more (or less) expensive to the public sector than conventionally procured and operated facilities comparing annual expenditures on a basket of FM related expenditures. This finding is reached comparing school level expenditure and does not express the true resource costs expended by the SPV against the in-house provider.

While the role of procurement methods may not bear out across the cost of operation for a whole facility, it does seem to matter for specific forms of service. Catering in both hospitals and schools serves as an area where private provision (be that outsourced or PFI) seems able to reduce costs. Evidence in hospitals suggests quality is as good or better with private provision.

The real difference from a WLC perspective while be revealed at the end of PFI contracts, when the condition of facilities can be assessed against their conventionally procured and operated equivalents. This may well bear out the supposed benefit of PFI procurement in terms of maintaining asset conditions with life cycle allocations for repair and maintenance.

9.1.4 Capital works

The key finding on capital works concerns a lack of difference in terms of change in outcomes between refurbishment and new build projects (figure 5.3). While earlier analyses suggested that new build improved outcomes faster than refurbishment based on a binary classification of samples, analysis of continuous CAPEX against change in EA reveal a remarkably uncorrelated relationship. This goes against the justification of the BSF capital programme based on supposed benefits of more intensively renewed facilities increasing outcomes, namely educational attainment.

Given this lack of association between per capacity unit spend on CAPEX and the improved outcomes, this suggests the distribution of capital grants might achieve better returns with more distribution of grants for refurbishments, rather than concentration on rebuilding fewer facilities.

9.1.5 Thesis contributions

The main contributions made by this thesis can be summarised as:

- **Methodological contribution**: the options and thresholds method for valuing outcomes in education as a key contribution and method that can be applied to interventions other than in education. This method provides a way of moving from quantity changes in EA, towards valuing changes in outcomes following capital investments. For applicability of this method it requires information on 1) proportion of people at different levels of education and 2) the wage up lifts associated with each level of education. Another significant methodological contribution involves the method developed to observe on-going operational cost in school through combination of accessed datasets.
- **Empirical contribution** – empirically based stylised WLC ratios for schools of 1 (c) to 1 (f) to 5 (s) at a discount rate of 3.5% with a 60 year asset life sets a benchmark for secondary comprehensives against which further studies can be compared. This is also a contribution in terms of providing assessors of the business cases for schools capital investment with better information against which to judge the proposed savings from future *investments in operation*.
- **Procurement** – comparisons of the WLC of operating PSAs suggests that procurement has limited association with either higher or lower cost to the public sector, against the notion that PFI's integrated form of contracts incentives investment in operations. The relevance of procurement method does bear out when looking at individual services, such as catering in hospitals where private provision (PFI or outsourced) is associated with lower cost and comparable or better quality of service.

9.2 Future themes

In attempting to summarise the findings of this thesis while placing them within a forward looking policy setting, a number of emerging themes in PSA delivery are pertinent. The first of these themes includes the increasing tendency for greater ***competition between alternative providers*** of public services requiring the use of PSAs. This is most notable in recent policies on promoting the academy status for schools, as well as the *free schools* programme, but is also apparent in healthcare settings with greater freedom for commissioners to choose their service providers. This

may be considered as an emerging scenario in which a more closed set of risky and uncertain future states of world will emerge. The second of these themes includes the ***allocation of funds between resource and capital budgets,*** as a practice within government fiscal management that draws very distinct lines between expenditures for on-going provision of services within PSAs and separately, for the provision of PSAs themselves. Finally, conclusions will reflect on the distinction between ***capital expenditure and capital investment***. The former here is considered as the minimum provision of PSA availability and fitness for purpose required to deliver educational and healthcare services, with the latter requiring a notion of additional allocation in pursuit of marginal gains in outputs and outcomes.

9.2.1 Competition between alternative providers

A monopoly form of provision for education and healthcare is giving way to a more contestable process for competition between alternative providers. In schools this can be seen in the spread of academies and free schools where schools compete for pupils and funding follows them. The incentives that drive investment in a competitive environment are very different than those in a centrally planned system. Under competition, schools may invest to attract both pupils and staff (and at the expense of other schools). Under monopoly forms of provision within a locality, the reasonable assumption is that intake is not affected by investment given the limited ability of parents in the area to pick a school for their children. When this is no longer the case, the notion that school physical environment may override the absolute level of outcomes as a stronger signal for school quality remains possible. This effect may temper any particular cohort effects (positive and negative) seen between pupils. In competitive models, rather than adding value to a similar cohort, one strategy has been emerging where schools are competing for the quality of intake, with schools that are able to attract *better* cohorts (more able children) benefit from improved attainment, regardless of their ability to teach in a more engaging and fruitful manner. The prospect for improving educational outcomes between schools is at some level zero sum in nature.

As competitive rivalry advances, there is good reason to reassess the discount rate used in the appraisal of capital (and other) investments into improving provisions and practices, with potential upwards adjustments to reflect the riskier prospect of individual school capital investments in competitive settings.

With a competitive system and an increasingly pluralised set of state educational providers, and adding, to the school estate (including new academies and free schools) it will necessarily mean that, in time, some schools will come under increasing financial pressure due to the inability to attract sufficient numbers of pupils (and per pupil revenue streams) to cover cost (fixed and variable). This will not necessarily be from the costs of facility maintenance (F) but rather for the larger costs of teacher staffing (S), a sum 5 times larger over the life of a typical secondary comprehensive. Without sufficient numbers of pupils, some schools will no be able to offer a full curriculum with appropriately trained staff, which itself may lead to further decline in numbers and cementing of vicious cycles towards closure. While it may be an acceptable policy outcome to let schools close due to lack of financial means, the lack of alternative school places in some localities makes the abandonment or under utilisation of education PSAs a particularly low VfM policy outcome. Where schools are required to close in particular areas, there are potential efficiencies to be had in options to abandon facilities in greatest need of remedial repair. Such information is currently being collected by the DfE under the PDSP and more recent Condition Data Collection, and could be well applied in application this this context, as well as wider capital investment appraisals.

The investment decision maker remains the individual school (in consultation with their LA for maintained schools). From this perspective, and given mounting pressure on financial sustainability, one might expect schools to increase their focus on the cost saving prospects of investment, rather than the aspirational improvements in outcomes, which they would not benefit from via additional funding.

The commissioning of schools involves the purchase of relatively low risk type construction, yet highly specific with regards to value in alternative use. This low risk nature is not necessarily the case for the on-going costs of their operation with many older facilities risking continually higher *f*. At an estate level, there are opportunities for improved coordination of the available data for improved evidence based decision-making in designing estate level programmes. A concern lies in the increased fragmentation of how the public estate is apportioned and managed. Increasing competition between different types of school institutions brings risks to the continued ability for the centre to observe school's operations (not in itself a reason not to pursue greater plurality in provision). This is particularly so for academy status schools given their reduced mandatory

reporting obligations. With this risk comes the opportunity for academy chains to adapt their own estate's maintenance and operational regimes, which may serve to demonstrate how to achieve efficiencies in operations where state schools have been unable.

Competition may also be pertinent in attracting the best teachers with schools using their physical environment as a differentiator for recruitment and retention. Given the recent increasing scarcity of qualified teachers, this may form an increasingly credible source of value for schools trying to attract teaching staff.

9.2.2 Resource and capital budgeting

Government spending comprises departmental expenditure limits (DEL) and annually managed expenditure (AME). DEL budgets cover spending that departments can be controlled (in the main), where as AME covers spending that is harder to control and determined by demand for statutory services and benefits (transfer payments). An on-going barrier to better WLC pursuit in the public sector concerns the distinction in budgets between those that fund annual resourcing to pay for staff and other operational costs, and those approved for investment in PSAs. The former is referred to as revenue spending (RDEL) and the later capital (CDEL).

This distinction between resource and capital budgets belies their dependence upon one another as an underlying principle of WLC frameworks (at least between c and f, if not s). The finding that costs following capital investment in schools do not reduce on-going operational cost systematically raises questions about the supposed cost saving benefits of *investments in operations*. This is both the case for conventionally procured schools as well as PFI facilities, where by these reductions in operating cost were expected. Without the ability to control for backlog maintenance (state of the PSA) it is hard to comment further on the effectiveness of procurement route to deliver whole life benefits. As school asset condition data amasses (see reference to PDSP and CDC) and early PFI facilities reach the end of their contracted life, opportunities for long-term WLC assessment between procurement methods will reveal themselves.

The separation in responsibility of schools between *financial management and governance* (EFA) and *educational performance* (DfE) is notable (Appendix 7). This serves as an example of the barriers within government between lines of accountability on delivering inputs (costs), outputs

(building performance) and outcomes (user performance). Complete alignment of these lines of accountability is likely not the optimal institutional structure in terms of delivering a complex process of national education. Greater alignment in accountability for capital and revenue expenditure offers ample opportunities to find efficiencies on the costs of school WLC.

9.2.3 Capital expenditure and productive investment

The distinction between capital expenditure and capital investment from one perspective will depend on the beliefs of those allocating scarce resources for capital works. If public clients commissioning PSA facilities believe that sums spent will provide additional return above and beyond the mere provision of *capacity*, then it may be considered as *investment*. By this classification, it might be said that the underlying justifications for much of the sums spent under capital programmes suggests these were indeed investments. This is especially so for school capital works given the *educational transformation* policy goal of BSF. In light of results on outcomes above, there seem many examples where these investments did not achieve their intended returns. At the portfolio level, given the limited sample of schools analysed, returns seemed sufficient to justify the programme investment.

9.2.3.1 Prioritising investment

The James review highlighted that despite BSF having the intention to renew all secondary comprehensives, initial capital grants were allocated based on readiness for delivery of capital projects.

> "Multiple funding streams diverted funds to those most adept at winning bids rather than necessarily to those in most need."
>
> James review, 2011, p5.

This included the need to have a Local Enterprise Partnership established to deliver BSF *waves*, as the mandated mechanism for delivery of programme investments. While this might have seemed a sensible process for allocating capital at the time, it may be a less than optimal approach if the goal

was to radically improve the EA of schools. Hindsight suggests greater prioritisation was warranted, the results of which could have been drastically different to those witnessed here.

The *potential* to improve EA is in part determined by the school level performance relative to national average levels. While the schools analysed in this work tended to have below average levels of attainment, there was considerable variance in prior attainment. With capital grants more scarce following the financial crisis in recent years, if grants are to be awarded in pursuit of improving outcomes (motive A), then it's allocation should be much more focused on those schools in greatest need of improvements in their facilities, and not just those with lowest prior attainment.

The processes for prioritising capital investment within government are of increased importance given the contrasting nature between long-lived assets and short time periods of capital programmes. BSF was highly ambitious given the 20 year timespan of its intended delivery. The eventual reality that well less than a quarter of the works were undertaken, before its cancelation by the incoming coalition government in 2010, should provide an example for future programmes.

Despite efforts to improve data on PSA estates, the application of estate level information is limited for helping prioritise capital investment in PSAs. PSBP 1 still entailed individual schools and local authorities bidding for capital grants, despite centralised and costly survey's (£20m+) being available for reference as to facilities state of repair. Good signs are emerging though in terms of using PDSP data for allocating capital grants for PSBP 2, but the timeliness of data collection and use across government is an area of key concern beyond DfE. Where the justification for capital investment is not in pursuit of remedial works (motive B), much more reliable evidence must be used to justify pursuit of improved outcomes. This is clear given the result above that the prospect for their improvement is highly risky, uncertain and often subject to factors well beyond the influence of capital investment programmes and wider policy.

A system of relying on applications for capital grants to a range of different funding streams from schools and local authorities seems to be a less than optimal process, as made clear by the James review's findings. If it is a means of rationing limited capital grants, it might be considered effective. If it is a means to prioritising capital grants to projects in most need, this will depend highly on the

uniformity and extent of school and local authority abilities to generate compelling business cases, regardless of the underlying need for investment.

PFI seems to be the only long-term institutional arrangement that can tie the hands of governments in term of their allocation to capital investment in and maintenance of PSAs. The trade off in terms of lack of flexibility in on-going budgeting on F (impacting on S), along side the limited WLC improvements to counter higher private finance charges, is an expensive trade off inherent in the PFI procurement method. The need for more flexible models is apparent, though new models will be subject to the requirements of private capital providers if they are to invest through them.

The opportunity for LAs to borrow themselves through Pubic Works Loan Board is still the conventional public finance alternative to private finance. Given historically low cost of capital for public borrowing, there is a unique (if not persistent) envelope for public investment.

There will no doubt exist better VfM interventions to achieve improvement in EA levels than a programme like BSF, especially given that it was intended to deliver capital investment to *all* schools. Finding those schools that are of greatest potential to benefit from capital investment may be identifiable through further analysis of centralised datasets. Such work might look to find the common characteristics in schools that seem to benefit most from recent investments.

9.2.3.2 Procurement

The higher cost of private capital in PFI procurement is clearly an impediment to it's wider adoption and the future use of this form of procurement method. This thesis has provided a range of ex post evaluations on PFI facilities and provides evidence that PFI procurement does not seem to cost any more or less when considering the full range of expenditures relating to c and f. That said, procurement does seem to matter for particular types of service, notably catering where private provision is associated with lower operational cost and as good or better service quality. This is seemingly not the case in cleaning services, leading to the suspicion that private provision may be more able to reduce cost and improve quality in services which are more capital (less labour) intensive.

The consideration of how the public sector might best manage the inheritance of large swathes of estates on completion of the numerous PFIs in operation is surprisingly not a topic the literature has seemingly considered much. The potential for sale and lease back type agreements, should the client feel they are achieving better VfM than they might achieve taking these assets back in-house, should be an area for attention for policy makers.

Equity incentives for the SPV will bear on the pursuit of investment in operations. The requirement for increased equity investment in future PF2 projects should serve to increase these incentives. The procuring authorities might benefit in the future by understanding this impact, especially if they intend to consider the pursuit of WLC savings as a viable defense against the higher costs of capital involved in applying this procurement method.

Establishing common indicators of asset condition remains an imperative on the principle of *what gets measured, gets managed*. This is pertinent for assessing the efficacy of alternative procurement methods given the role of asset maintenance that underpins a key source of value from use of PFI. It is concerning that in the recent years of fiscal austerity, the collection and collation of the data necessary for analysis of public estates and the forms of procurement used in to deliver capital investment has suffered. Policy makers and estate managers should resist such temptations to save on the cost of data collection. The investment made by the DfE in the PSDP programme serves as a good example of how a focus on data can feed back into informing future capital investment programmes.

The scaling back of capital programmes in schools and hospital PSAs following the GFC has also witnessed a change in the motives for capital allocations. More recent programmes have tended to move away from motive A (alteration and improvement) and considerable expansion via motive C (increased capacity towards minimal necessary additional capacity and particularly B (dealing with backlog maintenance). The motive for capital works should be reflected in the procurement methods being chosen. This movement towards lower capital project dealing with backlog maintenance is partly why the use of private finance has reduced, given its unsuitability in dealing with capital works of type B (with the inherent risks of refurbishment projects). The role of private finance in future public procurement is still in question, with very few PF2 projects having reached

financial close following the 2012 policy re-launched compared to the height of the PFI programme in 2005-2009.

9.2.3.3 Removal of Soft FM services in PF2

The decision of the UK coalition government to remove soft FM services from the PF2 procurement methods remains questionable, especially given the emphasis placed on the operational innovations that PFI projects are supposed to deliver. The evidence above suggests the performance of such services within operational PFI contracts are at least as good, often better, in terms of value for money than those seen in conventionally procured facilities. The reduction of the operational scope of future PF2 projects will necessarily mean that the potential returns from *investment in operations* are materially reduced, given the sizable proportion of the UC payment that goes to pay for soft FM services in present contracts (figure 5.1). This will have a negative effect on the potential for, and pursuit of WLC reducing innovations. These services will now be provided in-house or separately outsourced, incurring separate additional transaction costs and adding an interface risk in the delivery of facility operations.

9.2.3.4 Reflections on the maturity of PFI towards PF2

The development of PFI in the UK has been something of a learning curve, especially in aspects of timely procurement given the considerable length between OJEU to financial close, which has been a factor in the higher transactions costs. The typically much lower period from financial close to commissioning suggests projects are reaching operations promptly, as acknowledged by the NAO in numerous studies (NAO, 2003; National Audit Office, 2009b). Key issues such as balance sheet treatment, as well as the distribution of considerable financial savings via gain share mechanisms on re-financings serve as good examples of how this policy has adapted to become more acceptable for continued application. However, the implications for balance sheet treatment from these mechanisms remains a potential barrier for more *acceptable* terms for privately financed investment in PSAs.

9.3 Recommendations

The recommendations from this thesis will focus first on where data and methods may be improved for better evaluation of past capital programmes applying alternative methods, as well as involving different forms of capital work. The role of central government in being the *steward of data* on PSAs and estates is discussed. Finally, recommendations around the specific areas of outcomes, PFI procurement and sampling hospital PSA investments are provided.

9.3.1 Data and methods

Complete evaluation of returns on capital investment in long-term built assets requires consistent data collection throughout their creation and operational life. Data is an asset that depreciates in terms of value, as a source of timely insight, more quickly than other forms of fixed asset such as buildings. To improve the evidence base for policy decisions, including those concerning capital investment as forms of crucial decision, any and all data on PSA estates is required to inform the design of programmes. This thesis has demonstrated that this is done to varying degrees within the public sector. There is a worrying paucity of data in some aspects of costs and benefits of PSA ownership and operation, but good practice is emerging.

The information on both school and hospital PSA estates has been poor and incomplete in recent years, especially in regard to backlog maintenance and asset condition. One obvious factor in this is the devolved nature of their management with few centralised resources serving to benchmarking on-going operational cost or performance. For data collection efforts to have value, users must trust in and agree to be judged by common metrics. Where data quality is questionable, users doubt the ability to make decisions on the information it delivers. This has happened in recent years with regard to central PSA estate monitoring functions, but there are promising signs and pockets of developing excellence where resources have been dedicated to improve data and information. DfE's PDSP programme and the recent Cabinet Office construction cost benchmarking reports serving as good examples of estate wide data collection and cross sectoral analysis.

In terms of guiding the general approach to better use of collated data about PSA estates, two alternatives emerge as potentially useful tools for future capital allocation decision making.

1. Aggregate estate deterioration models – these would measure the current capital stock and define that required to estimate the resulting necessary investment for new capacity and maintenance expenditure.
2. A rate of return from marginal investment model – given the considerable effort and expense of the former approach, an alternative model might seek to prioritise capital investment allocation based on estimated rate of return.

Where as the former approach above might concentrate on timely and detailed monitoring of the whole estate for means of identifying where particular PSAs are in need of capital works, the latter would focus on the flows of costs associated with operation (without the additional cost of continual PSA condition surveys), as a more timely basis for allocating investment to upwardly constrain operating costs. This would involve a move towards a more advanced view of minimising WLC across estates, rather than at the single PSA level. It would entail capital programme allocation based on identifying schools and hospitals where observed operating costs depart significantly above benchmarked averages. Those that are witnessed to cost significantly more are investigated and become potential recipients for investment to reduce on-going costs if. Those that are witnessed to cost significantly less will serve as opportunities for case studies for best practice in WLC optimisation. As ever, the particular characteristics of each PSA must be borne in mind.

Recommendation 1: Consider the implications for alternative WLC minimising strategies between individual PSAs and over whole estates.

Recommendation 2: Apply centralised cost databases (such as CFR, ERIC) to identify those facilities operating significantly above / below average cost for means of prioritising capital investment and finding examples of best practice on PSA operational management.

Capital investment seeking to reduce on-going operational cost will constitute motive B, dealing with backlog maintenance in building elements in the worst states of repair. Such programmes would be in contrast to the early stated intention of the BSF programme to *renew the whole estate*, and intentionally so. PDSP data collected between 2012 and 2014 was not applied in the allocations for PSBP 1, but has been consulted for allocations in the PSBP 2. Opportunities for further insight

from more intensive analysis of CFR and DEC data are apparent, most notably concerning energy costs. Such data may reveal non-PSA asset characteristic determinants of cost and performance, with opportunity for behavioural studies and interventions designed to manage down high operating cost facilities.

The Macpherson review of government modeling highlighted numerous concerns about attempts to understand the risks and uncertainties of cost and benefits. The key recommendation from this report is in '*promoting a culture of effective quality assurance for business critical models*'. Instilling a culture is not a short-term goal and will require many years of effort to achieve. As part of instilling this culture, it is necessary that public sector analysts re-assess what data is currently available and then next, where the gaps exist in data to generate information for *crucial decisions*. This will provide quick wins to inform the estimation and assumptions inherent in the modelling of capital investments, without additional efforts to collect more data.

9.3.2 Centralised function as data lead

The Cabinet Office 2015 (and earlier) construction cost benchmarking efforts represent a genuine step change in the level of within and between programme level analysis. The collation of these analyses proves that when government is able to co-ordinate the input from multiple programmes, insightful information can be assembled to inform future programmes. Unfortunately, just as this initiative was gaining traction and a head of steam, it seems efforts have been re-directed and no further reporting of such detail has been published. Such efforts should be re-prioritised, not least to ensure that the data is being collated and consulted, but also to ensure transparency across departments on the performance of large scale capital programmes.

The Cabinet Office analyses have revealed that recent capital works are coming in at lower cost than previous programmes. Caution is advised in interpreting these as improvements in government procurement practices, given that more recent works have typically been lower specification in austere budgeting environments, and that supply chains during the post GFC period may be more price competitive resulting from low construction demand generally. For better like for like comparisons of CAPEX (C) per facility, further details on the specification of built PSAs is required to make reliable assessment on VfM.

Recommendation 3: Replicate the recent efforts of the Cabinet Office in pursuit of better CAPEX analysis and push these further to consider OPEX (f and s) information on the cost of PSA ownership and operation. Particular effort should be given to identify factors in operational cost, such as age and form of the particular PSA, as well as its condition and operational management regimes.

Recommendation 4: Analysis is needed to understand how f and s vary with capacity utilisation, for means of advising on the cost savings that can be had if, for example, pupils on roll reduce in a more competitive system of educational provision.

A side effect of increasing the plurality of providers through increased contestability has been to make centralised datasets more difficult to collate and maintain. The lack of transparency in public procurement processes and the lower requirement for academy and foundation trusts to report data to the centre are examples of this. With policies that seek to devolve and transfer responsibility for public service delivery comes the potential trade off in transparency. With the eventual responsibility for provision in the case of failure always falling back on the public sector, failure to monitor the operations of quasi-public providers risks being unprepared for when providers fail or are deemed unfit for purpose.

Recommendation 5: Government should consider the implications for central data collection of more contestable regimes of provision and alternative procurement methods. Where standard monitoring of alternative methods, such as PFI, is considered too onerous or in breach of commercial confidentiality, separate efforts should be made to consider more sympathetic means of monitoring cost and performance.

9.3.3 Whole life cost

There is a clear need to continue to amass data and analysis of the costs of ownership and operation of PSAs specifically, and built assets more generally. With the fiscal austerity of recent years set to continue, there remain opportunities to find efficiencies across estates with use of centralised cost and performance datasets. Some of low hanging fruit of public efficiencies have been plucked since the GFC. Detailed estate data will help in identifying where more focused interventions might be made to reduce the costs of PSA investment and maintenance.

Definitions of asset lives vary significantly within and between building types. The goal of recent capital programmes was for school buildings aimed at achieving asset lives of 60 years. This is useful for new stock, but a diverse legacy estate by age and condition requires criteria by which existing stocks of PSA are managed, maintained and when appropriate, retired and replaced.

Recommendation 6: Clarification on what determines asset lives of existing and new PSAs. Programme definitions should make clearer the reasons behind prioritising investment between ensuring fitness for purpose (motive A), preventing deterioration / obsolescence (motive B) and capacity additions (motive C)?

9.3.4 PDSP and collating schools data

It is clear that evaluation of the cost and performance of PSAs, as well as the outcomes of their users, are difficult to isolate from contextual factors. This is especially the case with relatively small samples of data on PSAs and partial coverage over estates. PDSP data collected by the EFA from 2012 is a good example of where data collection has been invested in and has fed into the allocation of capital and design of programmes in the case of PSBP 2. While PDSP surveys only provided a snapshot of the physical state of school buildings, the opportunities for additional research on the role of physical environments on educational outcomes and WLC remain. The collation of PDSP data alongside EA data would offer a unique insight into the role of physical environment on outcomes.

9.3.5 Outcomes in schools

The dynamics of EA are clearly complex. While the school level EA trajectory following capital investment seems to suggest some improved performance associated with the intervention, there is likely some reversion to the mean driving this observation. Further work is needed to monitor the EA performance of the set of schools identified as receiving capital investment to monitor the longer-term dynamics of outcomes following capital investment. More detailed analysis might look to control for pupil cohort effects and even look at within schools variance in EA through access to the national pupil level database. This may reveal differences in the way students of varying Sociodemographic background respond to improved environments, and through inductive

research, help develop new theories about how learning environments affect pupils and their achievement.

Recommendation 7: Additional analysis to control for regression to the mean for EA before and after renewal. This would help isolate the specific capital intervention drivers of EA. This work would also look to isolate Hawthorne effects before capital interventions. Both efforts might draw on control samples for schools with similar starting levels of EA that did not subsequently receive capital investment.

Recommendation 8: Longer time series studies are required to inform the development of the decay function concept applied in the method to value change in EA. This would entail looking back at the schools considered above (and others identified to have received capital investment) in 3-5 years from now to observe the longer-term path of EA relative to national average.

Recommendation 9: Model alternative scenarios for valuing changes in EA. This would include changing the wage premiums and FE & HE participation rates from those based on historical observation to reflect more recent observations and adjusted expectations about the future.

A notable benefit from the application of the above large sample quantitative methods are in informing future qualitative study sampling. It is proposed that for case studies seeking insight on the determinants of outcomes and the potential returns from investment in operations, they might draw on the approaches presented to guide purposeful sampling approaches. If facilities can be identified at the headline level as those achieving (or not) the desired intentions of capital interventions, this can allow case studies to focus on PSAs that offer greatest potential insight.

Recommendation 10: Case study and qualitative research on particular schools whose path of EA change is of particular interest, including those where capital investment was associated with large increases in EA, as well as those where EA reduced significantly.

9.3.6 Hospital investment evaluation

There is currently no systematic way to collate data from the few sources on hospitals construction, operations and their outcomes as there is for the school estate. This has limited the development of insights on the WLC of hospitals PSAs.

Recommendation 11: Improve facility level statistics across the range of WLC and value concepts for hospitals. Efforts might initially look to collate Trust level accounts for headline expenditures, with further investigation looking to attribute these to particular PSA facilities within the Trust. Further, this work will require access to healthcare outcomes data below the trust level for particular hospitals, to allow similar analyses to those achieved through analysis of EA.

The challenge of valuing changes in healthcare outcomes from any policy intervention, be it about investing in the facility or otherwise, is a much more difficult task than for analysing EA. This is in part due to the diversity of the services provided across different facilities, as well as the greater heterogeneity of patients when compared to school pupils. Further research should first seek to establish reasonable WLC ratios for the main types of healthcare facilities as a more achievable goal, and serve as a means of developing an appropriate framework for valuing healthcare outcomes.

Recommendation 12: Develop comparable WLC (and value) ratio concepts for hospital PSAs – a focus on complete new builds of 1 type of hospital, such as acute, would help provide focus and applicability for the stylised ratios. For establishment of C values, access might be sought to data behind recent Cabinet Office benchmarking reports.

9.3.7 Private finance procurement

Limited evidence for reduced WLC of PFI procured PSAs suggests continued skepticism of the benefits of private finance is warranted. Government should be clearer on the criteria used to assess the merits of private finance with greater transparency needed on past contracts, PSCs processes and monitoring of on-going operations. Criteria should align with the type of capital works envisaged in the initial OBC for the investment. It should not be based on accounting classification as to whether projects are on or off balance sheet for national accounting practices.

Recommendation 13: That government make clearer the criteria to be used to assess the relative merits of future procurements involving private finance, and make available the PSCs that have lead to the choice of PFI or conventional procurement.

Bibliography

Adair, J.G., 1984. The Hawthorne effect: A reconsideration of the methodological artefact. Journal of Applied Psychology 69, 334–345. https://doi.org/10.1037/0021-9010.69.2.334

Addis, B., Talbot, R., 2001. Sustainable construction procurement: a guide to delivering environmentally responsible projects. CIRIA, London.

Akerlof, G.A., 1970. The Market for "Lemons": Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics 84, 488. https://doi.org/10.2307/1879431

Allen Consulting Group, 2007. Performance of PPPs and Traditional Procurement in Australia. Infrastructure Partnership Australia, Sydney, Australia.

Aneurin Grant, Robert Ries, 2013. Impact of building service life models on life cycle assessment. Building Research & Information 41, 168–186. https://doi.org/10.1080/09613218.2012.730735

Armstrong, G., 2005. Preferred bidder price creep in the UK PFI market (MSc dissertation). University College London, London.

Arrow, K.J., 1969. The organization of economic activity: issues pertinent to the choice of market versus nonmarket allocation. The analysis and evaluation of public expenditure: the PPB system, Joint Economic Committee. 1, 59–73.

Baddeley, M., 2003. Investment: theories and analysis. Palgrave Macmillan, Basingstoke, Hampshire.

Barber, S.M., 2017. Delivering better outcomes for citizens: practical steps for unlocking public value (No. ISNB 978-1-912225-21-7). London.

Barras, R., 2009. Building cycles: growth & instability, Real estate issues. Ames, Iowa : Wiley-Blackwell, Chichester, U.K.

Barrett, P., Zhang, Y., Davies, F., Barrett, L., 2015. Clever classrooms: summary report of the HEAD project (holistic evidence and design).

Barrett, P., Zhang, Y., Moffat, J., Kobbacy, K., 2013. A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. Building and Environment 59, 678–689. https://doi.org/10.1016/j.buildenv.2012.09.016

Baumol, W.J., Bowen, W.G., 1965. On the performing Arts: The Anatomy of Their Economic Problems. The American Economic Review 55, 495–502.

Bennett, J., Iossa, E., 2006. Building and managing facilities for public services. Journal of Public Economics 90, 2143–2160. https://doi.org/16/j.jpubeco.2006.04.001

Bhaskar, R., 2010. Reclaiming Reality: A Critical Introduction to Contemporary Philosophy. Taylor & Francis.

Blanc-Brude, F., Goldsmith, H., Valila, T., 2006. Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement (SSRN Scholarly Paper No. ID 1104070). Social Science Research Network, Rochester, New York.

Bridge, A., Young In, S., Rowlinson, S., 2015. Models for engaging Public-Private Partnerships in civil infrastructure projects: a case of "having your cake and eating it too"? Presented at the Engineering Project Organization Conference, Edinburgh.

Britton, J., Dearden, L., Shephard, N., Vignoles, A., 2016. How English domiciled graduate earnings vary with gender, institution attended, subject and socioeconomic background (IFS Working Paper No. W16/06). IFS.

Cabinet Office, 2015. Construction Cost Reductions, Cost Benchmarks & Cost Reduction Trajectories to March 2015. London.

Cabinet Office, 2014. Construction Cost Reductions, Cost Benchmarks & Cost Reduction Trajectories to March 2014. London.

Chang, C.-Y., Ive, G., 2007. The hold-up problem in the management of construction projects: A case study of the Channel Tunnel. International Journal of Project Management, 25, 394–404. https://doi.org/10.1016/j.ijproman.2007.01.001

Chidambaram, B., 2013. Frischmann, B.M. (2012). Infrastructure - The Social Value of Shared Resources. Oxford/New York: Oxford University Press. International Journal of the Commons 7. https://doi.org/10.18352/ijc.386

Coase, R.H., 1937. The Nature of the Firm. Economica 4, 386–405. https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

Codinhoto, R., Health and Care Infrastructure Research and Innovation Centre, 2008. The effects of the built environment on health outcomes: research report. HaCIRIC, London.

Construction Industry Council, 2000. The role of cost saving and innovation in PFI projects. Published for the Construction Industry Council by Thomas Telford Pub., London.

Cook, D.L., 1962. The Hawthorne Effect in Educational Research. The Phi Delta Kappan 44, 116–122.

Crace, J., 2010. Michael Gove may underestimate impact of surrounding on pupils. The Guardian.

Cribb, J., Joyce, R., Keiller, A., 2017. The UK labour market: where do we stand now? (Briefing Paper No. BN197). Institute for Fiscal Studies.

Crocco, M., 2002. The concept of degrees of uncertainty in Keynes, Shackle and Davidson. Cedeplar, Universidade Federal de Minas Gerais.

de Valance, G., 2010. Innovation, Procurement and Construction Industry Development. Australasian Journal of Construction Economics and Building 10, 50–59.

Deakin, N., Walsh, K., 1996. The enabling state: the role of markets and contracts. Public Administration 74, 33–47. https://doi.org/10.1111/j.1467-9299.1996.tb00856.x

Debande O., 2002. Private financing of transport infrastructure: an assessment of the UK experience. Journal of Transport Economics and Policy 36, 355–387.

Department for Communities and Local Government, 2015. Improving the energy efficiency of our buildings: A guide to display energy certificates and advisory reports for public buildings.

Dept. for Business, Innovation and Skills, 2013. Tender price indices 2013 Quarter 2.

Dept. for Education, 2014a. Edubase.

Dept. for Education, 2014b. GCSE and equivalent results: 2012 to 2013 (revised).

Dept. for Education, 2013. Key Stage 2 results - Attainment tables.

Dept. for Education, 2012. Level 2 and 3 attainment by young people in England (Statistical No. SFR 05/2012), Children, Education and Skills. Dept. for Education, London.

Dept. for Education, 2010. A technical guide to contextual value added (including English and Maths) Key stage 2-4: 2010 model. London.

Dept. for Education and Employment, 2001. Press notice 2001-0023: Research findings show better buildings boost performance.

Dept. for Education and Skills, 2007. Better buildings, better design, better education: a report on capital investment in education. DfES, London.

Dept. for Education and Skills, 1998. Building bulletin - briefing framework for secondary school projects (Policy guidance).

Dept. of Health, 2008. From Deep Clean to Keep Clean (No. 289225). London.

Dickerson, A.P., Vignoles, A., 2007. The distribution and returns to qualifications in the Sector Skills Councils. Sector Skills Development Agency, Wath-upon-Dearne.

Dixit, A.K., Pindyck, R.S., 1994. Investment under uncertainty. Princeton University Press, Princeton, N.J.

Durbin, B., Yeshanew, T., 2010. BSF school report, B+ for attendance but C- for attainment.

Earl, P.E., 1995. Microeconomics for business and marketing: lectures, cases, and worked essays. E. Elgar, Aldershot, Hants, England ; Brookfield, Vt.

EC Harris, 2006. Indicative Building Costs - Cost updated to 3rd quarter 2006.

Eccles, R.G., Williamson, O.E., 1987. The economic institutions of capitalism: firms, markets, relational contracting. Administrative Science Quarterly 32, 602. https://doi.org/10.2307/2392889

Edkins, A., Ive, G., Murray, A., 2011a. Written evidence submitted to the Treasury Committee review of the Private Finance Initiative.

Edkins, A., Ive, G., Murray, A., 2011b. Operating the renewed school estate - an insight into cost and PFI. Presented at the RICS COBRA, Salford University.

Education and Skills Committee, 2007. Sustainable schools: are we building schools for the future?, seventh report of session 2006-07, Vol. 1: Report, together with formal minutes (No. HC 140-1). The Stationery Office, London.

Education Funding Agency, 2016. Priority School Building Programme: overview. URL https://goo.gl/wTOsLx (accessed 4.20.15).

Education Funding Agency, 2015. Property data survey programme: summary report. London.

Education Funding Agency, 2012. Property data survey programme: Survey manual part 3. London.

Edwards, P., Association of Chartered Certified Accountants (Great Britain), 2004. Evaluating the operation of PFI in roads and hospitals. Certified Accountants Educational Trust, London.

Evans, R., Haryott, R., Haste, N., Jones, A., 1998. The long term costs of owning and using buildings. Royal Academy of Engineering.

Fitzgerald, P., 2004. Review of Partnerships Victoria provided infrastructure. Growth Solutions Group, Melbourne.

Fourie, J., 2006. Economic Infrastructure: A Review of Definitions, Theory and Empirics. South African Journal of Economics 74, 530–556. https://doi.org/10.1111/j.1813-6982.2006.00086.x

Frontier Economics, 2012. Systematic Risks and opportunities in UK infrastructure. London.

Garrett, R., Mason, G., 2010. The value of skills: an evidence review (No. 22). UK Commission for Employment and Skills, Wath-Upon-Dearne.

Goh, B.H., Sun, Y., 2016. The development of life-cycle costing for buildings. Building Research & Information 44, 319–333. https://doi.org/10.1080/09613218.2014.993566

Gollier, C., 2002. Time Horizon and the Discount Rate. Journal of Economic Theory 107, 463–473.

Grout, P., 1997. The economics of the private finance initiative. Oxford Review of Economic Policy 13, 53–66. https://doi.org/10.1093/oxrep/13.4.53

Hart, O., 2003. Incomplete Contracts and Public Ownership: Remarks, and an Application to Public-Private Partnerships. The Economic Journal 113, C69–C76. https://doi.org/10.1111/1468-0297.00119

Hart, O., Moore, J., 1990. Property Rights and the Nature of the Firm. Journal of Political Economy 98, 1119–1158.

Hart, O., Shleifer, A., Vishny, R.W., 1997. The Proper Scope of Government: Theory and an Application to Prisons. Quarterly Journal of Economics 112, 1127–1161. https://doi.org/10.1162/003355300555448</p>

Health and Social Care Information Centre, 2015. Hospital Estates and Facilities Statistics.

Higher Education Funding Council for England and Wales, 2010. Trends in young participation in higher education: core results for England (No. 2010/03).

Hirschman, A., 1958. The Strategy of Economic Development. Yale University Press, New Haven.

HM Government, 2003. Every child matters. Stationery Office, London.

HM Treasury, 2015a. PFI signed projects list March 2015.

HM Treasury, 2015b. Review of The Aqua Book: Guidance on Producing Quality Analysis for Government.

HM Treasury, 2014. Assessing Business Cases "A Short Plain English Guide."

HM Treasury, 2012. A new approach to public private partnerships.

HM Treasury, 2011. The Green Book: appraisal and evaluation in central government.

Hodge, G., Greeve, C., 2009. PPPs: the passage of time permits a sober reflection. Economic Affairs 29, 33–39. https://doi.org/10.1111/j.1468-0270.2009.01864.x

House of Commons Education and Skills Committee, 2007. Sustainable Schools: Are we building schools for the future? - Seventh report of Session 2006-7, HC 140-1.

House of Commons Treasury Committee, 2011. Private Finance Initiative - Seventeenth Report of Session 2012-12 (No. HC 1146).

Hughes, W., Ancell, D., Gruneberg, S., Hirst, L., 2004. Exposing the myth of the 1:5:200 ratio relating initial cost, maintenance and staffing costs of office buildings. Presented at the 20th Annual ARCOM Conference, ARCOM, Reading, pp. 373–81.

International Organization for Standardization, 2017. ISO 15686-5:2017(en), Buildings and constructed assets — Service life planning — Part 5: Life-cycle costing.

Iossa, E., Martimort, D., 2008. The Simple Micro-Economics of Public-Private Partnerships. Centre for Economic and International Studies 6.

Ive, G., 2006. Re-examining the costs and value ratios of owning and occupying buildings. BRI 34, 230–245.

Ive, G., 2004. Chapter 16: Private Finance Initiative and the management of projects, in: The Wiley Guide to Managing Projects.

Ive, G., Chang, C.-Y., 2007. The principle of inconsistent trinity in the selection of procurement systems. Construction Management and Economics 25, 677–690.

Ive, G., Gruneberg, S., 2000. The Economics of the Modern Construction Sector. Palgrave Macmillan.

Ive, G., Murray, A., Edkins, A., Rintala, K., 2010. Cost and Performance comparison of PFI and Non-PFI Healthcare Infrastructure in England, in: 3rd Annual Conference of the Health and Care

Infrastructure Research and Innovation Centre. Presented at the Better Healthcare through better infrastructure, Edinburgh, pp. 88–102.

Ive, G., Murray, A., Marsh, R., 2015. Cost and value ratios of operating renewed English secondary schools. Building Research & Information 43, 465–485. https://doi.org/10.1080/09613218.2015.1021143

Ive, G., Rintala, K., 2006. Economics of relationships; managing opportunities and constraints, in: The Management of Complex Projects: A Relationship Approach. Wiley-Blackwell.

James, S., 2011. Review of Education Capital. Department for Education.

Keynes, J.M., 1936. The General Theory Of Employment, Interest, And Money, 1st ed.

Kirkham, R., Boussabaine, A.H., Awwad, B., 2002. Probability distributions of facilities management costs for whole life cycle costing in acute care NHS hospital buildings. Construction Management & Economics 20, 251–261. https://doi.org/10.1080/01446190110113701

Knight, F.H., 2009. Risk, uncertainty and profit. Signalman, Kissimmee, Fla.

Knight, F.H., 1921. Risk, Uncertainty and Profit. University of Chicago.

KPMG, 2010a. PPP Procurement - Review of Barriers to Competition and Efficiency in the Procurement of PPP Projects (No. QLDN05698CF). KPMG, Australia.

KPMG, 2010b. The impact of school renewal - Analyzing the evidence, Infrastructure Spotlight Report. KPMG, UK.

Laws, R.H.D., 2015. Priority schools building programme. Parliament.tv, London.

Leckie, G., Goldstein, H., 2016. The evolution of school league tables in England 1992 - 2016: 'contextual value added', 'expected progress' and 'progress 8' (Working paper No. 02/2016). University of Bristol, Bristol.

Leckie, G., Pillinger, R., Jenkins, J., Rasbash, J., 2010. School, family, neighbourhood: which is most important to a child's education? Significance 7, 67–70. https://doi.org/10.1111/j.1740-9713.2010.00421.x

Leiringer, R., 2006. Technological innovation in PPPs: incentives, opportunities and actions. Construction Management and Economics 24, 301–308. https://doi.org/10.1080/01446190500435028

Lodge, G., Rogers, B., 2006. Whitehall's black box: accountability and performance in the senior civil service. Institute for Public Policy Research, London.

Macpherson, N., 2013. Review of the quality assurance of Government analytical models: final report (No. PU1404). HM Treasury, London.

Medawar, P.B., 1982. Plato's Republic. Oxford University Press, Oxford.

Ministry of Justice, 2015. Cost per place and cost per prisoner. National Offender Management Service Annural Report and Accounts 2014-15. (Management Information Addendum.). Ministry of Justice.

Ministry of Justice, 2014. Talks begin over contracts to tackle re-offending. URL https://www.gov.uk/government/news/talks-begin-over-contracts-to-tackle-reoffending (accessed 4.22.14).

Mohammadi, A., Murray, A., Edkins, A., 2013. Value for Money in Hospital Facilities Management: The Evidence. The Infrastructure Forum.

Mott Macdonald, 2002. Review of Large Public Procurement in the UK. London.

Mumford, M.J., 1998. Public projects, private finance: understanding the principles of the private finance initiative. NPV+ from Griffin Multimedia, Welwyn Garden City.

Murray, A., Ive, G., Edkins, A., 2013. Integrated procurement and whole life cost: a graphical representation of the relative benefits of alternative procurement methods, in: CIB Congress 2013. Brisbane.

Murray, A., Mohammadi, A., Ive, G., 2014. Comparing alternative procurement operations - the case of hospital soft FM services in England. Presented at the International Conference on Construction in a Changing World, Sri Lanka.

Naderi, H., 2015. Investigating delay in the delivery of PFI projects (MSc dissertation). UCL, London.

NAO, 2012. Equity investment in privately financed projects.

NAO, 2003. Improving the PFI tendering process.

National Audit Office, 2017. Capital funding for schools (No. HC 1014). London.

National Audit Office, 2016. Financial sustainability of schools.

National Audit Office, 2015. The choice of finance for capital investment. London.

National Audit Office, 2014. The financial sustainability of NHS bodies (No. HC 722). London.

National Audit Office, 2013. Review of the VFM assessment process for PFI.

National Audit Office, 2010a. Financing PFI projects in the credit crisis and the Treasury's response.

National Audit Office, 2010b. The performance and management of hospital PFI contracts. Stationery Office, London.

National Audit Office, 2009a. Performance of PFI Construction.

National Audit Office, 2009b. Private Finance Projects: A paper for the Lords Economic Affairs Committee.

National Audit Office, 2007. Benchmarking and market testing the on-going services component of PFI projects.

National Audit Office, 2005. Darent Valley Hospital: The PFI contract in action.

National Audit Office, 2003. PFI: Construction Performance.

National Patient Safety Agency, 2010. Patient Environment Action Team dataset 2010.

National Patient Safety Agency, 2007. The national specification of cleanliness in the NHS: a framework for setting and measuring performance outcomes (No. 0000JULY05).

Office of Budget Responsibility, 2017. Pubilc Sector Finances historic databank.

ONS, 2006. Including finance lease liabilities in public sector net debt.

Organisation for Economic Co-operation and Development, 2011. Education at a glance, 2011 OECD indicators. OECD, Paris.

Palmer, K., 2000. Contract issues and financing in PPP/PFI (Do we need the 'F' in 'DBFO' projects?).

Partnerships for Schools, 2009. Schools Building Survey.

Pollock, A.M., 2002. Private finance and "value for money" in NHS hospitals: a policy in search of a rationale? British Medical Journal 324, 1205–1209. https://doi.org/10.1136/bmj.324.7347.1205

Pollock, A.M., Price, D., Player, S., 2007. An examination of the UK Treasury's evidence base for cost and time overrun data in UK value-for-money policy and appraisal. Public Money and Management 27, 127–134.

Porter, M.E., Thomas, L., M.D., 2013. The Strategy That Will Fix Health Care. Harvard Business Review.

PricewaterhouseCoopers LLP., 2003. Building better performance: an empirical assessment of the learning and other impacts of schools capital investment (No. 407). Dept. for Education and Skills Publications, Annesley, Nottingham.

PriceWaterhouseCoopers LLP, 2001. Building performance: an empirical assessment of the relationship between schools capital investment and pupil performance (No. 242). Dept. for Education and Employment, Annesley.

Pritchett, L., 2000. The Tyranny of Concepts: CUDIE (Cumulated, Depreciated, Investment Effort) Is not Capital. Journal of Economic Growth 5, 361–384.

Public Accounts Committee, 2011. Forty Fourth Report: Lessons from PFI and other projects (No. 44). London.

Rintala, K., 2009. PFI in schools building - does it influence educational outcomes? (Industry No. RRD-129963), Infrastructure Spotlight Report. KPMG, London.

Rintala, K., 2005. The economic efficiency of accommodation service PFI projects. Technical Research Centre of Finland, Espoo.

Rintala, K., 2004. The economic efficiency of accommodation service PFI projects. University College London, London.

Rintala, K., Root, D., Ive, G., Bowen, P., 2008. Organizing a bidding competition for a toll road concession in South Africa: The case of chapman's peak drive. Journal of Management in Engineering 24, 146–155.

Rioja, F.K., 2003. Filling potholes: macroeconomic effects of maintenance versus new investments in public infrastructure. Journal of Public Economics 87, 2281–2304. https://doi.org/10.1016/S0047-2727(01)00200-6

Robinson, H., Scott, J., 2009. Service delivery and performance monitoring in PFI/PPP projects. Construction Management and Economics 27, 181–197.

Runde, J., 1991. Keynesian uncertainty and the instability of beliefs. Review of Political Economy 3, 125–145. https://doi.org/10.1080/09538259100000039

Runeson, G., 1997. The role of theory in construction management research: comment. Construction Management and Economics 15, 299–302. https://doi.org/10.1080/014461997373033

Shackle, 1988. Business, Time and Thought. Palgrave Macmillan UK, London. https://doi.org/10.1007/978-1-349-08100-4

Shackle, G.L.S., 1974. Keynesian kaleidics; the evolution of a general political economy. Edinburgh University Press Aldine Pub. Co, [Edinburgh] [Chicago.

Shackle, G.L.S., 1938. Expectations, investment, and income. Humphrey Milford, Oxford University Press, London.

Shaoul, J., 2005. The Private Finance Initiative or the Public Funding of Private Profit?

Shaw, G.B., 2008. Getting Married. NuVision Publications.

Shleifer, A., 1998. State versus private ownership. National bureau of economic research.

Simmonds, D., 2015. Priority schools building programme. Parliament.tv, London.

Smith, A., 1776. The Wealth of Nations.

Smyth, H., Edkins, A., 2007. Relationship management in the management of PFI/PPP projects in the UK. International Journal of Project Management 25, 232–240.

Standard & Poors, 2013. Key Credit Factors for the Engineering and Construction Industry. (Credit Rating Methodology No. 1693780 | 300067985).

Taleb, N.N., 2007. The Black Swan: The Impact of the Highly Improbable. Random House Publishing Group.

UK Commission for Employment and Skills, 2010. UK employment and skills almanac 2009. UKCES, [London].

University Hospital Birmingham NHS Foundation Trust, 2006. Birmingham New Hospitals Project - Full Business Case.

Value for Money Drivers in the Private Finance Initiative, 2000. . Arthur Andersen Enterprise LSE.

Walker, I., Zhu, Y., 2013. The impact of university on the lifecycle or earning: some further analysis (BIS Commission No. 112). BIS.

Wang, J., 2008. Comparative performance of UK PFI and non-PFI hospitals, in: Transformation through Construction. Presented at the CIB, Dubai.

Weitzman, M., 1998. Why the Far-Distant Future Should be Discounted at its Lowest Possible Rate. Journal of Environmental Economics and Management 36, 201–208.

Williams, J.J., Hong, S.M., Mumovic, D., Taylor, I., 2014. Using a unified school database to understand the effect of new school buildings on school performance in England. Intelligent Buildings International 1–18. https://doi.org/10.1080/17508975.2014.931834

Williamson, O.E., 1981a. The economics of organization: The transaction cost approach. American journal of sociology 548–577.

Williamson, O.E., 1981b. The economics of organization: The transaction cost approach. American Journal of Sociology 548–577.

Williamson, O.E., 1979. Transaction-Cost Economics: The Governance of Contractual Relations. Journal of Law and Economics 22, 233–61.

Wing Yin, L., 2008. Elaboration analysis of the relationship between delivery model and educational attainment (MSc dissertation). University College London, London.

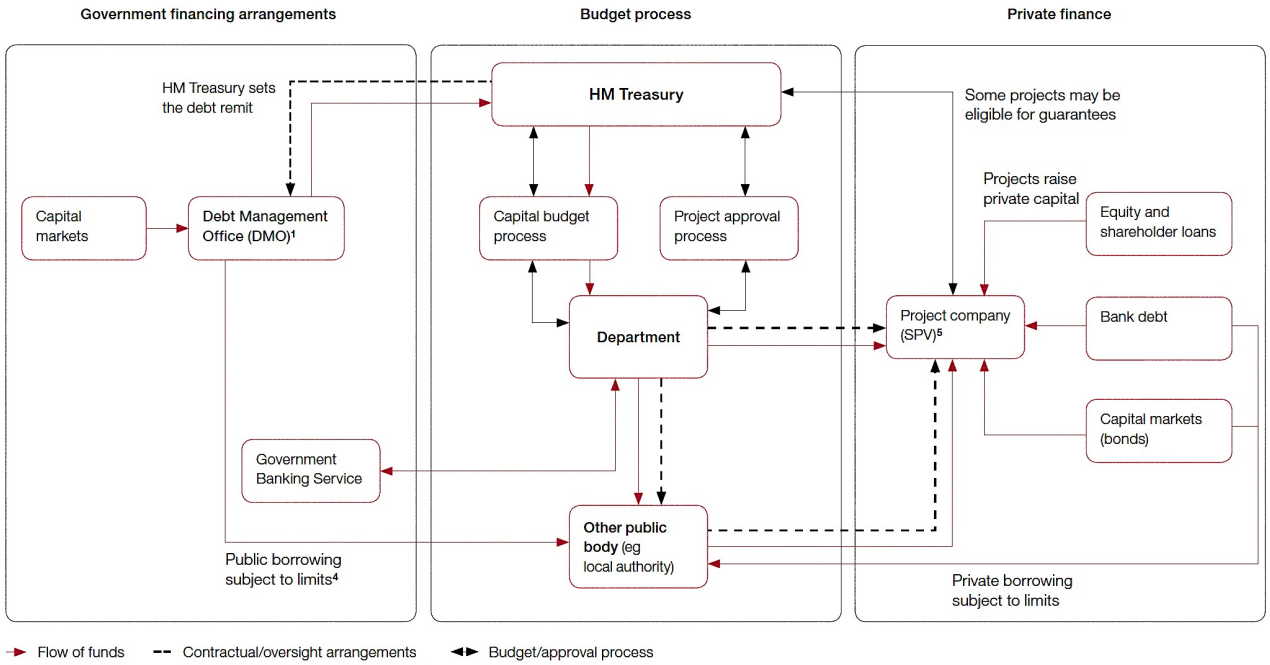
Yescombe, E.R., 2002. Principles of project finance. Academic Press.

Appendices

Appendix 1: Organisations involved in capital investment and financing decisions. Source: NAO, 2015, fig. 12.

Figure 12

Organisations involved in capital investment and financing decisions



Notes

1 The DMO provides debt and cash management activities on behalf of HM Treasury.

2 Most government revenue is from taxation rather than borrowing. In addition National Savings and Investments provides funds via retail investors. There are also supranational lenders eg the European Investment Bank. This chart does not include these activities.

3 Guarantees and borrowing powers are not available in all circumstances. The public bodies which have the ability to borrow are not under direct central government control (eg local authorities, foundation trusts).

4 The Public Works Loan Board (administered by the DMO) makes loans to local authorities using funds from the National Loans Fund.

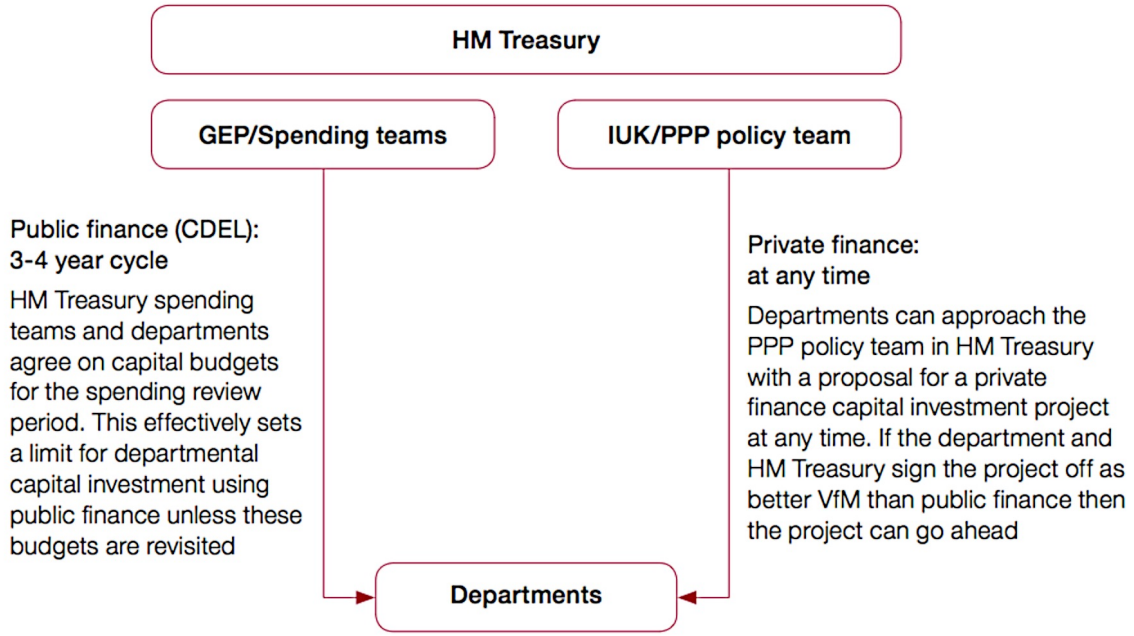
5 Department/Public body agrees PFI/PF2 contract with the Special Purpose Vehicle (SPV) and pays unitary charge.

Source: National Audit Office analysis

Appendix 2: Public and private finance investment approval process. Source: NAO, 2015, fig. 13.

Figure 13

Public and private finance investment approval process



Notes

1 Capital budgets are often increased outside of the spending review period but increases are typically relatively small in comparison to overall budgets so this generally provides limited extra flexibility.

2 GEP: General Expenditure Policy; IUK: Infrastructure UK; PPP: Public-Private Partnerships.

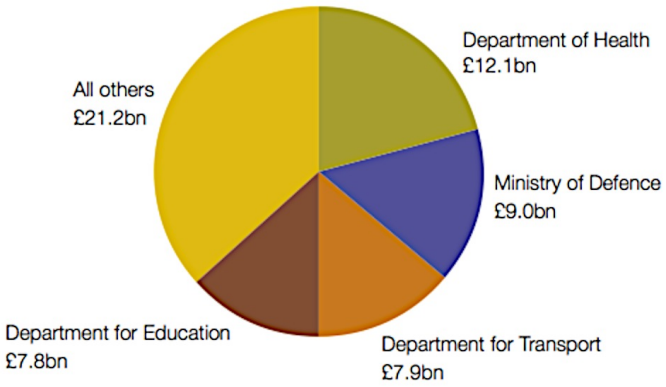
Source: National Audit Office analysis

Appendix 3: Use of private finance, by department and project type. Source: NAO, 2015, fig. 8.

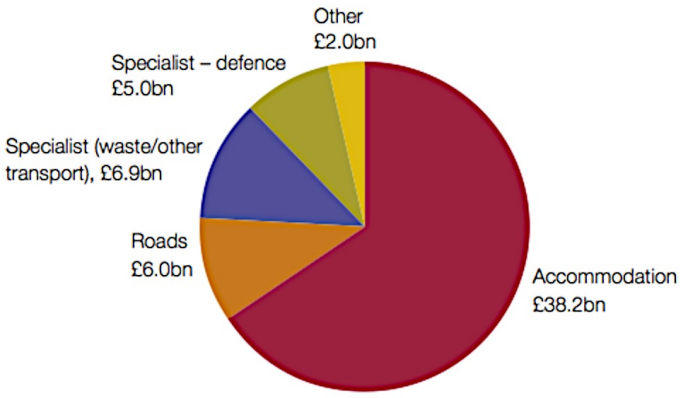
Figure 8

Use of private finance, by department and project type

Projects by department (£bn)



Private finance projects by type (£bn)



Notes

1 Projects are valued according to their capital value.

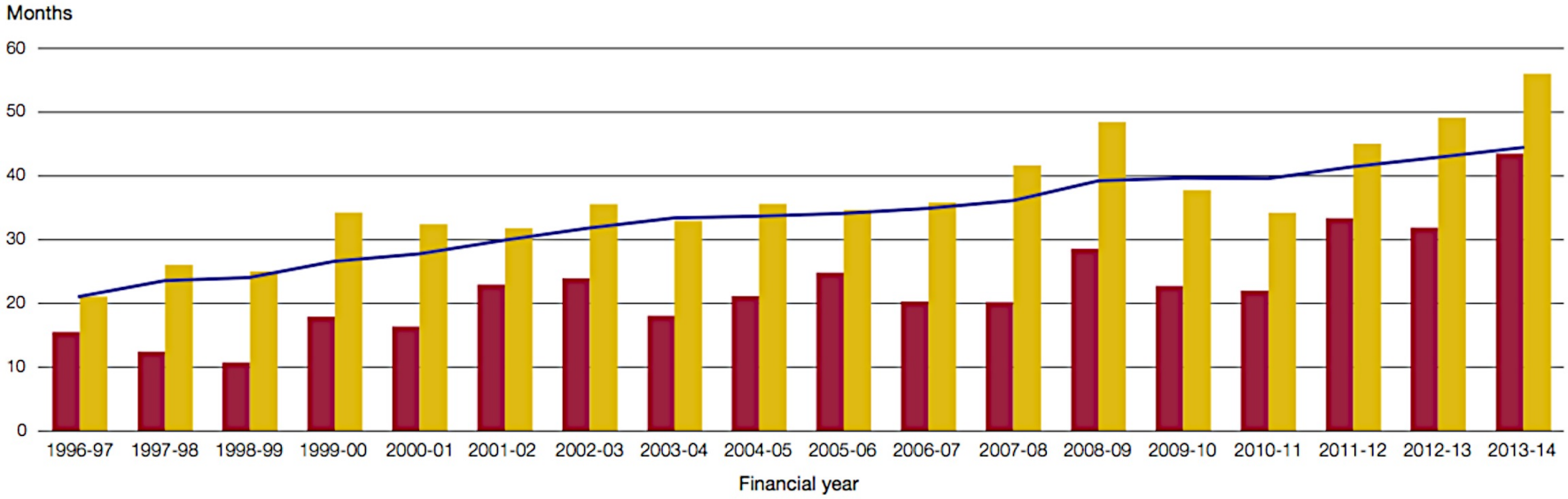
2 Accommodation includes military barracks so these have not been included in the Specialist – defence category.

Source: National Audit Office analysis of HM Treasury PFI database (updated 15 December 2014)

Appendix 4: Private finance procurement length. Source: NAO, 2015, fig. 17.

Figure 17

Private finance procurement length



Note

1 OJEU: *Official Journal of the European Union*, a publication in which all public sector contracts with a value exceeding a certain threshold must be published.

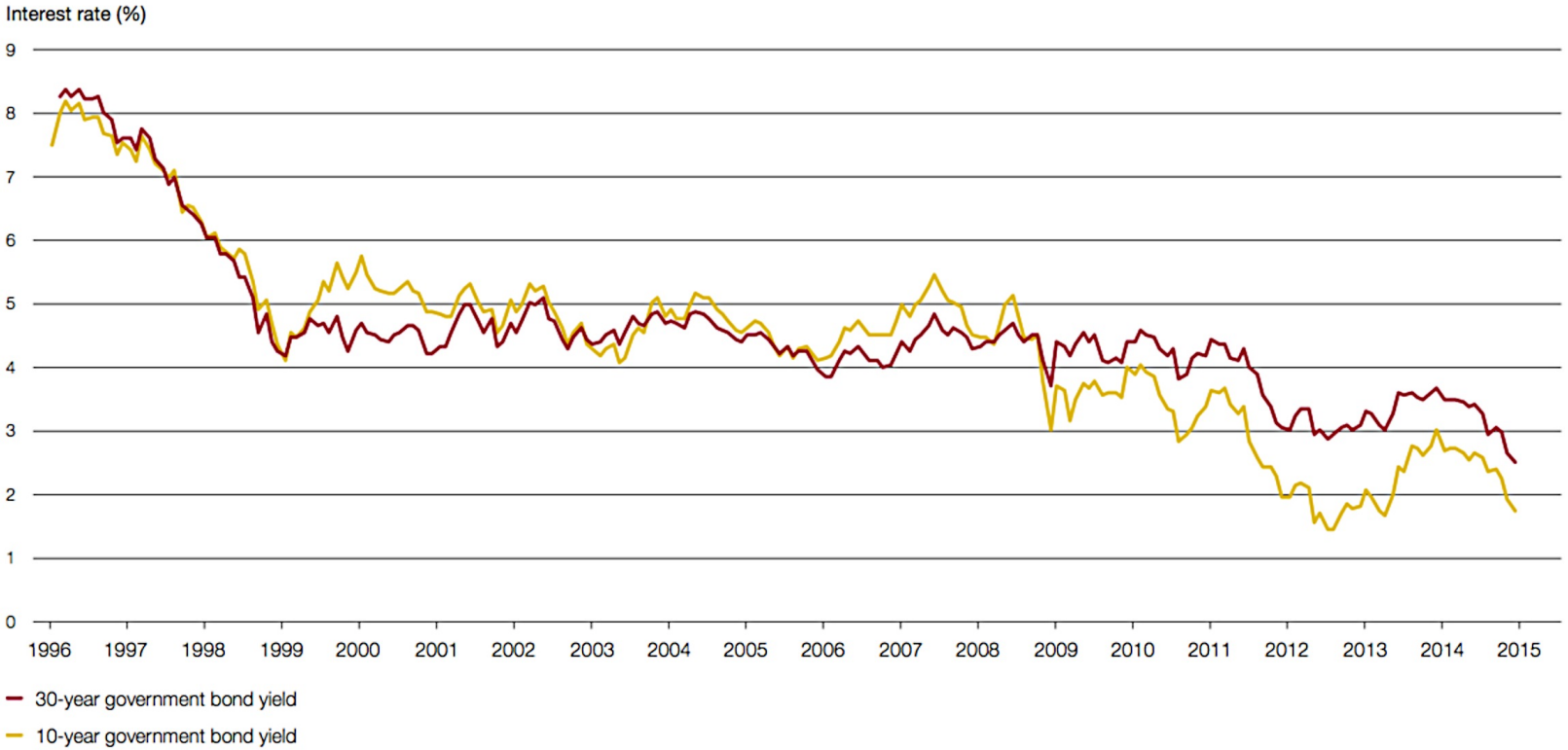
Source: HM Treasury PFI database (updated 15 December 2014)

Appendix 5: Government borrowing costs. Source: NAO, 2015, fig. 21.

Figure 21

Government borrowing costs

The government borrowing costs have reduced in the past 20 years

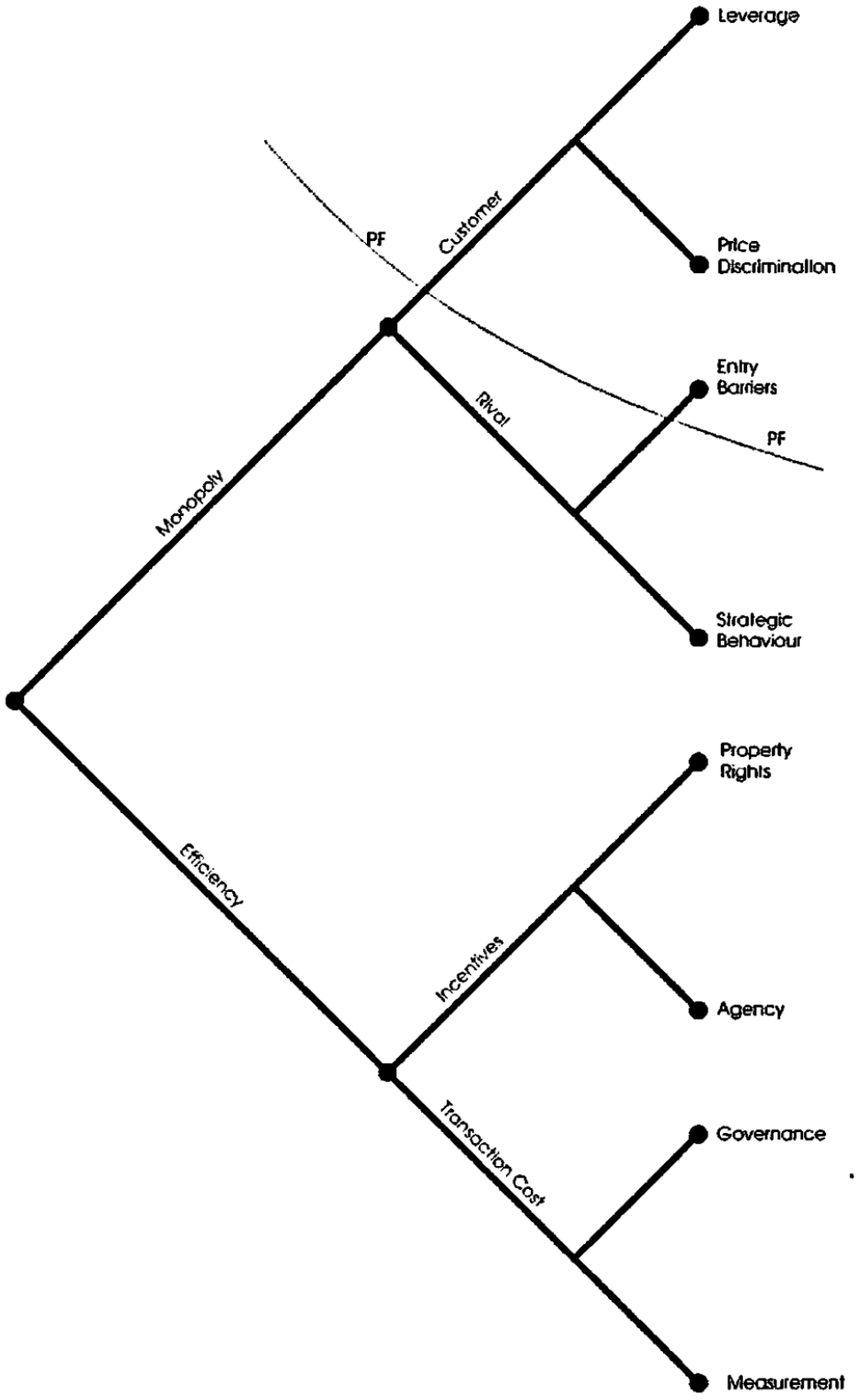


Note

1 The Debt Management Office issues gilts with a range of maturities. The average is around 15 years.

Source: Bloomberg

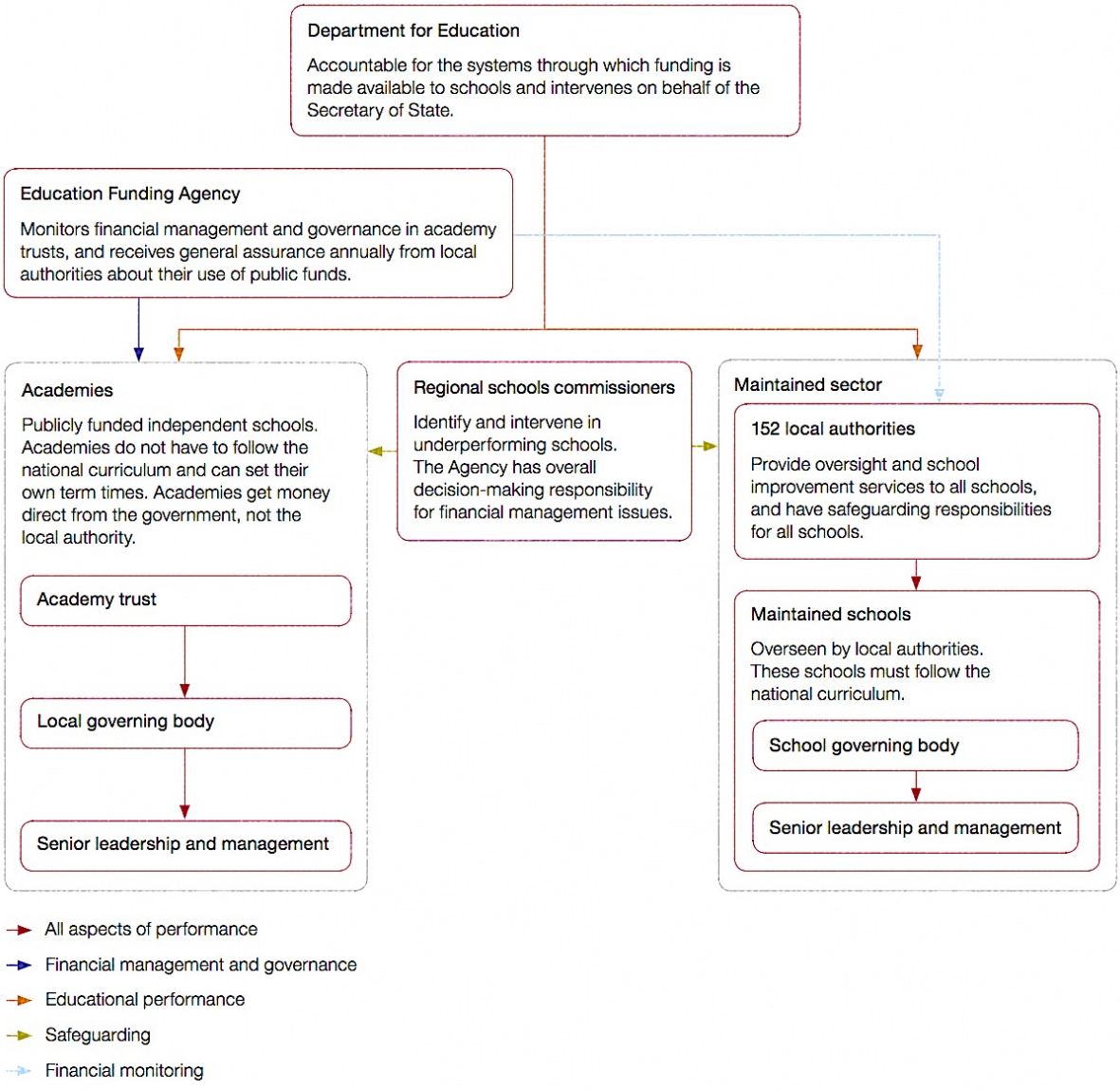
Appendix 6: The TCE tree. Source: Williamson, 1981b.



Appendix 7: Roles and responsibilities of the main organisations involved in schools financial sustainability. Source: NAO, 2016, fig. 1.

Figure 1

Roles and responsibilities of the main organisations involved in schools' financial sustainability

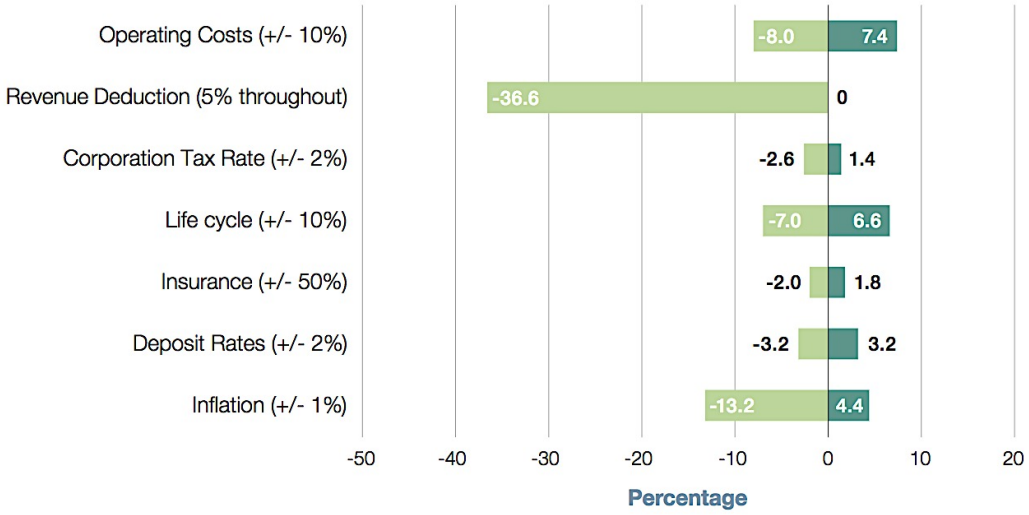


Source: National Audit Office analysis of Department for Education and Education Funding Agency material

Appendix 8: Sensitivity of returns to risks retained during operational stage. Source: NAO, 2012, fig. 5.

Figure 5

Sensitivity of returns to risks retained during the operational stage



NOTES

1 The project financial model has been run for the cost increases or decreases shown, which are percentage points for corporation tax, deposit rates and inflation.

2 The revenue deduction of 5 per cent, shown above, is after any recovery from contractor(s).

3 For changed deposit rates, see paragraph 2.8. Life-cyle risk is discussed in paragraph 2.11.

4 Under some contracts, changes in insurance costs may be shared with the Authority.

5 Investors usually have part of the agreed price linked to a price index, but may not be fully protected.

Source: Reproduced with permission from HICL Infrastructure Company Limited Report to investors, 23 September 2010

Appendix 9: Space allocations for school facilities. Source: Dept. for Education and Skills, Building Bulletin, 1998.

Key Formulae for Middle Deemed Secondary and Secondary Schools

N = number of pupil places

Minimum Building Areas	9–13 middle schools	11–16 secondary schools	11–18 secondary schools
basic teaching	50 + 2.5N	50 + 3N	200 + 3.06N
halls	250 + 0.3N	600 + 0.3N	600 + 0.3N
learning resources	50 + 0.2N	75 + 0.25N	125 + 0.29N
staff and administration	75 + 0.24N	125 + 0.3N	125 + 0.31N
storage	100 + 0.29N	175 + 0.35N	200 + 0.36N
dining and social	25 + 0.1N	25 + 0.2N	100 + 0.26N
'float'	150 + 0.17N	250 + 0.3N	250 + 0.32N
TOTAL NET BUILDING AREA	**700 + 3.8N**	**1300 + 4.7N**	**1600 + 4.9N**
LIKELY GROSS BUILDING AREA	**1000 + 5.4N**	**1850 + 6.7N**	**2250 + 7N**

Minimum Site Areas	All middle schools and secondary schools (except confined sites)	Middle and secondary schools in confined sites
pitches	10000 + 35N	provided 'off-site'
soft informal and social	800 + 2.5N	600 + 2.5N
games courts (hard surfaced)	600 + 2N	2000 (MUGA)
hard informal and social	400 + 1.5N	200 + 1N
habitat	200 + 1N	0.5N
'float'	1000 + 5N	remainder of site
TOTAL NET SITE AREA	**13000 + 47N**	**2800 + 4N minimum**
LIKELY SITE AREA: from	**14000 + 52N**	**4000 + 5N**
to	**16000 + 59N**	**5000 + 6N**

These formulae are the basis of the graphs later in the document. They can be used for schools where there are (approximately) the same number of pupils in each year up to Year 11. Gross area figures are approximate to allow an easy 'rule of thumb'. The stay-on rate is assumed to be 62.5% in the 11-18 schools. If the number of pupils in each year is not the same or the sixth form stay-on rate is different, the table below should be used to determine the correct formula.

Appendix 10: Questions raised for respondents to the House of Commons Educational Select Committee's hearing on the Priority School Building Programme, March, 2015.

- How the allocation of funding under the PSBP has affected schools, including those who were due to receive funding under the Building Schools for the Future programme
- The impact on schools in need of repair or rebuilding that have not received funding
- The experiences of schools who received funding under phase 1 of the programme.
- The value for money of the PSBP compared to Building Schools for the Future