Measurement of Health System Performance

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Abstract

Objective of this PhD thesis is to investigate new ways of measuring health system performance. First, we focus on the development of an output index for healthcare. Four key challenges are involved: (1) correct identification of healthcare output and (2) of its quality characteristics, (3) addressing the issues relating to the existence of technological progress, and (4) identification of a way of weighting different goods and services into a single index. We develop an output growth measure that takes into account and tries to address all four key challenges. We calculate cost weighted output indices both by NHS sector and for the NHS as a whole.

Second, we investigate whether it is feasible to develop a model of output and productivity growth for a single programme of care. Using the output index developed in part I, we calculate output and productivity growth measures for all circulatory diseases in England, for the time period 1998/99 – 2003/04. We explore the use of patient reported health outcome measures for two procedures. We use average unit costs data to account for inputs used in the production process. We find that output growth for hospital treatment of all circulatory diseases has increased when quality characteristics are taken into account, which also results in annual improvements in physical productivity.

Third, we investigate the impact of devolution on income-related inequality in health and inequity in the delivery of healthcare in England, Wales and Scotland by means of a concentration index. Health is captured through three measures of self-assessed health. The utilisation of healthcare resources is proxied by GP consultations, outpatient visits and inpatient stays. We find that after devolution no clear pattern of change in income-related inequality in health and inequity in healthcare utilisation.

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A mio papà e mamma,
Senza dubbio

Ad Adriana,
il mio primo e più grande amore

Sam and George
Alessandro
Maia
Charlotte
Kiera
Sonia
And to all children
because Yours is the future

"I sogni son desideri chiusi in fondo al cuor..."
Cenerentola – Walt Disney

"It's not because things are difficult that we dare not venture. It's because we dare not venture that they are difficult."
Seneca – Roman Philosopher

"And now, the end is near
And so I face the final curtain.
My friend, I'll say it clear,
I'll state my case, of which I'm certain."
My way – F. Sinatra

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All mistakes, omissions, and inaccuracies are my sole responsibility.

Data from the *General Household Survey* (GHS) were provided by the ESDS Government Data Archive. Data from the *Hospital Episode Statistics* (HES) were provided by NHS Health and Social Care Information Centre, on license from the Department of Health. Data from the *National Schedule Reference Costs* are accessible on line. Health outcome data on patient reported health status were made available by a private health insurer and a Hospital Trust. Neither the original collectors of the data nor the suppliers bear any responsibility for the analysis or interpretations presented here.

Declaration

The analysis presented in Part I is a revised version of a research which has led to the publication of various pieces of work:

Dawson, D., Gravelle, H., O'Mahony, M., Street, A., Weale, M., Castelli, A., Hardman, G., Jacobs, R., Kind, P., Martin, S., Stevens, P., Stokes, L., Developing new approaches to measuring NHS outputs and productivity, Centre for Health Economics, University of York, Centre for Health Economics Research Paper 6, pp. 216, 2005.

Castelli, A., Dawson, D., Gravelle, H., Street, A., The challenges of measuring government output in the healthcare sector, *Social Policy Review* 17, p. 183-202, 2005.

Castelli, A., Dawson D., Gravelle H., Jacobs R., Kind P., Loveridge P., Martin S., O'Mahony M., Stevens P., Stokes L., Street A. and Weale M., A new approach to measuring health system output and productivity, National Institute Economic Review, No. 200, p. 105-117, 2007.

This chapter has been built from research carried out by a number of researchers both in CHE and at the National Institute for Social and Economic Research. My contribution towards the initial research spanned all the diverse aspects and stages of a typical research process, contributing towards both the development of the new methodology and the carrying out of the empirical analysis. This latter aspect proved to be crucial in fine-tuning the final formulation of the output growth index, which is in its current form very data dependent. My understanding of the way the computation needs to be carried out is one the most critical tasks in developing an index of output growth. Further, I have carried out the extensive data collection and collation, the calculation of the cost weighted output index, and drafting of various reports and papers. In this chapter, I have extensively re-estimated the overall NHS output growth index, adding a novel analysis by NHS setting, which is a major step in understanding the various components that feed into the overall NHS output growth index. A summary paper of the main findings of our research has been presented at the 6th European Conference on Health Economics, Budapest, in 2006.

The empirical analysis presented in Part II is a revised and extended version of previously published pieces of work:

> Castelli, A. and P.C. Smith, "Circulatory disease in the NHS: measuring trends in hospital costs and output", Centre for Health Economics Research Paper 21, pp. 68.
>
> Castelli, A. and P.C. Smith, "Treatment of circulatory disease in the NHS – Measuring trends in hospital costs and output", published by Health Foundation – QQUIP – Quest for Quality and Improved Performance.

The paper has also been presented at the *Health Economist's Study Group Meeting* in Norwich, January 2008. This chapter has been built from research I carried out with a colleague of mine and which has lead to two publications. In the original work, my contribution has been equal to that of my co-author regarding the development of the original idea, although the collection, collation and analysis were mainly carried out by me as well as the writing of the first and successive drafts. Further and more importantly in this chapter, I have added a section measuring hospital productivity of circulatory diseases, as well as carrying out an extensive sensitivity analysis to check the validity of methods used. These two aspects were carried out by me only and are not included in the publications mentioned above.

The empirical analysis presented in Part III has been developed by me. I have chosen the methodological approach, collected the data and conducted the empirical analysis. It has been presented at the *International Health Economics Association conference*, Barcelona, in 2005.

Introduction

The concern with measuring health system performance and health care is not recent. As early as the 1860s, Florence Nightingale concerned herself with recording patients leaving her care as relieved, unrelieved or dead. Since then, it has become increasingly important to collect, analyse and disseminate information on health system outcomes data in order to understand and improve performance (OECD, 2002). Different stake-holders, from national accounts, to policy-makers and all those that are usually responsible for the provision, funding and regulating of the production and provision of healthcare services, are usually interested in finding ways of assessing the impact of government policies. The principal reason to measure health system performance derives from the very goal of each public health system: to deliver **equitable, efficient,** and **effective** healthcare services to patients that need them, in a **timely** manner and with **dignity** (Naylor *et al.*, 2002). It is, therefore, extremely important to be able to use available information to assess the impact that different government policies have or may have on any of the goals that a health system pursues.

This PhD thesis is divided into two distinct areas of research. In the first (Part I and II), we address the measurement of health system performance in terms of how efficient and productive a health system is, or otherwise; whether the extra financial resources spent in the NHS, for example, have produced value for money. In the second (Part III), we explore whether the objectives in terms of equitable treatment of patients who are in need of care are affected by changes in the political administration of the National Health Service.

The first area of research focuses its attention on the English NHS; firstly by developing a new output index with which to estimate whole system output growth. Such macro measures of productivity are important when deciding how much public money to devote to the NHS, and in holding the NHS to account. Secondly, recognising that it is also important to gain an understanding of the productivity of individual programmes of care, so as to ensure that resources are allocated efficiently within the NHS, we examine 'macro' level productivity at the national level for a single programme of care – circulatory disease – in the hospital setting.

The second area of research deals with the impact of policy reforms that occur at an even more 'macro' level, as they have been implemented by the national government and have potential impacts on the National Health Services of England, Scotland and Wales.

Hence, this thesis addresses the issue of measuring health system performance from three different points of view: 1) the 'macro' national level of analysis of the health system in England, Scotland and Wales, 2) the analysis of one particular health system: the English NHS; and finally 3) the analysis of a one component of a health system: a single programme of care.

A summary of the content of each Part of this PhD thesis is presented below.

Part I *"Measuring government output: the case of Health"* focuses on the development of an output index for healthcare. Four key challenges are involved when measuring output growth. First, it is necessary to identify and quantify healthcare output correctly. Second, even if it is possible to count these output, it is difficult to measure their quality. In particular, two aspects need to be resolved: 1) identifying what constitutes the quality of healthcare, and 2) develop a way of incorporating these quality characteristics into an output growth index. Third, technological progress changes healthcare output continuously, with new treatments and drugs, but also with new ways of delivering existing services. Fourth, some means of weighting different goods and services is required in order to aggregate them into a single index. We develop an output growth measure that takes into account and tries to address all four key challenges. As data on quality characteristics of NHS care are currently available only for hospital inpatient services, and for some specialties of outpatient visits, we present output growth estimates, both quality-adjusted and unadjusted, first by NHS sector. This allows us to investigate and understand how different quality indicators impact on the measure of output growth. We then proceed in calculating and discussing the overall NHS output growth measure.

Part II – *"Circulatory disease in the NHS: measuring hospital output and productivity"* investigates whether it is feasible to develop a model of output and productivity growth for a single programme of care: circulatory diseases. As early as 1962, Scitovsky recognised the importance of measuring costs of a whole episode of care, proposing to develop indices that would not count the costs of items such as drugs, physicians' visits, etc, but would aim at determining the costs of the **complete treatment of individual illnesses.** Consistent with Scitovsky, the US literature on disease-specific and patient-based healthcare output and price indices focuses on the direct measurement of medical costs of treating an episode of illness. We use the output index developed in part I to calculate output measures for all circulatory diseases in England, for the time period 1998/99 – 2003/04. A series of diagnosis and procedures falling under the classification of circulatory diseases are identified and mapped to Healthcare Resource Groups (HRGs), which constitute the unit of account of the hospital data used in this chapter. Hospital output is adjusted for survival rates, both 'in-hospital' and 'in-hospital and 30-days post discharge'. We explore the use of patient reported health outcome measures for two procedures – coronary bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) – to highlight the potential of introducing more general health outcomes into the output growth index. We use average unit costs data from Reference Costs to account for inputs used in the production process for the treatment of all circulatory diseases. Finally, we determine productivity growth for circulatory diseases.

Part III "Equity in the delivery of healthcare in Great Britain: the impact of decentralisation" investigates the impact of devolution on equity in the delivery of healthcare in the constituent countries of Great Britain: England, Wales and Scotland. So it is using performance measurement to explore policy impact. Decentralisation of the health care sector has received substantial attention as a policy reform in the last decade or so in many countries. Even so, the effects of this reform are neither thoroughly investigated nor completely understood. We believe that in public health systems, there is the risk that equity will be undermined by a policy of decentralisation. In particular, decentralisation of the health care sector can jeopardise equity if individuals who are "equal" in every respect but the 'jurisdiction' in which they happen to live are treated differently than they would be in a more centralised structure. In 1998 the Labour Government passed an important reform which transferred political power and

responsibilities from Westminster to Scotland, Wales and Northern Ireland. Health is the most important responsibility that has been devolved to constituent countries in the UK, representing about 70 per cent of the budget that the devolved governments have control over. Prior to devolution, health services in the constituent countries of the United Kingdom were administered as part of the National Health Service, which was designed to achieve common standards across the whole of the UK. However, since devolution, each constituent country has been granted freedom to organise aspects of their NHS differently, subject to overarching criteria and constraints. Data are taken from the General Household Surveys (GHS) administered in 1995/96 and 2001/02. In particular, we test for income-related inequity in health care utilisation within and across the three constituent countries of Great Britain, by means of a concentration curve index. The level of health is captured through different measures of self-assessed health. The utilisation of primary and secondary care is proxied by GP consultations, outpatient visits and inpatient stays. Self-assessed health, however measured, and the utilisation of health care resources is standardised by age and sex for individuals reporting morbidity, following the direct standardisation methodologies outlined in O'Donnell and Propper (1991).

1 Measuring government output: the case of Health

The first part of this thesis addresses the issue of the measurement of government output, and in particular of the healthcare sector. It is of great relevance not only for the National Accounts but also to policy-makers who are usually responsible for provision, funding and/or regulating these public goods and services. There are a number of challenges involved in this, which we address in this chapter. We propose a quality adjusted index formulation for the measurement of the NHS output. In Section 1.2 we define price and output indices. An overview of the issues relating to the measurement of government output in general is presented in Section 1.3. The challenges in government output measurement are then addressed for health system output in Section 1.4. In Section 1.5 we introduce the methodology used in measuring the output of the English health system. Data sources and variables used to calculate the quality adjusted cost weighted output index (CWOI) are briefly described in Section 1.6.We then address the issues of how to determine healthcare output and its quality characteristics in Section 1.7. Cost weighted output indices by sector and for the NHS as a whole are presented in Section 1.8, followed by conclusions and implications for policy and future research.

1.1 Introduction

The government is a major actor in every economy. Its functions span from setting policies, to forming and maintaining social structures, to collecting taxes, and redistributing resources. Most governments also have an extensive role in the provision and/or financing of a wide range of goods and services. In particular, governments provide public goods and services which are of two types: collective goods and services and individual goods and services. The former comprise goods and services provided to society as a whole, whereas the latter include goods and services that are consumed, generally, on an individual basis. Government provision and expenditure on collective services are justified by their status as public goods, which people can neither be

excluded from nor abstain from consuming (Myles, 1995). National defence is the classic example. For the countries shown in Table 1-1, government spending on collective services averages about 30 per cent of total government spending and about 15 per cent of GDP. The UK spends less than the average of these countries, spending proportionately less on general public services but more on defence.

Table 1-1 - Government expenditure in selected EU countries (2004)

	Countries									
	United Kingdom		Germany		Spain		France		Italy	
Government expenditure	% of Govt exp	% of GDP	% of Govt exp	% of GDP	% of Govt exp	% of GDP	% of Govt exp	% of GDP	% of Govt exp	% of GDP
Collective services										
General public services	9.8	4.2	12.9	6.1	12.3	4.8	13.6	7.2	18.6	8.9
Defence	5.9	2.5	2.4	1.1	2.8	1.1	3.7	1.9	2.9	1.4
Public order and safety	5.9	2.5	3.5	1.7	4.7	1.8	2.5	1.3	4.0	1.9
Economic affairs	6.2	2.7	7.8	3.7	13.4	5.2	5.6	3	8.0	3.8
Environment protection	1.7	0.7	1.0	0.5	2.2	0.9	1.5	0.8	1.8	0.8
Individual services										
Health	15.8	6.7	13.0	6.1	14.1	5.5	13.7	7.3	14.0	6.7
Education	13.7	5.8	9.0	4.3	11.3	4.4	11.6	6.2	9.6	4.6
Social protection	36.5	15.6	46.7	22	33.4	13	41.7	22.2	37.7	18
Housing and community amenities	2.2	0.9	2.3	1.1	2.1	0.8	3.4	1.8	1.5	0.7
Recreation, culture and religion	2.3	1	1.3	0.6	3.6	1.4	2.7	1.4	1.8	0.9
Total	100	42.7	100	47.1	100	38.9	100	53.2	100	47.7

Source: Eurostat online (2008) (http://epp.eurostat.ec.europa.eu)

Although not explicitly mentioned in the table above, it is worth noting that some health expenditures are on collective services including amongst others public and environmental health services.

A larger proportion of government spending is on individual goods and services such as healthcare, education, social protection, recreation services, and cultural services, which together account for an average of 31% of GDP for these countries. A common justification of government provision of such services is that, left to the market, there would be general under-provision or socially unacceptable inequalities of access. Of these individual services, government expenditure on social protection is the largest category, incorporating such things as sickness, disability, housing and unemployment benefits. The UK government spends proportionately more on health and education than the other European countries where there may be a higher proportion of private expenditure on these services.

In recent years there has been considerable international interest in finding ways of examining the efficiency and effectiveness of public services. The interest in measuring the output and efficiency of government services is not, however, new. From the early 1960s up until the end of 1990s, the output of the public sector in all national accounts, as well as in the UK, was valued simply by adding up expenditure on inputs, an approach termed the "output=input" convention.

This approach had the advantage that it bypassed the measurement and the valuation of non-market goods and services. However, three main drawbacks are associated with this method. First, it is circular and self-justifying. The value of output produced by the public sector is determined by the amount of resources the government decides to spend on producing or purchasing public goods and services. Second, any improvements in the production process that make it less costly, say, to produce the same amount of goods/services will necessarily appear as a reduction in the output. For example, if the introduction of a new drug allows for patients to be treated more cost-effectively without being admitted to hospital, the convention of equating inputs to outputs would show a fall in the "output" of the health system because total expenditure appears to have fallen. Thirdly, the output=input conventions necessarily implies that the government sector is characterised by constant (zero) productivity growth.

The inadequacy of this convention led to recommendations from international bodies such as the United Nations and Eurostat for the development of measures of government "outputs" using methods that are independent of expenditure on inputs (Worldbank, 1993; Eurostat, 1995). A system of accounts was introduced in Europe in response to the UN System of National Accounts 1993 (SNA93), known as ESA95.

The standard practice started to shift gradually from measuring inputs (the number of doctors and nurses employed in the health sector; the number of teachers in schools) to outputs (the number of operations performed; the number of children taught) (Klein, 2000). It became more and more crucial to find ways of improving the efficiency with which resources were used (Hood, 1991; Pollitt, 1985; Smith 1995) and most importantly to prove whether the extra resources that were injected in the public sector produced 'value for money' (Griffiths, 1992; Pollitt, 1995; Webster, 1998).

In particular, the Office for National Statistics (ONS) began to update its methodology in constructing the national accounts in line with ESA95 for health, education, and administration of social security as early as 1998 (Office for National Statistics, 1998; Neuberger and Caplan, 1998; Caplan, 1998). Direct indicators of government "output" were introduced for the above areas of the public sector, which took the form of cost-weighted activity indices. In the following years, the new methodology extended to all other government functions (Baxter, 2000; Pritchard, 2001; Ashaye, 2001; Pritchard, 2002; Pritchard, 2003). So, for instance, instead of reporting what was spent on education, the ONS started to measure how many pupils were taught. Similar changes were incorporated in the 2000 and 2001 *Blue Books*, for administration of justice, fire and personal social services (Office for National Statistics, 2000; Office for National Statistics, 2001; Netten *et al.*, 2002, 2005 and 2006).

Further, in 2000 the British Prime Minister made the decision to significantly increase public expenditure on the National Health Service and on education. This provided the impetus for identifying some of the benefits that derive from the increased expenditure in order to demonstrate that the money is well spent. However, it was soon clear that 1) tools to measure whether the new investment was delivering more and better services were inadequate; and 2) sufficient information to measure "value for money" was not available. In 2002 this lead the National Statistician to commission Sir Tony Atkinson to conduct an independent review of the measurement of government output in the National Accounts (Atkinson 2005), with the aim

'To advance methodologies for the measurement of government output, productivity and associated price indices in the context of National Accounts, recognising: a) the full scope of government outputs; b) differences in the nature and quality of these outputs over time; c) the relationship between government outputs and social outcomes; d) the need for comparability with measures of private sector services' output and costs; e) the existing work of the Office for National Statistics (ONS); and f) the appropriate measurement of inputs, including quality and the distinction between resource and capital, so that, together with the measurement of output, light can be thrown on developments in government productivity' (Atkinson, 2005).

The interest in measuring output and productivity of non-market services is not confined to the National Accounts. It is of great relevance also to policy-makers, who are usually responsible for the provision, funding and/or regulating these public goods and services.

This chapter addresses the issues relating to the measurement of the output and productivity of one particular governmental function[1]: Health. Healthcare output (and productivity) can be measured in two different ways by either using patient-based/disease specific measures or overall health system measures. The first considers single diseases or areas of healthcare and is the object of analysis of chapter 2. In this chapter we address issues related with overall measures. These aim at assessing and valuing the output and productivity of an entire health system.[2]

1.2 Price and output indices

Measuring changes in price and volumes of consumer goods and services can be achieved by using either a price index or an output index. There is a certain degree of duality between the measurement of prices and volumes: as Eurostat (2001) points out 'one can either deflate a current year value with a price index, or alternatively extrapolate a base year value with a volume index to arrive at an estimate in prices of the base year', thus only one of the measures is required and the other can be derived as a residual. The two approaches are not completely interchangeable, however, with a price index generally preferred over a volume index in most contexts, with the exception of government goods and services for which consumers do not pay at point of use (Eurostat, 2001).

A price index usually assumes the evaluation of a constant basket of goods and services over time. In the Laspeyres form this would imply the measurement of

$$(1)\ PI_t = \frac{\sum_i p_{it} \times q_{i0}}{\sum_i p_{i0} \times q_{i0}}$$

Where p_{it} is the price of good i at time t; and q_{i0} represents the fixed basket of goods and services as measured in time 0 (= base year). In the healthcare sector, the calculation of a price index requires knowledge of the prices paid by private/public medical insurers as well as out-of-pocket payments made by consumers for the healthcare goods and services received. Real output growth in the healthcare sector is then calculated by deflating expenditure by the price index. In the US healthcare sector where prices (of some form or another) are available, it is feasible to measure real output using price deflation (Christian, 2007).

Price indices are less useful as measures of productivity change in a health system like the British NHS, as healthcare goods and services are provided free of charge to all patients at the point of use. In the absence of prices, the UK literature has focused on output growth measures. This allows the measurement of how output changes over time, given a fixed set of prices or costs. The Laspeyres form of an output index can be written as

$$(2)\ QI_t = \frac{\sum_i q_{it} \times p_{i0}}{\sum_i q_{i0} \times p_{i0}}$$

Where q_{it} represents the quantity of healthcare good/service i at time t; and p_{i0} measures its price (= cost) in the base year 0.

1.3 Challenges when measuring public sector output

Internationally, the need to compile national accounts has provided a motivation for greater standardisation in describing, measuring and valuing goods and services provided or purchased by the government.

The first step in moving towards the measurement of government "output" is to define what constitutes an accurate measure of it. The preferred starting point should be to consider the full range of goods and services that are valued by society as a whole. In the case of the provision of hospital services, for example, patients may not only expect

to receive a certain treatment, but also that its standard is of high quality, that they did not have to endure a long waiting time, and not least that their health is improved as a result of contact with the health system.

However, this has posed a number of challenges to economists, policy-makers and national accountants.

First, there are difficulties in describing and quantifying what constitutes the "output" of the public sector. For example, the maintenance of armed forces is justified on the grounds that it deters aggression from other countries but the extent to which defence spending reduces the threat of war is very difficult to measure. Similarly, fire services, for example, deal not only with the extinguishing of fires, which is an easily countable activity; they also deal with fire prevention, which is more difficult to measure. Moreover, if fire services become increasingly better in preventing fires, so that the number of fires extinguished decreases, a simple count of activity in terms of fire extinguished would not correctly reflect the level of output produced by the sector.

Secondly, even if it is possible to count government "output", it may still be difficult to measure its quality. In the case of education, for example, a simple count of lessons taught does not capture the quality of these lessons; a better indication of which could be given by the number of qualifications obtained by the pupils (an output measure). Further, there are other benefits (outcomes) associated with education that affect individuals' utility and hence should be accounted for. Remaining with the education example, a different way of looking at the quality of these qualifications is to consider the higher earnings that pupils may expect to receive because of their qualifications (an outcome measure).

Further, there are difficulties related to the measurement of governmental "output" over time in the presence of technological progress. For example, in the case of healthcare, if technological change makes it possible to reduce the number of treatments required to treat a certain illness/disease, then a volume measure that simply considered a count of activity would show a decreasing level of government output (and productivity) over time. Technological progress may also have a positive effect on the quality of public goods and services. In the healthcare sector, for example, technological progress

constitutes a very important source of quality improvements. Technological changes of this nature can be embodied in a classification system such as the Diagnostic Related Groups (DRGs) only by a res-structuring of the system itself. This has been an important consideration in the development of the most recent version (v. 4) of the Healthcare Related Group (HRG) system in England, for example.

And finally, a further difficulty arises when one wants to aggregate different goods and services into a single output index, in which case some means of weighting these different goods and services together must be devised. In the private sector, prices exist that reflect the marginal evaluation of the benefits and costs associated with a given good or service to consumers. Market prices are, hence, used as weights in an output index. In contrast, most non-market goods and services are provided free of charge or at a nominal price, which does not reflect the value to the consumer, at the point of delivery. Hence, some other way of aggregating these goods and services must be devised.

1.3.1 Describing outputs

In order to facilitate the identification of the accurate measure of government "output", a common distinction is made between activity, outputs and outcomes (Eurostat, 2001; Dawson, 2005).

Activity refers to, for example, the number of hospital consultations, the number of lessons taught, or the number of patrols carried out by the police. Activity data is usually available and easy to measure; however, it might not be detailed or comprehensive enough. Moreover, counting simple activities does not allow for the quality characteristics of these to be taken into account.

Output is defined in terms of bundles of activities (Eurostat, 2001; Atkinson, 2005; Dawson *et al.* 2005). In the case of individual goods and services, such as health and education, outputs are easily identifiable as an 'actual delivery of that output takes place from the producer to the consumer' (Eurostat, 2001). Thus, the output of the public education sector would be given by the number of GSCEs obtained, for example. In the case of the healthcare sector, the output is constituted by the amount of care received by

a patient. Similarly to activity, using output measures has the limitation that they do not capture all quality aspects of the goods and services delivered. Hence, it is important to identify both objective and subjective characteristics of public goods and services that affect individuals' utility.

The third and final distinction considers the outcomes achieved by the public sector. These relate to the overall and/or specific benefits that derive from the provision of public goods and services, which are valued by individuals and society as a whole. As such, they appear to also include the quality characteristics of public goods and services. They are identified in terms of, for example, the level of crime, the level of education in the population, and life expectancy. Outcomes need to be used, however, with caution as these can also be affected by factors external to the public sector. Only outcomes that are directly attributable to the working of the public sector should be in fact accounted for in a volume measure. This would require the isolation of the marginal contribution that the public sector makes in a specific area. This is not always a feasible task; and even when feasible, it may be extremely costly. It is, however, unquestionable that outcome measures are a potential source of information of the quality of the services provided by the public sector and should be used alongside an appropriate measure of governmental "output" to quality-adjust it (Eurostat, 2001; Atkinson, 2005).

The use of indicators based on outputs, as defined above, is advocated by Eurostat (2001) and Atkinson (2005) on the grounds that unlike for market goods and services prices for governmental goods and services are usually not available as these are provided in most cases free of charge at the point of delivery and in some at a nominal price that is not 'economically significant' (Eurostat, 2001). In particular, Atkinson recommends that in measuring government output, one should follow procedures similar to those adopted for market outputs (Principle A^3, Atkinson, 2005). Further, the Eurostat Handbook (2001) outlines some criteria that should be satisfied in order to be an 'appropriate' price and volume measure (type A method). An output indicator has to be as comprehensive as possible, covering for any particular public sector area, all goods and services provided; it should use cost weights for each type of output in the base year and it should be as detailed as possible. A final requirement is that output is quality-adjusted. On this regard, Atkinson (2005) requires explicitly that only

"incremental contribution" attributable to the workings of the public sector should be accounted for (Principle B).

1.3.2 Measuring quality

Considering quality aspects is particularly important, both in the private and in the public sector. Accounting for quality and quality change is not, however, an easy task. In general, the quality of a product is defined 'by its (physical and non-physical) characteristics' (Eurostat, 2001). Hence, different varieties of the same product can be considered as products of different qualities. Quality can also be related to the way a product is prepared and to how, where and when it is delivered. Further, the conditions of sale, circumstances and environment can all be considered as making up the quality of a certain product (Eurostat. 2001). If a product's characteristic changes, it is to be considered as a different quality of the product. Any change in the characteristics of a product needs to be registered as a change in the volume and not in price (cf. ESA95, par. 10.16).

Valuing changes in quality is not straightforward. In a situation of 'perfect competition', the market price of a product gives an indication of an individual's preferences and the producer's costs. Or in other terms, the market price reflects both the consumer's marginal willingness to pay for an extra unit of that product, and the producer's marginal cost to produce that extra unit without making a loss. Hence, differences in prices of two products can be interpreted as reflecting differences in the value that consumers attach to the characteristics (quality) of these two products. Higher quality products are usually associated with higher prices. This applies only to markets governed by perfect competition; in all other situations price differences can be due to a variety of reasons.

In the case of goods and services provided by the public sector where prices do not exist as these are supplied free of charge or at a nominal price at the point of delivery, other ways of incorporating quality characteristics into an output measure need to be developed. Three different approaches are feasible. The first approach focuses on the direct measurement of the quality of the output itself. This could be done through the administration of surveys to assess the quality of public services. These are believed to

be able to '[...] give (some) indications of the changes in quality over time' (Eurostat, 2001). The difficulty inherent with this type of approach is that the information can be subjective and not consistent over time.

The second approach concentrates on the measurement of the quality of inputs (Eurostat, 2001). This approach implies that the quality change in inputs automatically reflects a quality change of the output. An assumption that can only be truly verified by measuring the quality of the outputs.

The third approach focuses on the identification and measurement of the outcomes associated with a public good or service. In this way, changes in quality are investigated as changes in some outcome indicator. For example, in the case of the police force, a reduction in the level of crime can be used as an indication of the improved effectiveness of the police. In the case of healthcare, a reduction in mortality rates can be used as an indication of improved effectiveness of the healthcare system. A number of problems are, usually, related with using an outcome indicator. The first, which we have mentioned earlier in the chapter, is that an outcome may be affected by factors that are external to the working of the public sector. Hence, it is important to be able to attribute the marginal contribution made by the public sector. Another problem mentioned in the Handbook is that there may be a time lag between the change in the quality of the output and the change in the quality of the outcome. Further, it states that on a practical basis, there may be difficulties in linking an outcome indicator to an output indicator.

1.3.3 Measuring change over time

Technological progress is one of the determinant of how outputs change over time, especially in the case of health. It is responsible for the introduction of completely new goods and services (e.g. new surgical treatments, drugs); for changes in the quality characteristics of existing goods and services; for the way services are being delivered; etc.

In the private market, improvements in quality tend to be reflected by increases in the real value of products; if this has increased, the assumption is made that the increase in

value is capturing an increase in quality. A second approach is to use hedonic price techniques (Cockburn and Anis, 2001) to calculate the implicit prices of the various characteristics of a good or service.

1.3.4 Valuing outputs and quality characteristics

The majority of governmental goods and services are provided free of charge or at a nominal price at the point of delivery. In the absence of prices to reveal individuals' marginal valuations of government outputs, alternative means of estimating their values need to be found. There are three main competing approaches: extrapolating private sector prices; using contingent valuation methods; and unit costs.

The use of private sector prices is only feasible if goods and services provided by the former have similar characteristics to those publicly provided. This is quite problematic as the quality characteristics of private goods and services may be different to those publicly provided. An example is posed by private healthcare output which produces a mix of outcomes (shorter waiting times, better quality of 'hotel services') that are arguably more valuable. Thus, the price of private healthcare may overstate the willingness to pay for NHS output.

Dawson *et al.* (2005) have also explored the use of international prices for the healthcare sector and have rejected this option on three grounds: 1) there is no market for healthcare and all domestic prices are distorted in some way; 2) countries use different classification system to define and group their activity, making it impossible to compare like with like; and 3) even for those healthcare activities that are comparable, they find that the valuation basis is sensitive to which country the data came from.

Another way of measuring the social value attached to different outputs or to their characteristics is to elicit individuals' willingness to pay for them through contingent valuation techniques. These have been used for example to elicit people's values for various aspects of environmental protection and the premium individuals are prepared to pay to live within the catchment area of a good primary school. A number of studies have also used this technique to evince the relative value that people put on different aspects of healthcare, eg. Diener *et al.* (1998). The problem associated with this

technique is that many research studies are necessary to determine people's willingness to pay for all good and services provided by the government, making it a not viable option. Moreover, the studies would need to be repeated frequently if new goods and services are being offered or simply to measure change over time.

In the National Accounts the assumption is made that marginal social values are measured by the unit costs of production. This requires that two assumptions hold true, namely that 1) average unit costs are equal to marginal costs and 2) that resources are allocated efficiently within a particular public sector. These assumptions are, however, highly questionable. Moreover, using cost weights has the drawback that more expensive activities have a higher weight attached. If these activities were to be substituted by more cost-effective one, this would result, in principle, in a reduction of the output measured.

In the following Section, a very brief summary of the literature on the measurement of healthcare output is presented. Key journal articles, working papers and books were identified through a systematic search on two electronic databases: Health Management Information Consortium (HMIC)[4] and EconLit. These were searched between April and May 2004, and restricted on publications from 1989 onwards. A search strategy was implemented after having identified a number of key words. These were: price index; medical productivity, healthcare productivity, multifactor productivity, amongst other. A further refinement search strategy was also implemented to ensure a closer focus on the research area of interest. Full details on search strategies for both the HMIC and Econlit databases can be found in Appendix 1-B.

We focus in this chapter on literature concerning the measurement of output growth by means of price/output indices, which are particularly relevant for our proposed new methods and the methodology adopted in the National Accounts.

1.4 Measuring healthcare output

As early as 1962, Scitovsky recognised the importance of measuring the costs of a whole episode of care, proposing "...an [price] index which would show changes, not in

the costs of such items of medical care such as drugs, physicians' visits, and hospital rooms, but in the average costs of the **complete treatment of individual illnesses** [emphasis added] such as, for example, pneumonia, appendicitis, or measles"[5]. Consistent with Scitovsky, the US literature on disease-specific and patient-based healthcare output and prices indices focuses on direct measurements of medical costs of treating an episode of illness. These have been developed for various illnesses such as heart attacks (Cutler *et al.*, 2001), mental health (depression: Berndt *et al.*, 2002, and Berndt *et al.*, 2001; schizophrenia: Frank et al., 2003) and cataract surgery (Shapiro *et al.*, 2001). Further, Cutler and Huckman (CH) (2003) and Mai (2004) investigate the effect of technological change in medical treatment on healthcare output growth and productivity. Mai's analysis is carried out within an output index approach. More recently, the Atkinson Review (AR) (2005) set out an important recommendation encouraging the use of "whole courses of treatment for an illness, rather than its components (para 8.39, AR (2005))" when constructing an output measure. This type of measure is thought to be more appropriate when considering the quality of healthcare provided, technological change and the possible treatment substitution that is usually associated with medical innovations. The task of incorporating changes in quality is one of the most challenging when measuring healthcare output growth as these are likely to be an important source of productivity change in many sectors of the economy (European Commission, 2002).

Shapiro *et al.* (1999), Berndt *et al.* (2000) and Cutler *et al.* (2001) outline a number of challenges when dealing with the pricing of healthcare goods and services, making it a much more difficult task than that of pricing private goods and services.[6] First of all, there is the problem of moral hazard, which occurs in situations where most medical care payments are paid for by private and/or public insurers, with consumers only paying a given (and relatively small) percentage of total medical costs. Subsidisation means that consumers are likely to consume more than their marginal value. However, Shapiro *et al.* (1999) add that patients bear substantial non-pecuniary costs, such as pain suffered and a period of recovery, which will most likely impact on their demand for healthcare. These non-monetary costs need to be considered as well. The second difficulty derives from the existence of asymmetric information between patients and physicians, with the latter sometimes not acting in their patients' best interests (principal-agent problem). These two aspects of the healthcare sector make it

particularly difficult to construct and interpret consumer price indices, as the marginal private costs and social costs do not coincide.

A third difficulty derives from technological and organisational changes that result in new services being introduced all the time, and/or to improve the efficacy of existing treatments. In particular, Shapiro *et al.* (1999) analyse two possible effects: 1) it can lead to a considerable improvement in outcomes; 2) it can reduce both monetary and non-monetary costs to patients. They note that when technology results in an increase in the treatment value, more treatment is likely to take place. This might be reflected in a greater number of patients treated as well as in interventions taking place at different stages of an illness. A change in the timing of interventions has occurred in the treatment of many conditions, including cataracts, angioplasty and joint replacement. Interestingly, it this has not always been beneficial, as for example, Chernew, Fendrick and Hirth (1997) point out in the case of gall bladders, where it resulted in unnecessary operations.

Finally, the most important problem in the measurement of healthcare goods and services is that individuals do not value these goods directly but value the expected effect they have on their health. Routine measures of these health effects are rarely available, thus making it particularly challenging to allow for quality change. Shapiro *et al.* (1999) argue that improvements in outcomes and reduced patient burden should be reflected in the price index. To allow for this, the net benefit (immediate and life-time lasting benefits) of the treatment needs to be measured, and changes in this net benefit should then be used to adjust unit costs. One approach is to undertake patient surveys, with scope for either contingent valuation methods to be applied to elicit patients' valuation of hypothetical outcomes, or for quality adjusted life years or QALYs[7]. These can be combined with expert opinions on the efficacy of treatment administered. Shapiro *et al.* stress that both patients' assessments of the value of outcomes and expert opinions on the effects of treatments should take into consideration the variation and uncertainty in successful outcomes and how the illness would have progressed if not treated.

To conclude, Shapiro *et al.* make a number of recommendations for the measurement of price indices for the healthcare sector. They argue that a 'standard metric' for quality-

adjusting the price of treatments is required, which should also incorporate knowledge of medical professionals and experts. They propose the development of a "database of values of healthcare outcomes". This database should be based on standard values for "broad dimensions of impairments", such as blindness, deafness and mortality, followed by an ongoing evaluation of how changes in treatments impact upon outcomes in terms of these dimensions. In this manner, consistency across varying diagnoses could be achieved.

1.4.1 The measurement of healthcare output in the UK National Accounts

The measurement of healthcare "output" in the National Accounts prior to 2004 included 16 different activity series (Pritchard, 2004a). One series counted inpatient and day case activity, which accounted for about fifty per cent of the expenditure included in the index. Outpatient activity, community health treatments, GP prescribing and dental treatments were counted separately[8]. One of the limitations of this approach lies in the fact it used very broad categories of activity, which washed out all quality and complexity aspects of the different treatments. Further, it gave an equal weight to all activities regardless of their complexity, cost and clinical benefit, so for example a simple procedure such as the removal of varicose veins had the same weight as the more complex procedure of a heart bypass surgery.

This rudimentary method was updated by ONS in collaboration with the Department of Health in June 2004. The new methodology was extended to incorporate higher differentiation of healthcare activity. In particular, it used hospital inpatient activity data classified in about 1,200 Healthcare Resource Groups (HRGs), following a recommendation set out in the Eurostat Handbook (2001) that suggested to measure 'output (= treatments) [...] on the basis of the so-called Diagnosis Related Groups (DRGs) type classifications. DRG systems are similar to HRGs and are used to classify hospital stays into groups that are medically meaningful and as homogeneous as possible with regard to resource use'.

Average unit cost information for hospital activity is derived from the National Schedule of Reference Costs, which also constitute the source of volume and cost data

for the remaining other NHS activity (400 groupings). General practice consultations and prescribing is derived, respectively from the General Household Survey and the Prescription Pricing Authority. Other activity includes NHS Direct, NHS Direct Online, NHS Walk-in-Centres and Dentistry.

Although a more comprehensive method, the ONS/DH cost weighted activity measure has a number of limitations that need to be addressed in order to meet the requirements set in the Eurostat Handbook (2001) and the principles proposed in the Atkinson Review (2005). In particular, two aspects need to be improved to comply with the calculation of type A methods and with principle B of the Atkinson Review.

A more comprehensive measure of healthcare output needs to be introduced, where possible, and quality characteristics of healthcare services need to be investigated and incorporated into the output measure.

1.5 Methodology

We have developed a new methodology to measure NHS output growth and productivity (Dawson *et al.*, 2005, Castelli *et al.*, 2007b), that addresses the issues relating to the measurement of the most appropriate unit of healthcare output, and investigates the issues regarding the quality characteristics of this output.

An ideal index – value weighted output index (VWOI) – is developed to capture the value of what is produced by the NHS. It adjusts volumes of activity to take account of changes in (the quality of) healthcare characteristics. Weights are attached to these characteristics that reflect the marginal value society places on them. A feasible[9] version of the ideal index by Dawson *et al.* (2005) has been developed taking into account nature and availability of healthcare data. In particular, it incorporates adjustments for health outcomes, life expectancy, and it may also take into account any possible detrimental effect caused by having to wait for treatment (see eq. (1)) (Dawson *et al.*, 2005)

(1) $$I_{yt}^{xq} = \frac{\sum_j x_{jt+1}\left[\left(a_{jt+1} - k_{jt+1}\right)\left(1 - e^{-r_L L_{jt+1}}\right)\pi_k\right]/r_L - w_{jt+1}\pi_W}{\sum_j x_{jt}\left[\left(a_{jt} - k_{jt}\right)\left(1 - e^{-r_L L_{jt}}\right)\pi_k\right]/r_L - w_{jt}\pi_W}$$

x_{jt} is the volume of output in period t,; a_{jt} is the probability of surviving treatment j at time t; k_{jt} is equal to the ratio of a measure of patient-recorded health outcome before treatment (h^0_{jt}) and after treatment (h^*_{jt}) at time t; L_{jt} represents healthy life expectancy after treatment, which is assumed to vary by treatment j and over time, and is discounted using interest rate r_L; and w_{jt} is waiting time, which is also allowed to vary by treatment j and over time. π_k and π_W are the marginal social values respectively for a quality adjusted life year (QALY) and for a day spent waiting.

Output is defined in terms of whole courses of treatment provided to a patient. Patients often require multiple contacts with different parts of the health system in their care pathway. Complete treatments should comprise all healthcare activities (operative procedures, diagnostic tests, outpatient visits, consultations etc) that are relevant for a given treatment, that is 'medical services, paramedical services, laboratory and radiological services and, in the case of hospitalisation, non-medical services such as the provision of food and accommodation' (Eurostat, 2001). Ideally, we would like to be able to link together all the different treatments that an individual receives, from GP consultations to inpatient stays, readmissions, outpatient attendances, follow up care and prescriptions. The main advantage of this type of measure is that it would make an output growth index less subject to fluctuations/distortions due to changes in medical and/or organisational practice, and technological change (Atkinson, 2005).

IT technology currently available in the UK does not allow for such a measure of healthcare output to be implemented yet. An alternative measure is developed limitedly to inpatient (elective and day cases, emergency) admissions, which builds on the method[10] developed by Lakhani *et al.* (2005) and allows to link all episodes of care received by a patient when transferred from one consultant to another within the same provider; and to link these records also to other providers if a transfer is required by the patients' course of care.

Outcomes of healthcare output are defined in terms of those characteristics that affect an individuals' utility and that individuals value in their contact with the healthcare sector as patients. The primary objective of a health system is to improve the health of patients, thus improved health outcomes are the most important characteristic of treatment.

The focus in health economics has been on the change in health produced by a course of treatment and measured, usually, in terms of QALYs (Williams, 1985). This is but one of the characteristics of healthcare that affects individuals' utility. Other valued characteristics are various measures of patient experience such as waiting time, choice of date of treatment, certainty of date of treatment, being treated with dignity and respect, distance and travel time to services, the interpersonal skills of healthcare staff, the range of choice and quality of hospital food, and the degree to which patients feel involved in decisions about their treatments (Castelli *et al.*, 2007a; Atkinson[11], 2005).

The value weighted index incorporates only some of these quality aspects of healthcare: survival following treatment; a measure of the change in health status; life expectancy and waiting time.

The remaining challenge is to place a value π_{kt}, expressed in some unit of account, on the characteristics of healthcare goods and services. The issue of valuing outputs and quality characteristics has already been addressed in Section 1.3.4. The main conclusion is that value weights for public healthcare output do not currently exist. However, Eurostat (2001) and Atkinson (2005) recommend the use of unit cost to weight healthcare output.

Thus, we formulate a cost weighted output index (CWOI) (see eq. (2), Dawson *et al.*, 2005). Similarly to the VWOI, the cost weighted output index allows to adjust NHS output to take into account changes in survival rates (a_{jt}), in health outcomes (k_j), life expectancy (L_{jt}) and in waiting times (w_{jt}). Its Laspeyres form[12] is:

$$(2) \qquad I_{yt}^{xq} = \frac{\sum_j x_{jt+1} c_{jt} \left(\frac{a_{jt+1} - k_j}{a_{jt} - k_j} \right) \left[\frac{\left(1 - e^{-r_L L_{jt+1}}\right)}{r_L} - \frac{\left(e^{r_w w_{jt+1}} - 1\right)}{r_w} \right]}{\sum_j x_{jt} c_{jt} \left[\frac{\left(1 - e^{-r_L L_{jt}}\right)}{r_L} - \frac{\left(e^{r_w w_{jt}} - 1\right)}{r_w} \right]}$$

The main difference to the VWOI lies in that it uses cost weights to capture the relative importance of each NHS output and adjusts these weights where outcome data are available.

Equation 2 presents the formula of the full quality-adjusted output growth index, where all quality dimensions are taken into account. In order to investigate the effects of incorporating these quality characteristics into an output growth measure, we construct four alternative output indices. These are presented in Table 1-2.

Table 1-2 – Cost weighted output indices

Quality adjustment	Output growth index
None (CWOI)	$I_{ct}^{x} = \frac{\sum_j x_{jt+1} c_{jt}}{\sum_j x_{jt} c_{jt}}$
Survival (CWOI 1)	$I_{ct}^{xa} = \frac{\sum_j x_{jt+1} c_{jt} \left(a_{jt+1} / a_{jt} \right)}{\sum_j x_{jt} c_{jt}}$
Survival and health (CWOI 2)	$I_{ct}^{xak} = \frac{\sum_j x_{jt+1} \left(\frac{a_{jt+1} - k_j}{a_{jt} - k_j} \right) c_{jt}}{\sum_j x_{jt} c_{jt}}$
Survival, health & life expectancy (CWOI 3)	$I_{ct}^{x} = \frac{\sum_j c_{jt} x_{jt+1} \left(\frac{a_{jt+1} - k_j}{a_{jt} - k_j} \right) \left(\frac{1 - e^{-rL_{jt+1}}}{1 - e^{-rL_{jt}}} \right)}{\sum_j c_{jt} x_{jt}}$

Source: Dawson *et al.* (2005)

The first and most simple output growth index is the cost weighted output index (CWOI) without any quality adjustment, where x_{jt} is the amount of output undertaken in period t and c_{jt} is the average unit cost of output j in time t.

The other two indices allow to determine the effects of quality adjusting NHS output by survival rates only, and by survival rates and change in health status. In CWOI 1, the ratio a_{jt+1}/a_{jt} represents the proportionate increase in surviving treatment for output j between period t and period t+1. *Ceteris paribus* and assuming that mortality rates have been improving over time, quality adjusting the output growth measure should yield higher growth rate. The magnitude of the survival adjustment on the overall output growth measure depends clearly on the initial survival rate a_{jt}; if the majority of NHS patients survive their treatments, then the overall effect of this quality adjustment on output will be minimal.

Changes in pre- and post-treatment health status are incorporated in CWOI 2, alongside survival rates. k_j is an estimate of the proportionate effect of treatment conditional on survival. It is calculated as the ratio of average health reported outcome pre- (h^0_j) and post- treatment (h^*_j) Note that k_j is time-invariant in this application as data on patients' health status before and after treatment are currently not routinely collected on an annual basis.

The last index (CWOI 3) in Table 1-2, incorporates life expectancy (L_{jt}) defined as the average age of patients getting treatment j at time t, discounted at the rate r_L. In this way we are able to estimate the effect on health, condition on survival, over the remaining life years of a patient. *Ceteris paribus*, and assuming that life expectancy is increasing over time; we expect that incorporating this further quality adjustment should yield better estimates of the output growth index.

In Section 1.7, we present all data used to construct these output growth indices. In particular, we describe how the output measure for hospital inpatient stays is constructed. Inpatient data is currently the only data that contains the required information to follow a patient through his/hers healthcare pathway ('whole course of treatment). Further, we address the issue of quality-adjusting NHS output; we analyse what *should* be measured and what *can* be measured, given current data collection.

A brief description of the various data sources used to populate the NHS output growth index is provided in the next Section.

1.6 Data Sources

Several data sources are used to populate NHS output over the time period 1998/99 – 2003/04. The Hospital Episode Statistics (HES) is used as the data source for inpatient electives and non-elective (emergencies) stays; the National Schedule of Reference Costs (hereafter, simply referred to as Reference Costs) provides data on all other NHS activity, such as outpatient care, ambulance services and mental health services. It also contains data on average unit costs, which are used as weights in the calculation of the output growth index. Data on primary care are not readily available; hence, estimates of primary care consultations are produced using the General Household Survey (GHS). Data on pharmaceuticals prescribed are available from the Prescription Pricing Authority (PPA). All these sources are described in further detail in the remainder of this section.

Hospital Episode Statistics

HES database provides information on admitted patient care delivered by all NHS trusts in England, including acute hospitals, primary care trusts and mental health trusts, from 1989 onwards. It also records care provided to NHS patients by the independent sector, including that taking place in treatment centres, and care given to private patients in NHS hospitals.

HES includes information on all medical and surgical specialties, comprising more than 12 million patient records (Hesonline, 2009). Patient records are collected according to the financial year (1st April to 31st March) in which the episode of care finished.

Each patient record includes information on the *demographic characteristics* (e.g. age, gender) of patient treated, *clinical information* such as diagnosis and procedures performed and details of the hospital and specialty where the patient received treatment; *administrative information*, such as time waited and date of admission; and *geographical information* on where the patient was treated and area in which she

resides. Each episode of care is classified in terms of Healthcare Resource Groups (HRGs).

HRGs are designed as grouping of treatments with similar clinical characteristics and similar resource use (NHS, 2008). They are determined from both procedural (OPCS) and diagnostic (ICD) codes, that are intended to capture every detail of a clinical event by simple alpha-numeric symbols. OPCS stands for Office of Population Census and Survey and it is the standard classification system in use in England to record healthcare procedures and interventions. The version of OCPS used to inform HRG versions[13] 3.0, 3.1 and 3.5, which are used in this chapter, is version 4.2. ICD stands for International Classification of Disease and Related Health problems, which is the diagnosis coding system in use worldwide. It is developed and managed by the World Health Organization (WHO). The version used to inform HRG versions 3.0, 3.1 and 3.5 is version 10.

Reference Costs

The HRG coding system is also used as one of the basis for reporting activity and average unit costs in the Reference Costs database. Reference Costs were introduced in England in 1997 and constitute the basis for setting prices under Payment by Results (DH, 2006). Costing of NHS activity is a complicated exercise, and it requires a methodology that takes into account the type of patients treated and the nature of treatment administered to patients. To this end NHS providers collect and record data based on HRGs.

Reference Costs provide detailed information (e.g. activity, average unit costs) on a broad range of surgical procedures and medical treatments administered to NHS patients in a number of settings. It covers services provided by NHS hospital trusts, by Primary Care Trusts, and by a number of other settings, as well as covering paramedic services provided by Ambulance NHS Trust (2003/04 onwards). The coverage of NHS activity included in the Reference Costs database has increased over time, as well as the quality of the data submitted. We recognise that the Reference Costs may suffer from the usual drawbacks associated with routinely collected data in terms of large variation in the unit costs measures (Jacobs and Dawson, 2003). These variations may be due to 'differences in case-mix, resources being used, factor prices, particular hospital features,

different priorities, differences in the quality of services and patient outcomes, the external environment, different accounting treatments, data errors and random fluctuations (Jacobs and Dawson, 2003)'. Nonetheless, we believe that they make for a valuable and reliable source for both activity and average unit costs data for the purposes outlined in this chapter.

General Household Survey

The General Household Survey (GHS) is a multi-purpose continuous survey carried out by the Social Survey Division of the Office for National Statistics (ONS) since 1971. The survey collects information on a range of topics from people living in private households in Great Britain. The topics cover health and use of health services, household and family information, education, and employment, amongst others [14]. The GHS is affected by a number of drawback that are widely recognised (Atkinson, 2005). One of the limitations of the GHS, as outlined by the Office for National Statistics in a recent quality review exercise (ONS, 2005b), is posed by the nature of the clustered sample design. It is stated that 'clustering has can lead to an increase in sampling error if the households or individuals within the PSUs [Primary Sampling Units] are relatively homogenous but the PSUs differ from one another (ONS, 2005b)'. Other limitations are more generally related to the collection of information through surveys. These are systematic error, random error and sampling error[15].

However, it constituted the most comprehensive source[16] of data for this particular sector at the time this analysis was carried out. Cost weights for primary care consultations are taken from PSSRU's annual publication reporting Unit Costs of Health and Social Care[17], which estimates the unit costs of GP and nurse consultations using a variety of official and unofficial sources. Several of the estimates rest on self reported GP activity from the 1992/3 GP Workload Survey[18]. These constitute the most recent survey of GP activity at the time the analysis was carried out. A more recent survey was carried out in 2006/07[19].

Prescription Pricing Authority

The Prescription Pricing Authority collects data on primary care prescribing in order to remunerate pharmacists and dispensing GPs. It constitutes, therefore, a reliable and comprehensive measure of the volume of prescriptions dispensed in England. The

prescriptions data are disaggregated by product type (item). A system is in place to calculate reimbursements and remuneration to all drug dispensers[20] that are registered in England.

1.7 Outputs and quality characteristics

1.7.1 Output measure for hospital inpatient stays

Each record in HES represents a Finished Consultant Episode (FCE), defined as the time a patient spends under the care of a single consultant. We convert FCEs into continuous inpatient spells of NHS care, a measure developed by Lakhani *et al.* (2005) and used in Dawson *et al.* (2005). This measure enables one to capture in a more precise manner patients' journeys across NHS hospital providers.

Lakhani's method, in fact, enables one 1) to link all episodes of care received by a patient when transferred from one consultant to another within the same provider; and 2) to link records of patients transferred to other providers to receive, for example, more specialist procedures[21] that are required by the patients' course of care.

In particular, to identify the episodes of care associated with each continuous inpatient spell, all episodes are sorted by a number of patients' admission details and patient's identifiers (HESID, EPISTART, EPIORDER AND EPIEND fields in this order) (Lakhani *et al.*, 2005). In this way, it is possible to identify all episodes of care associated with the same patient and that may belong to the same Continuous Inpatient Spell (CIPS). Transfers to other providers (hospital) can also be considered by imposing certain checks. We follow the methodology set out in Dawson *et al.* (2005) to identify CIPS of NHS care.

Table 1-3 reports the number of episodes available in HES and the number of provider spells and NHS spells that can be obtained by linking FCEs by provider (for provider spells) and by provider and across providers (for CIPS of NHS care).

Table 1-3 – Number of finished consultant episodes, provider spells and CIPS of NHS care by HES data year

HES data year	FCE Episodes (millions)	Provider spells (millions)	CIP spells (millions)
1997/98	11,404	10,893	10,799
1998/99	12,001	11,350	11,211
1999/00	12,203	11,285	11,106
2000/01	12,273	11,257	11,075
2001/02	12,316	11,183	10,994
2002/03	12,719	11,739	11,542
2003/04	13,332		12,148

The numbers are very similar, an indication that the majority of CIPS of NHS care is made up of single episodes of care. However, there is a number of CIPS with multiple finished consultant episodes. As HRGs are usually assigned at episode level and having linked episodes into spells, there is the need to assign an HRG code to each CIPS. This is done on the basis of the HRG code of the first finished consultant episode within a CIPS of NHS care. This can be justified on the basis that it identifies the underlying health condition that brought up the initial contact with the healthcare system. It is worth noting, however, that the HRG thus assigned may not be the dominant or most costly procedure (HRG) within a patient's CIPS[22].

Two limitations are identified with the way CIPS are constructed. First, important co-morbidities may be present, which this particular linkage method may "wash out". Secondly, the case-mix of a CIPS HRG may well change over time. However, we accommodate for this by applying in-year cost weights to hospital output.

Cost weights are derived from the Reference Costs. These are, however, assigned to FCEs. Hence, a method was developed to determine average unit costs of CIPS HRGs. First, we allocate every patient i to the HRG recorded in the first FCE, designated by HRG j. For each patient, we then calculate the cost of their CIPS ($c_i^{CIPS\_HRGj}$) by summing the HRG costs across all the FCEs that are assigned to the same patient.

$$(12)\quad c_i^{CIPS\_HRG_j} = c_i^{FCE-HRG_j} + \sum_{k \neq j}^{n} c_{ki}^{FCE-HRG_j} \qquad \forall i$$

Where $c_i^{FCE-HRG_j}$ represents the unit costs of the first finished consultant episode, which also determines the HRG code to be assigned to patient i CIPS of NHS care. The second component in equation (12) allows us to attribute to each patient all subsequent associated with his/her treatment pathway, ie until the end of his/her continuous inpatient spell of NHS care.

So, once we have calculated total costs for each patient treated, we calculate the total cost of all CIPS allocated to HRG *j*, indicated by the left-hand side of equation (13). This is obtained by summing all patients' costs whose first episode of care is grouped under HRG *j*, and of which we have an amount *x*:

$$(13)\ C_j^{CIPS-HRG_j} = \sum_i^x c_i^{FCE\_HRG_j}$$

Total volume of CIPS activity (ie the number of patients treated whose first HRG is the same) assigned to HRG *j* is designated with $x_j^{CIPS\_HRGj}$. The average CIPS cost for HRG *j* is hence calculated by dividing the total CIPS cost for this HRG by the number of CIPS assigned to HRG *j*.

$$(14)\ c_j^{CIPS-HRG_j} = \frac{C_j^{CIPS-HRG_j}}{x_j^{CIPS-HRG_j}}$$

1.7.2 All other NHS activity

For all remaining NHS activity (outpatient visits, A&E, community services, etc), Reference Costs are used to provide data on both volume of activity and average unit costs. It is not possible to summarise these data into an output unit, as we have done for hospital inpatient records.

As explained in Section 1.6, the coverage of NHS activity included in the Reference Costs has increased substantially over time. This is due to 1) the inclusion of activity that was previously unmeasured, and 2) the re-categorisation of previously quantified

activity. In both cases, we are presented with data for any two adjacent years that is not exactly the same and hence cannot be directly compared.

The *traditional* approach (Eurostat/Commission of the European Communities *et al.*, 1993) so far used requires output categories to be consistent across adjacent years. Thus, allowing for the inclusion of activity categories if and only if information is available in two successive years. This is not a good approach as it leads to the loss of potentially a great volume of activity.

We propose an alternative method, which involves the *mapping* of new and retiring activities. The mapping requires that new and retiring categories are somehow related and judgements need to be made about the nature of their relationship. This method represents an improvement on the traditional approach, as the mapping allows for some activity that would have previously been lost to be included. However, it has the limitation that it is not always possible to map all activity, especially previously uncounted one.

1.7.3 Quality adjustments

The quality of NHS activity is defined in terms of the characteristics valued by patients. These include the impact that treatment has on health outcomes, the length of time waited for treatment, the uncertainty attached to having to wait for a treatment, patient experience, etc. We consider two different dimensions of quality: health outcomes and waiting times.

1.7.3.1 Health outcomes

The most important characteristic of healthcare is the contribution it makes to improve individuals' health state. As recommended in Eurostat (2001) and Atkinson (2005), it is only the marginal contribution of healthcare or "value added" to a patient's health that should be taken into account and included in a measure of output growth. This means measuring the health gain that patients derive from healthcare treatment. The most commonly used measure is Quality Adjusted Life Year (QALY), which measures the change in the quantity and quality of life, with health gains discounted to the present

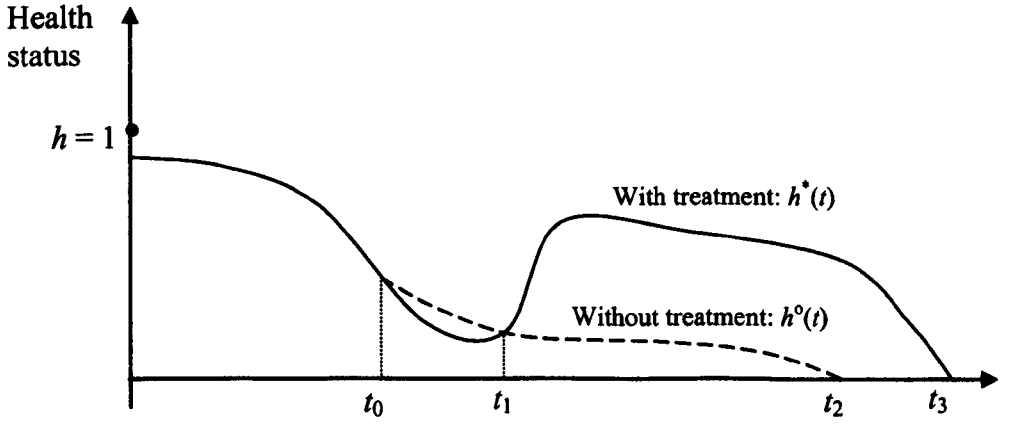
time. Theoretically, the gain in health outcome should be measured as the difference between the number of QALYs that accrue to an individual from being treated with those that an individual faces without treatment.

Consider Figure 1-1, $h^{0}_{(t)}$ and $h^{*}_{(t)}$ denote respectively the health profile of an individual that does not receive any treatment and that of one who receives treatment. As can be seen, the health profile of an individual left without treatment deteriorates over time until she dies at time t_2. If the person is treated at time t_0, her health status is slightly reduced, a non unlikely event after some treatments, before an increase is registered. Moreover, in the example presented here, the treatment has also lengthens the life of the patient from t_2 to t_3.

So, if we want to measure the QALY gains associated with being treated as opposed to not being treated, and in terms of Figure 1-1, we should measure the difference between the area under the 'with treatment' curve less the area below the 'without treatment' curve.

This is, however, not feasible for two reasons. The first is ethical, in the sense that it is very unlikely to leave a person untreated. The second is a practical one, as the routine collection of data would feasibly allow only for snapshots measurements to be taken at certain points in time. In conclusion, this means that we can only observe pre- and post-treatment health status, and that these are snapshots taken at particular points in time.

Figure1-1 – QALY gain from treatment



It is also apparent from Figure 1-1 that the timing of the pre- and post-treatment snapshots of health status is crucial. It is not unlikely for patients to report a reduced health status immediately after being treated, before recovering health and registering a substantial health gain. In some other cases, such as terminal care, the aim of the treatment is not to improve health status but to reduce the deterioration of it, whilst extending the length of an individual's life. This would result in an unchanged post-treatment snapshot measure of health status. A similar scenario occurs also in case of palliative care, whereby patients' quality of life is improved without any effect on their length of life.

Hence, some concern exists on whether the rate of growth of $\Delta h = h^* - h^0$ is an appropriate approximation to the rate of growth of the effect of treatment on the discounted sum of QALYs; that is, whether the rate of change in the snapshot measures approximates the rate of change in the area under the 'without treatment' and the 'with treatment' health profiles.

Dawson et *al.* (2004) and Castelli *et al.* (2007b) conclude that given the lack of data on without treatment health states, the use of pre- and post-treatment health status measures, although imperfect, represents an improvement in current practice. This accords with the ONS recommendation that 'it is better to measure the right thing approximately than the wrong thing precisely' (Caplan, 1998), implying that any new indicator would constitute an improvement in existing practice[23].

As health outcomes associated with each treatment are not observed directly, Dawson *et al.* (2005) have devised a formulation which involves combining together (i) short-term survival rates, (ii) pre- and post-treatment health status measures and (iii) healthy life expectancy.

Patient reported health status

There are three potential ways of estimating the change in health status before and after receiving healthcare treatment: (i) clinical trial data, (ii) expert opinions and (iii) observational data.

The use of clinical trials data is advocated in a number of papers (Berndt *et al.*, 2001; Mai, 2004), and it is suggested that these are combined with or validated by expert opinions (Berndt *et al.*, 2002). This route was also investigated by Dawson *et al.* (2004a, 2004b) and a number of drawbacks associated with it were outlined. Examples of the limitations[24] were that the study population is not representative of patients receiving the same treatments in routine practice, because of the existence of inclusion/exclusion criteria; clinical trials address very specific conditions, whilst fairly aggregated classifications (such as HRGs) are needed in the construction of productivity indices; and the measurement of productivity change necessitates continuous information of the effect of interventions over time. There are only a few studies published that have attempted to investigate whether the time of intervention has any impact on the effectiveness of the intervention itself.

Dawson *et al.* (2004b) surveyed users of the EQ-5D instrument[25] in clinical trials and reviewed thirty published studies that have employed this instrument. The EQ-5D data extracted from this source and which we were used to infer pre- and post-treatment health measures to use within this chapter are given in Table 1-C.1 in Appendix 1-C. It was necessary to map EQ-5D scores obtained from clinical trials, which are carried out on very specific conditions, to fairly aggregated HRGs groupings.

The second option available to estimate the change in health status is to use expert opinions. Clinicians would be asked to provide estimates of the health outcomes associated with certain ailments. In order for these estimates to be used within an output growth measure, clinical experts should provide a description of changes in health state for given conditions and for the corresponding interventions. These effects should be summarised in terms of a standard metric. Further, clinical experts should provide information on how health outcomes are likely to change over time for every condition and how this would affect a patient's life expectancy. These judgements could be provided in isolation by single clinicians or through the creation of panels of experts deliberating together or a combination of both (Berndt *et al.*, 2002).

Williams (1985) used clinicians in isolation for the derivation of profiles of patient health status in the evaluation of Coronary Artery Bypass Grafting (CABG), with the aim of converting the opinions of cardiologists into a standard generic classification of

health status. Cardiologists were also asked to predict patients' health state conditional on alternative forms of treatment. Another study was conducted in the Netherlands (Stouthard *et al.*, 1997) to establish disability weights for diseases to be used to build a burden of disease model.

Three limitations can be associated with this approach: 1) potential danger of clinicians' judgements being influenced by their vested interests; 2) the existence of uncertainty around the effectiveness of specific treatments and/or the future health pathway may comprise the forming of a generalised and accepted consensus; 3) the organisation of expert groups for all areas of NHS care would be quite costly. However, a clear advantage of using expert groups is that it makes the process of collecting new data redundant and that health outcomes are dependent on the experience of professionals who have an understanding not only of the conditions, but also of the available treatments.

The third option, which is also the one explored in this chapter, is to use observational data. It relies on the collection of data through a questionnaire administered to all NHS patients before and after receiving a treatment. This type of data was not routinely collected in the NHS at the time this research was carried out[26]. Notwithstanding that, we were able to gain access to data collected by a NHS hospital trust and a private health insurance provider (Vallance-Owen *et al.*, 2004). These two healthcare providers administered surveys to patients before and after an intervention on a number of health conditions and treatments. The instruments used were SF-36[2728] and VF-14[29] (for cataract procedures since 2001).

The Orthopaedics and Trauma unit at York District Hospital has been collecting SF36 since March 2001 for patients undergoing both knee and hip replacements. Patients completed the SF-36 instrument up to December 2002, after which the shorter SF-12 instrument was administered to patients. The first questionnaire was administered to patients during their first recorded outpatient appointment before the operation took place. This enabled one to determine patient's health status before receiving surgery. A second questionnaire was administered pre-operatively upon admission. Post-operative health outcomes were obtained predominantly through postal questionnaires (some were collected during follow-up appointments) sent to patients between three to six months

following their operation, and then again after 12 months. The overall dataset obtained is very small, as it included: 253 patients at the pre-operative stage, whilst the follow-up questionnaires administered after three months was completed by 203. The private health insurance provider has been collecting outcomes data (before and after health status) since 1998. The dataset contained 90,000 patient treatment episodes covering the period 1998 – 2003. Patients filled in a questionnaire before receiving treatment and three or four month post treatment depending on whether the instrument is SF-36 or VF-14 (for cataract procedure since 2001). The collection exercise by the private health insurance provider was intended originally to be comprehensive, but as from 2002 efforts have been concentrated on a number of high volume procedures, such as cataract surgery, Percuteneous Transluminal Coronary Angioplasty (PTCA) and Coronary Bypass (CABG), Primary Hip Replacement. Data obtained from these two sources, along with some EQ-5D values from clinical trials, were used to infer the values for pre- and post-treatment health status for a number of diagnosis and procedures, which were then linked to their relevant HRGs. (Dawson *et al.*, 2005). A full list of the identified thirty HRGs can be found in Appendix B, along with the their respective pre- and post treatment measures of health status.

Short-term survival rates: in-hospital and 30-days from discharge and healthy life expectancy

Two measures of short-term survival rate[30] can be extracted from the HES database: 'in-hospital' and 'in-hospital and 30-days post discharge'. HES data records for each patient the method of discharge, identifying the circumstance under which a patient left hospital, which enables one to capture the number of patients that were discharged as dead. 'In-hospital' mortality rates are determined by the number of patients that are discharged as dead. Further, ONS date of death data can be linked to the HES dataset so that deaths following discharge can be identified. Our second mortality indicator is given by the sum of in-hospital deaths and deaths that occur within 30 days of discharge from hospital.

The first type of mortality indicator is justified by the fact that these deaths are more capable of being influenced by the NHS. The second needs some more clarification. There a number of patients who are likely to die within a short period of being discharged. Should reductions in these deaths be attributed to the working of the NHS;

for example to reflect changes in medical (good) practice? And which should be the correct cut-off point for the attribution of deaths to the operating of the NHS? The second indicator is commonly used in a variety of studies (Kosecoff *et al.*, 1990; Rogers *et al.*, 1990; Lunn *et al.*, 1987) and it is also based on US evidence that shows how reported in-hospital mortality for some conditions has decreased over time, whilst the 30 day death figures show a substantial increase (Baker *et al.*, 2002). Moreover, 30-day post discharge mortality rate is less susceptible to manipulations.

'In-hospital' and '30-days post discharge' survival rates for all hospital activity recorded in the HES dataset are highly correlated. In 2003/04 this was equal to 0.994 for elective inpatient stays and 0.987 for non-elective inpatient stays.

Although incorporating survival rates into a healthcare service output growth index can be considered as a way forward to quality-adjust the measure of healthcare services, it is not free of problems. The most important is the issue of attribution, as increased survival rates (or any other health outcome) may be associated with a number of factors (epidemiology, demographics, technological advances in the pharmaceutical industry, etc) other than improvements in NHS practice.

Dawson *et al.* (2005) explore the use of both short-term survival rates, and indicate a preference towards the '30-day post discharge' measure. In this chapter, we will use only the latter measure when quality-adjusting NHS output (see Section 5).

Healthy life expectancy is derived from combining information on patient's gender and average age in each HRG (available in HES) with life tables and the 1996 Health Survey for England (Prescott-Clarke and Primatesta, 1998). Estimates of life expectancy are taken from the Interim Life Tables 2000-2002 for the United Kingdom (Annual Abstract, 2002, p. 71) and from these the difference between total life expectancy and quality-adjusted life expectancy shown in the 1996 data (Dawson *et al.*, 2004b) are deducted. The underlying assumption made is that of constant morbidity, although there is no clear indication on whether healthy life expectancy is rising faster or slower than life expectancy as a whole, that is whether expected period of poor health is getting longer or shorter.

Both life expectancy and quality-adjusted life expectancy tables suffer from the problem that they provide data only for specific ages in the case of the first, or age bands in the case of the second. Hence, it is necessary to interpolate and extrapolate in order to obtain the year-specific figures which we require. The interpolation allows to interpolate/extrapolate up to the age of 95. Life tables provides clearly the reference years around which the spline interpolates, while for the data on quality-adjusted life the assumption is made that they relate to the mid-point of the range shown. For people over 90 the figure is assumed to relate to 94. The method is subject to inaccuracy particularly outside the range of data and thus for the very elderly.

A table showing (i) life expectancy interpolated/extrapolated from the *Annual Abstract* table, (ii) the interpolated/extrapolated difference between total life expectancy and quality-adjusted life expectancy from the 1996 table and iii) the resulting estimate of quality-adjusted life expectancy calculated by subtraction is presented in the Appendix 1-D. Only the figures in column (i) for each sex were updated for the purpose of the research carried out in this chapter, as it became known only at a much later stage that the Government Actuary's website provides life expectancy figures for each year, making the interpolation exercise unnecessary.

The interpolation/extrapolation was carried out by a member of the research group and quality-adjusted life expectancy data were provided to be incorporated in the quality-adjusted output growth index.

1.7.3.2 Waiting times

There are two ways that having to wait for a diagnostic test and/or treatment can affect patients. First, patient can dislike waiting per se irrespective of the effect that deferring treatment may have on their health and ultimately on their discounted sum of quality-adjusted life-years. In this case, waiting time is considered as a characteristic of the healthcare service.

Second, patients' health may be negatively affected by having to wait long periods of time before receiving a treatment, which potentially can have a detrimental effect on patients' health because (a) the condition of a patient can deteriorate whilst waiting for

the treatment, (b) the health gain post treatment may be reduced, and (c) the overall time period over which improved health can be enjoyed is reduced. In this circumstance, waiting time is introduced as a *scaling factor* of the more general health effect. Hurst and Siciliani (2003) found some evidence on deterioration of health and premature death associated with waiting for cardiology treatment.

We will consider in this chapter only the second effect of waiting times. Dawson *et al.* (2005) and Castelli *et al.* (2007a) explore also the introduction of waiting times as a characteristic in the construction of an output growth index.

Two possible ways[31] are identified in Dawson *et al.* (2005) and Castelli *et al.* (2007b) to model waiting as a scaling factor. The first values treatment at the time a person is placed on the waiting list, with health effects being discounted to this date. The second possibility is to value treatment at the time a patient receives treatment, with health effects discounted to the date of treatment. As the aim of an output index is to capture the value of a certain good or service as it is consumed, it is more consistent to measure the benefit of treatment at the time it takes place. Further, this approach implies that longer waits are charged more, so that reducing long waiting times will have a greater impact than reducing short waiting times in the output growth index. In other terms, the charge for waiting can be thought of as the welfare loss associated with not being treated immediately. This is then compared to the benefits of the treatment for the residual lifetime.

We will use waiting time as a scaling factor with discounting to date of treatment with charge for waiting in this chapter.

Two alternative summary statistics are explored. Mean wait and 80^{th} percentile waiting time. The second enables one to capture long waits, which affect not only the individuals that experience these waits but also other patients that are waiting for treatment.

Each patient record in HES contains two fields that allow to calculate the waiting time as the difference between the date a patient is placed on the inpatient waiting list (ELECDATE) and the date the person is admitted to hospital (ADMIDATE).

These fields are used to calculate both mean and 80th percentile. Year-on-year changes in waiting times will be presented in Section 1.8.1 for inpatient elective and day cases only, as emergencies admissions do not experience any waiting time.

Waiting times are also available for a limited number of outpatient specialty areas. Summary figures are presented in Section 1.8.2.

1.8 Results

1.8.1 Hospital output

The total volume of hospital output, for both elective and day cases and emergencies, has increased over the time period considered, as shown in Table 1-4. Year-on-year changes in elective and day case output are volatile. Hence, some volatility in the cost weighted output index, both un-adjusted and quality-adjusted, should be expected. The magnitude of this volatility depends on the crucial interactions between volumes of output, cost weights, and the quality adjustors.

Total volume of hospital emergencies declined up to 2000-01, before registering a steady increase. The sharp increases in the last two years of the time period under investigation are also expected to be reflected in the CWOI; the magnitude of the effect, however, will once more depend on whether the increase is recorded in high cost procedures, and also on the interaction with the quality adjustors.

Table 1-4 - Hospital elective and emergencies output

Year	Volume of Hospital output				
	Elective and day cases	*% change*	*Emergencies*	*% change*	*Total % change*
1998/99	5,380,183		5,609,801		
1999/00	5,443,010	1.17%	5,457,681	-2.71%	-0.81%
2000/01	5,435,477	-0.14%	5,441,082	-0.30%	-0.22%
2001/02	5,343,658	-1.69%	5,458,431	0.32%	-0.68%
2002/03	5,533,727	3.56%	5,804,449	6.34%	4.96%
2003/04	5,692,896	2.88%	6,246,937	7.62%	5.31%

Table 1-5 shows average unit costs for hospital output, respectively for elective and day case inpatient stays and emergencies admissions. In both cases, average unit costs have steadily increased over the time period considered.

Table1-5 - Cost of hospital output

Year	Output weighted average unit costs	
	Elective and day cases	*Emergencies*
1998/99	733	1,111
1999/00	732	1,170
2000/01	779	1,254
2001/02	858	1,358
2002/03	927	1,454
2003/04	937	1,444

Summary statistics for average short-term survival rates, separately for elective and day case and emergencies, are shown in Table 1-6. As expected mean in-hospital survival rates for patients treated as an elective or day case are similar to their respective 30-post discharge figures. Greater differences exist when comparing emergencies in-hospital survival rates to the 30-day post discharge one. Overall, the statistics show a consistent improvement in average survival throughout the time period.

Table1-6 - In-hospital and 30-day post discharge survival rates

Year	Mean in-hospital survival rate		Mean 30-day survival rate	
	Elective and day cases	*Emergencies*	*Elective and day cases*	*Emergencies*
1998/99	0.9964	0.9566	0.9931	0.9464
1999/00	0.9967	0.9558	0.9935	0.9455
2000/01	0.9969	0.9574	0.9939	0.9476
2001/02	0.9970	0.9564	0.9942	0.9467
2002/03	0.9970	0.9585	0.9944	0.9497
2003/04	0.9973	0.9602	0.9949	0.9521

Average remaining life-expectancy is decreasing over the time period considered. A reflection, perhaps, that more elderly patients have been treated in NHS hospitals. This is expected to have a negative impact on the quality-adjusted CWOI.

Table1-7 - Average remaining life expectancy for elective and emergency patients

Year	Output weighted average life expectancy	
	Elective and day cases	*Emergencies*
1998/99	25.28	33.72
1999/00	24.80	34.14
2000/01	24.35	33.89
2001/02	24.12	33.88
2002/03	23.92	33.05
2003/04	23.61	32.68

Year-on-year changes in waiting times for hospital admissions, both mean and 80th percentile, show also some volatility over the period, as shown in Table 1-8.

Table1-8 - Waiting times for hospital admission

Year	Waiting time	
	Mean	*80th percentile waiting time*
1998/99	89.2	134.1
1999/00	81.2	118.5
2000/01	82.8	119.7
2001/02	85.7	125.2
2002/03	89.0	129.7
2003/04	86.1	127.2

1.8.1.1 Hospital output growth index

Hospital output is the only NHS output for which all quality indicators, as described in Section 1.7.3, are available. Therefore we present here the cost weighted output growth indices without any quality adjustment and with all quality adjustments. Quality adjustments will be introduced one at a time to elicit their differential effects on output growth. All tables report the Laspeyres formulations of the output index. The preferred measures of survival and waiting time, respectively 30-day post discharge and 80th percentile waiting time, are used to quality adjust hospital output along side pre- and post-treatment health status and life expectancy.

Table 1-9 shows output growth without any form of quality adjustment; thus, capturing the effect of the increase in volume of hospital output, weighted by average unit costs. As expected the CWOI is positive throughout the period. However, the growth rate in each period does not match the percentage changes in volume (see Table 1-4). A possible explanation can be that changes in output mix have occurred between adjacent years. The effect that we capture with the unadjusted CWOI is then the shift of hospital output towards more complex (i.e. costly) procedures.

Table1-9 - Output growth in the hospital sector

	Hospital - unadjusted CWOI
Laspeyres	
1998/99 - 1999/00	1.85%
1999/00 - 2000/01	0.90%
2000/01 - 2001/02	0.96%
2001/02 - 2002/03	4.45%
2002/03 - 2003/04	5.79%
Average growth	**2.79%**

Table 1-10 shows cost weighted output growth indices adjusted by short-term survival only (column (i)); short-term survival with health effect (column (ii)) and short-term survival, with health effect and life expectancy (column (iii)).

Introducing 30-day post discharge survival rates only has a varied effect on output growth compared to the unadjusted CWOI. The smaller growth in 1998/99 – 1999/00, for example, is due to a considerable decrease in emergency admissions (see Table 1-4),

which are also associated with a decrease in survival rates. The latter has the effect of reducing even further the output growth. In 2000/01 – 2001/02 the slight decrease (about 0.06 percentage points) in the output growth index with survival compared to the unadjusted one is also due to a decrease in survival rates in emergencies admissions. Further, it is worth noting that the impact of survival adjustment depends on the rate of change of survival across HRGs and their cost shares. Our data show that the variations in survival rates are concentrated in relatively few procedures with very high unit costs, with the majority concentrated in procedure with low unit costs.

The impact of allowing for 30-day post discharge survival rates on the output growth indices of the remaining adjacent years is positive, a reflection of improved survival rates. Overall, adjusting hospital output with patients' survival rates has a positive impact on output growth, which increases on average by 3.01 per cent per annum. Compared to the unadjusted CWOI, quality-adjusting output to take into account of improved survival rates adds 0.26 percentage points per annum.

Table1-10 - Output growth in the hospital sector with survival, health effect and life expectancy adjustment

Years	Hospital - simple survival adjustment	Hospital - survival adjust. with health effect	Hospital - survival adjust. with health effect & life expectancy
	(i)	(ii)	(iii)
1998/99 - 1999/00	1.25%	0.74%	1.10%
1999/00 - 2000/01	1.14%	1.48%	1.27%
2000/01 - 2001/02	0.90%	0.84%	0.69%
2001/02 - 2002/03	5.38%	6.45%	6.17%
2002/03 - 2003/04	6.35%	7.11%	7.11%
Average growth	**3.01%**	**3.32%**	**3.27%**

Cut-off set equal to 0.10 in columns (ii) and (iii)

The second column (ii) allows for the positive health effects enjoyed by those surviving hospital treatments. The estimate of the proportionate effect of treatment ($k_j = h_j^0/h_j^*$, see Section 1.7.3.1) for all treatments for which we do not have pre- and post-operative health status is derived from the sample of procedures for which data are available (Castelli *et al.*, 2007a) and is set equal to 0.8 for elective and day case inpatient stays and equal to 0.4 for emergency stays. A cut-off point is introduced for treatments with high mortality rates, to ensure that $a_j - k$ is never negative. For these procedures we adjust only by survival rates and not by survival rates and the assumed health effect.

Dawson *et al.* (2005) carried out a sensitivity analysis of the effect of choosing different cut-off points on the output growth rates, leading to the choice of a cut-off equal to 0.10, which corresponds to a survival rate below 90 per cent.

In all years, except for 1998/99 – 1999/00 and 2000/01 – 2001/02, the health benefits contribute positively to growth over and above the simple survival adjustment. Overall, taking into account improvements in survival after treatment and health effects adds on average 0.21 percentage points per annum and 0.52 percentage points per annum, respectively to the CWOI with survival adjustment only and to the unadjusted CWOI. Thus, it is possible to conclude that survival adjustment which incorporates crude but not implausible adjustments for health effects is capable of significantly adding to the growth in hospital output.

The third column shows the effect of incorporating change in remaining life expectancy into our output growth measure. Life expectancy is estimated at the average age of patients receiving treatment j, and a discount rate is applied to remaining life equal to 1.5 per cent. As average remaining life expectancy is decreasing (see Table 1-7), we expect the growth rates to reflect this. On average hospital output now grows at 3.27 per cent per annum. Output growth rates for most pairs of adjacent years are also smaller.

Table 1-11 shows the hospital output growth rates allowing for waiting times, along side the previous quality adjustments. Waiting times are measured as the 'certainty equivalent wait' at the 80th percentile of the waiting time distribution for each elective HRG. Waiting times are introduced as a scaling factor, with a charge for waiting (set at 1.5 per cent) representing the welfare loss associated with having to wait for a treatment.[32] The same cut-off point for the proportionate change in health effects, conditional on surviving treatment, is introduced as explained above.

Table1-11 - Quality-adjusted output growth

Hospital - quality adjusted CWOI	
Laspeyres	
1998/99 - 1999/00	1.16%
1999/00 - 2000/01	1.24%
2000/01 - 2001/02	0.67%
2001/02 - 2002/03	6.21%
2002/03 - 2003/04	7.22%
Average growth	**3.30%**

Changes in waiting times add on average 0.51 percentage points per annum to the unadjusted CWOI and 0.03 percentage points per annum to the CWOI with survival, health and life expectancy adjustments. In some pairs of adjacent years, the full quality-adjusted CWOI is smaller than the other two. This is due to the fact that the impact of changes in waiting time is dependent on the cost weights associated to each HRG. Our data suggest that most reductions in waiting times are concentrated amongst HRGs with low average unit costs.

In conclusion, our proposed quality-adjusted output index yields higher rates compared to the unadjusted one. This suggests that failing to take into account the quality characteristics of hospital output would result, on average, in an under-estimate of NHS hospital output.

1.8.2 Outpatient activity

A large volume of NHS patients are seen in outpatient settings. These can be organised by GPs who refer their patients to a consultant to obtain a more in depth assessment of their conditions before deciding for the most appropriate course of treatment. These visits are registered as first appointments. A large proportion of patients visit the outpatient department on a number of subsequent occasions, either as part of their healthcare pathway to monitor recovery after a hospitalisation, for example, or to obtain results of diagnostic tests undertaken.

Data on outpatient visits can be found in the Reference Cost database. Changes have occurred with time in the way outpatient attendances have been recorded, with a general

increase in the number of categories over time. Table 1-12 shows how data collection for outpatient activity by type of categories has evolved over time in NHS Trusts where the majority of outpatient activity is carried out. Outpatient first and follow-up appointments are recorded by specialty. The outpatient category 'Pseudo-HRG' refers to outpatient activity that is recorded using a coding system similar to the HRG coding system used for inpatient activity (both elective and emergencies), although the actual codes do not correspond with the one used to group inpatient activity.

Table1-12 - Outpatient categories in NHS Trusts, 1999/00 - 2003/04

	1999/00	2000/01	2001/02	2002/03	2003/04
Outpatient					
First appointments	52	55	57	58	79
Follow-up appointments	52	55	57	61	80
Pseudo - HRG	28	191	191	191	10
Oupatient Maternity					
First appointments	-	4	4	8	8
Follow-up appointments	-	4	4	8	8
Other	-	4	4	-	-

It is possible from the quarterly returns submitted by NHS hospitals (QM08[33]) to attach waiting times to some of the specialties. These quarterly returns gather data for over 60 specialties. The waiting times are reported in weeks for each quarter. The mean outpatient waiting time for those seen during the quarter was calculated as a weighted average of the mid-points of each time band with the number of patients seen employed as the weight for each band (for the over 26 weeks wait we employed 32.5 weeks as the 'mid-point' for this band). To convert this quarterly data into annual waits, a weighted average of the quarterly waits was calculated with weights reflecting the number of outpatients seen in each quarter. Activity weighted average waiting times are reported in Table 1-14.

As explained in Section 1.7.2, our method for calculating the cost weighted output index involves the mapping of new and retiring activities; this may result in total volumes of activity for the same year to be different when compared to two adjacent years in the time series. A summary of the volume of activity by type of outpatient activity is shown in Table 1-13; years in the middle of the time series will have two

figures, the first of which reports volume of activity mapped to the previous year and the second shows volume of activity mapped to the following year.

Table1-13 - Outpatient activity

	1999/00	2000/01	2000/01	2001/02	2001/02	2002/03	2002/03	2003/04
Outpatient								
First appointments	5,626,749	4,881,695	5,847,683	6,216,523	6,234,138	6,501,658	5,395,934	5,877,881
Follow-up appointments	14,002,032	12,998,209	14,549,859	14,979,873	15,104,153	15,390,721	13,632,101	14,034,584
Pseudo - HRG	5,350,427	8,651,305	20,262,255	20,760,092	20,596,752	21,810,858	25,302,800	26,711,255
Oupatient Maternity	-	-						
First appointments	-	-	633,267	616,455	18,788	89,716	689,002	729,867
Follow-up appointments	-	-	1,724,299	1,638,909	80,685	135,084	1,730,165	2,012,874

Aggregated total volumes of activity are shown in Table 1-14, along with activity weighted average unit costs and waiting times.

Table1-14 - Outpatient, activity, average unit costs and waiting times

Years	Volume of activity	Activity weighted average unit costs	Activity weighted average waiting times (weeks)
1999/00	24,979,208	75.94	6.66
2000/01	26,531,209	76.93	5.58
2000/01	43,017,363	78.29	3.59
2001/02	44,211,852	85.65	3.57
2001/02	42,034,516	84.07	3.78
2002/03	43,928,037	90.89	3.31
2002/03	46,750,002	91.45	2.39
2003/04	49,366,461	98.30	2.15

There can be quite remarkable differences in the total volumes of activity included in the calculations of the output growth index for the same year; as can be seen for 2000/01, for example. For this particular year, in fact, the calculation of the output growth index between 2000/01 and 2001/02 uses a volume of activity which is more than double to that compared to the previous year. This is the cause of the huge variability in the average unit costs and waiting times reported for the same years (attached to two 1999/00 and to 2001/02, respectively). It is, hence, very difficult to predict any effect that these will exercise on the cost weighted output growth index. However, activity weighted average unit costs and waiting times appear to be improving

over time, this is likely to be reflected in the quality adjusted CWOI compared to the unadjusted one.

1.8.2.1 Outpatient output growth index

Estimates of output growth are shown in Table 1-15. Overall, the unadjusted and quality adjusted CWOIs reveal an average growth rate of respectively 4.49 and 4.50 per cent per annum. This is an indication that incorporating waiting times has a positive, albeit very small, effect on the average output growth rates; an exception is given for the quality adjusted CWOI between 2000/01 and 2001/02, which is smaller than the unadjusted estimate.

Table1-15 - Growth in outpatient activity

Outpatient - unadjusted CWOI		Outpatient - quality adjusted CWOI	
Laspeyres		**Laspeyres**	
1999/00 - 2000/01	4.435%	1999/00 - 2000/01	4.440%
2000/01 - 2001/02	3.349%	2000/01 - 2001/02	3.345%
2001/02 - 2002/03	4.678%	2001/02 - 2002/03	4.713%
2002/03 - 2003/04	5.483%	2002/03 - 2003/04	5.500%
Average growth	**4.49%**		**4.50%**

1.8.3 Mental Health care services

Data on services provided to patients affected by mental health conditions is available from two sources. The HES database records services provided to patients with mental health problems by HRGs. The HES database includes also data on a patient's waiting times and survival rates. Further, using information on patient's gender and average age in each HRG and combining this with life tables and the 1996 Health Survey for England (Prescott-Clarke and Primatesta, 1998), it is possible to calculate average life expectancy for each HRG in mental health. The HES data on mental health are described in section 1.8.3.1. The Reference Costs database also contains information on services provided to patients with mental health conditions; these are described in section 1.8.3.2.

1.8.3.1 Inpatient data from HES

HES data on services provided to patients with mental health conditions is grouped to form CIPS of mental health HRGs (T codes). Volumes of mental health inpatient output are reported in Table 1-16. These have fallen over time for activity undertaken both in an elective setting and as emergencies up to 2001/02; after this year volumes of activity first increase and then decrease for elective and day case patients, whilst emergencies show an upward trend. The sustained decrease in activity undertaken as elective and day cases might be an indication of efforts made to treat patients in other settings rather than to hospitalising them.

Table1-16 - Mental Health output recorded in HES

Year	Volume of output	
	Elective and day cases	*Emergencies*
1998/99	46,883	173,949
1999/00	44,569	160,485
2000/01	44,156	154,524
2001/02	42,917	149,053
2002/03	44,366	159,293
2003/04	43,435	164,840

Reference cost data do not report the average unit costs of treating mental health conditions by HRGs; hence, we have assigned the average cost of other mental activity reported in the Reference Costs database to mental health HRGs (group T) recorded in HES. These have resulted in the following average unit costs assigned to CIPS HRGs for mental health (Table 1-17).

Table1-17 - Costs applied to mental health inpatient output

Year	Output weighted average unit costs	
	Elective and day cases	*Emergencies*
1998/99	163	210
1999/00	172	250
2000/01	186	273
2001/02	174	281
2002/03	204	291
2003/04	213	313

Survival rates for mental health patients are reported in Table 1-18. Survival rates are improving over the time period considered, although no particular trend is emerging.

This will have an effect on the quality-adjusted CWOI, with some variability to be expected.

Table1-18 - Survival rates for mental health patients

Year	Mean in-hospital survival rate		Mean 30-day survival rate	
	Elective and day cases	*Emergencies*	*Elective and day cases*	*Emergencies*
1998/99	0.9853	0.9728	0.9783	0.9611
1999/00	0.9862	0.9707	0.9802	0.9598
2000/01	0.9860	0.9717	0.9798	0.9608
2001/02	0.9889	0.9683	0.9833	0.9566
2002/03	0.9858	0.9682	0.9808	0.9582
2003/04	0.9860	0.9695	0.9812	0.9597

A similar pattern emerges also for life expectancy, which are driven partly by the survival rates and partly by the age/gender mix of mental health patients in each given year (see Table 1-19).

Table1-19 - Life expectancy for mental health patients

Year	Output weighted average life expectancy	
	Elective and day cases	*Emergencies*
1998/99	28.72	25.10
1999/00	29.25	25.18
2000/01	29.52	25.01
2001/02	29.31	24.64
2002/03	28.74	24.18
2003/04	28.99	23.65

Waiting times are reported in Table 1-20, these do not show any particular trend, although up to 2000/01 there appears to be an improvement for both mean and 80th percentile waiting time. After that waiting times have a variable trend.

Table1-20 - Waiting times for mental health patients

Year	Output weighted average waiting time	
	Mean	*80th Percentile*
1998/99	30.76	30.91
1999/00	26.62	26.75
2000/01	23.21	23.21
2001/02	28.50	28.71
2002/03	27.16	27.29
2003/04	63.20	34.60

1.8.3.2 Activity in Reference Costs

Mental health activity in the Reference Cost is reported in different categories (see Table 1-21). These have evolved over time, with more categories being added every year.

Table1-21 - Mental Health activities in Reference Costs

	Unit of measurement	2000/01	2001/02	2002/03	2003/04
Inpatient Data	Occupied bed days	5	5	5	5
Booked Appointments Data	First Appointment	-	4	4	4
Outpatient Data	First Attendance	4	-	-	-
Booked Appointments Data	Follow up Appointment	-	4	4	4
Outpatient Data	Follow up Attendances	4	-	-	-
Domiciliary Visit Data	Visits	2	2	2	2
Secure Unit Data	Occupied bed days	-	4	10	9
Specialist Services Inpatient Data	Occupied bed days	-	4	3	4
Specialist Services Booked Appointments Data	First Appointment	-	4	4	4
Specialist Services Booked Appointments Data	Follow up Appointment	-	4	4	4
Specialist Teams	Clients seen	-	1	1	1
Day Care Facilities	Patient days	-	-	1	1

Inpatient data in the Reference Costs is recorded on the basis of occupied bed days, total number of which is reported in Table 1-22. As explained earlier (see Section 1.7.2), only activity that was recorded in any two consecutive years is included; hence, it is not possible to draw any defining conclusions in existing trends.

Table1-22 - Inpatient occupied bed days, Reference Costs

Year	Occupied bed day	
	Inpatients	*Specialist Services*
2000/01	9,827,178	-
2001/02	10,466,514	-
2001/02	10,470,063	65,045
2002/03	10,455,038	69,093
2002/03	10,455,038	73,925
2003/04	9,456,791	75,795

Table 1-23 reports volume of activity and average unit costs for all mental health services recorded in the Reference Costs with the exclusion of inpatient activity. The figures show an increasing trend for volumes of activity included in the calculation of the output growth index. No clear trend emerges for average unit costs.

Table1-23 - Mental Health activity in Reference Costs, excluding inpatient activity

Year	Volume of activity	Activity weighted average unit costs
2000/01	5,922,305	107.35
2001/02	8,178,005	111.70
2001/02	10,219,416	141.67
2002/03	10,693,796	139.75
2002/03	14,311,174	134.95
2003/04	14,967,284	148.43

1.8.3.3 Growth in Mental Health Activity

The growth rates for mental healthcare activity are reported in Table 1-24. These were calculated using inpatient data from HES and all remaining mental healthcare data from the Reference Costs. Due to the fact that Reference Costs data are only available from 2000/01, output growth rates are first presented separately for the inpatient mental activity as reported in HES and all other mental health activity as reported in the Reference Costs. A column that combines all data into one single output growth index is also provided. The quality-adjusted output growth estimates are presented only for HES inpatient mental health activity, as no quality adjustors are available for activity reported in the Reference Costs; hence, in the second part of Table 1-24 only HES and 'All' quality-adjusted output growth estimates are given.

Table1-24 - Growth in mental health care activity

	Mental Health - unadjusted CWOI		
	HES	*Reference Costs*	*All*
1998/99 - 1999/00	8.30%	-	8.30%
1999/00 - 2000/01	3.32%	-	3.32%
2000/01 - 2001/02	-4.10%	36.19%	33.23%
2001/02 - 2002/03	15.59%	6.64%	6.84%
2002/03 - 2003/04	10.12%	3.16%	3.35%
Average growth	**6.65%**	**9.20%**	**11.01%**

	Mental Health - quality adjusted CWOI	
	HES	*All*
1998/99 - 1999/00	7.42%	7.42%
1999/00 - 2000/01	4.00%	4.00%
2000/01 - 2001/02	-4.86%	33.17%
2001/02 - 2002/03	15.05%	6.83%
2002/03 - 2003/04	10.38%	3.36%
Average growth	**6.40%**	**10.96%**

Looking at the unadjusted CWOI first, the estimates for HES inpatient activity (first column in Table 1-24) show some variability in the growth trend. In particular, a positive growth in mental health inpatient activity is interrupted in the period 2000/01 – 2001/02. This is part due to a decrease in the volume of activity in 2001/ 02 compared to the previous year for both elective and emergencies (see Table 1-16). The decrease in volume of activity is also emphasised by a decrease in average unit costs (see Table 1-17). The second column in Table 1-24 reports unadjusted cost weighted output growth estimates for mental health activity as reported in the Reference Costs. These results need to be interpreted very carefully as the major increase between 2000/01 and 2001/02, is due to improved recording of mental health activity, rather than to a genuine increase in the number of mental health services offered.

A similar pattern emerges also for the quality-adjusted CWOI for HES inpatient activity. The impact of quality adjusting inpatient mental health activity varied over the time period considered. In three cases the quality adjustment has produced a smaller output growth estimate: between 1998/99 and 1999/00, 2000/01 and 2001/02, and 2001/02. The first is mainly driven by the decrease of inpatient activity, although more costly types, as reflected in the positive unadjusted CWOI for these two years. The

second and third are driven by a combination of reduced life expectancy and increased waiting times associated with both elective and emergency output.

The overall quality-adjusted CWOI from 2000/01 onwards will reflect the effects of combining in one output growth estimate both the quality adjusted activity and the unadjusted activity. No further conclusions can be drawn.

1.8.4 Primary care consultations and prescribing

In this section we assess the output growth in the primary care sector. General practice activity is captured in our measure of NHS output in terms of primary care consultations and prescriptions. Primary care consultations are not measured directly so we have to rely on survey information; on the other hand detailed data are collected about every prescription dispensed in England.

1.8.4.1 Primary care consultations

Estimates of consultation activity are derived from the consultations reported by respondents in the General Household Survey. Respondents are asked about consultations in the previous 14 days. The estimate of the number of consultations per year is made by multiplying the number of reported consultations in the 14 days prior to interview by 26.

Information is available on the location of the consultation (surgery, home, phone) and, after 2000, by provider (GP, practice nurse). From 1988 the GHS has collected data over a financial year (April to March). No allowance has been made for seasonal factors - the date of the consultation varies across respondents and has also varied between rounds of the GHS. There have been large changes in the numbers of consultations reported in the GHS for some age-gender groups from one year to the next. Further, in 1999/2000 no GHS was held, so that estimates for this particular year had to be interpolated from values from previous years.

Table 1-25 reports estimates of activity by type of consultation. The same unit costs were used for each year, except for 2003/04[34]. These are reported in the table below.

Table1-25 - Activity (000 contacts) and costs in primary care

	Activity						Cost	
	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	All years	2003/04
GP Home Visit	11,067	11,144	8,580	9,982	12,050	12,309	47	50
GP Telephone	19,964	20,102	17,600	22,568	21,690	22,144	17	19
GP Surgery	154,504	155,572	157,740	169,477	192,800	203,774	15	16
GP Other	31,465	31,683	36,080	14,973	14,460	11,906	20	22
Practice Nurse	-	-	-	81,000*	84,000	96,995	8	8
Total	**217,000**	**218,500**	**220,000**	**217,000**	**241,000**	**250,133**		

* Practice Nurse consultations are not included in the output growth measure for 2000/01 and 2001/02.

Estimates of primary care consultations show some variability across years and by type of consultation. Overall, and except for 2001/02, these appear to increase over time. As unit costs are the same for the first 6 years, fluctuations in the output growth measure will be driven by changes in volumes of activity, whilst for the years 2002/03 and 2003/04 the output growth measure will also be affected by the increase in consultations' unit costs as reported.

1.8.4.2 Primary care prescribing

Current DH practice is to consider prescriptions dispensed by GPs as activity and hence, these will be included as health care outputs in our measure of NHS output. Technically, however, prescriptions should be treated as an input in the production of health. In the hospital sector, for example, drugs administered enter the output index as an element of the cost weight (Reference Cost) attached to each treatment and are not counted separately as activities.

Nonetheless, one can justify the inclusion of prescription drugs in the primary care sector as an activity on the following grounds: (i) they constitute GPs value added through prescribing and (ii) the value GPs add to healthcare output is not reflected in the assumption that the wage rate approximates the marginal product of GPs.

The volume of primary care prescriptions is derived from Prescription Pricing Authority (PPA) data. Table 1-26 shows the volume of dispensed prescriptions in the primary care sector, which has increased in the time period under investigation.

Table1-26 - Volume of primary care prescriptions, PPA data

Year	Categories	Volume of activity
1998/99	178	509,261
1999/00	178	526,630
2000/01	178	553,207
2001/02	184	583,150
2002/03	186*	614,902
2003/04	186	649,155

* In the calculation of the output growth measure for 2001/02 and 2002/03 only 184 categories for 2002/03 are used that match up with the same categories collected for 2001/02.

Costs data are also available, which are used to weight prescribing activity.

1.8.4.3 Growth in primary care activity

Growth rates in the primary care sector are calculated as an unadjusted cost-weighted output index, these are reported in Table 1-27 for the Laspeyres measure. The first column of figures shows growth rates for primary care consultations only, whilst the last column includes also growth in prescriptions dispensed.

Table1-27 - Growth in primary care and prescribing activity

Year	Primary Care	Primary Care & Prescribing
1998/99 - 1999/00	0.69%	3.11%
1999/00 - 2000/01	-1.11%	3.09%
2000/01 - 2001/02	-2.53%	3.35%
2001/02 - 2002/03	10.27%	8.89%
2002/03 - 2003/04	4.96%	6.55%
Average growth	**2.46%**	**5.00%**

Figures for primary care consultations show a decreasing trend in the early years, followed by a rapid increase for the years 2001/02 and 2002/03 and a further slowdown in the last two years of the time series.

The growth rates for the primary care sector show some variability throughout the entire period; overall, the figures show an average 5 per cent per annum.

1.8.5 Other health care services

This section considers all other categories of NHS activity reported mainly in the Reference Costs and activity for NHS Direct, NHS Direct Online and Walk-in-Centres. The unit in which these activities are reported differs substantially; therefore, we describe them under several broad headings.

As the starting year of Reference Cost data collection varies for different activities, great variability across categories is to be expected. For most NHS activity, data collection has become more extensive with always greater number of categories being included every year. It is not, however, unlikely to find cases where data collection has been either discontinued or for which re-groupings[35] have taken place. As explained elsewhere, other NHS activities were mapped in any two adjacent years, where necessary; this may result in volumes of activity for the same year to be different when compared to the adjacent years in the time series.

1.8.5.1 Other NHS activity in Reference Costs

Activity for Accident & Emergency was first reported in the Reference Costa database in 2000/01, with type of activity recorded increasing over the time period considered. Ambulance services were first reported in the Reference Cost in 2002/03, prior to that year only the total number of emergency journeys was recorded. This data was made available to us by the Department of Health. See Table 1-28.

Table1-28 - A&E and ambulance services

Year	Categories	
	A&E	*Ambulance*
1998/99	-	1
1999/00	-	1
2000/01	9	1
2001/02	9	1
2002/03	12	69*
2003/04	12	69

Table 1-29 shows the volumes of activity both for A&E and Ambulance services, which have been increasing throughout the time period considered. Please note that in the last two years of the time series under investigation, a substantial increase of the number of

categories has occurred, going from one category only to 69. The greater detail with which Ambulance services are now collected could explain some of the increase in the volume of activity recorded, which therefore cannot be considered as genuine increases in volumes.

Table1-29 - A&E and ambulance, volume of activity

Year	A&E	Ambulance
	Attendances	*Emergency journeys/Incidents/ Responses*
1998/99	-	2,720,000
1999/00	-	2,850,000
1999/00	-	2,850,000
2000/01	-	2,910,000
2000/01	11,016,935	2,910,000
2001/02	11,013,425	3,090,000
2001/02	11,013,425	3,090,000
2002/03	13,956,924	3,178,000
2002/03	13,956,924	5,193,302
2003/04	14,706,365	5,464,831

Clinical measurement, pathology and radiology tests categories are shown in Table 1-30, and volume of activity in Table 1-31. The total number of clinical measurement and pathology tests have been increasing throughout the time period, whilst radiology have registered more volatile changes. Part of the volatility in the total numbers can be explained by the extension of the categories in which activity is recorded, which made it sometimes impossible to map old and new categories.

Table1-30 - Clinical measurement, pathology and radiology tests, categories

Year	Categories		
	Clinical measurement tests	*Pathology tests*	*Radiology*
1998/99	-	-	-
1999/00	-	-	-
2000/01	-	10	18
2001/02	-	11	18
2002/03	7	11	23
2003/04	7	11	23

Table1-31 - Clinical measurement, pathology and radiology, volume of activity

Year	Clinical measurement tests	Pathology tests	Radiology
	Number of Tests	*Number of Tests*	*Number of Tests*
1998/99	-	-	-
1999/00	-	-	-
1999/00	-	-	-
2000/01	-	-	-
2000/01	-	78,164,296	5,506,811
2001/02	-	95,487,658	5,108,087
2001/02	-	95,982,120	5,048,073
2002/03	-	112,943,034	5,117,269
2002/03	177,211	112,947,762	5,064,983
2003/04	279,570	153,275,528	5,293,747

The types of audiological services offered by the NHS include hearing aids, and hearing aid repairs, neonatal screening, etc. Table 1-32 shows that the total number of categories reported is decreasing, although the total volumes of activity for this healthcare services is substantially increasing in 2003/04 compared to the first year of the time series (see Table 1-33). Some volatility in recorded volumes is due to our mapping procedure.

Table1-32 – Audiological and critical care services

Year	Categories	
	Audiological services	*Critical care services*
1998/99	-	7
1999/00	-	9
2000/01	6	10
2001/02	6	11
2002/03	3	11
2003/04	3	11

Critical care services, also shown in Tables 1.32 and 1.33, regard intensive care services offered to both babies and adult for a number of high risk ailments (e.g. special care baby unit, coronary care unit, and burns intensive care). These appear to have increased substantially throughout the time period, along with an increase in the number of categories reported in the Reference Costs.

Table1-33 - Audiological and critical care services, volume of activity

Year	Audiological services	Critical care services
	Activity	*Bed days*
1998/99	-	1,587,599
1999/00	-	1,671,545
1999/00	-	1,696,962
2000/01	-	1,721,974
2000/01	412,073	1,768,761
2001/02	357,702	2,008,297
2001/02	638,123	2,020,411
2002/03	357,718	2,014,846
2002/03	1,456,087	2,014,846
2003/04	1,968,143	2,090,733

The number of sessions of renal dialysis and the number of kidney transplantation recorded in the Reference Cost data do not show any clear pattern in the volume of activity over time (see Tables 1.34 and 1.35). Spinal injuries (measured as bed days) and Community services (measured in terms of attendances, first contacts, etc) have all increased over time.

Table1-34 - Renal dialysis & kidney transplantation, spinal injuries and community services

Year	Categories		
	Renal dialysis & kidney transplantation	*Spinal injuries*	*Community Services*
1998/99	-	-	-
1999/00	-	-	-
2000/01	4	-	-
2001/02	4	1	13
2002/03	7	1	47
2003/04	7	1	47

Table1-35 - Renal dialysis, kidney transplantation and community services

Year	Renal dialysis & kidney transplantation	Spinal injuries	Community Services
	Sessions/ episodes	*Bed days*	*Various*
2000/01	6,005,375	-	10,720,595
2001/02	7,069,042	-	14,216,401
2001/02	7,069,042	99,018	14,216,401
2002/03	6,179,293	110,266	13907717
2002/03	6,712,142	110,266	28,546,059
2003/04	7,650,658	110,859	27,922,818

Day Care, hospital at home, regular admission and ward attenders activities were first recorded in the Reference Cost data in 2002/03. Day care activity captures regular attendance mainly for stroke and elderly patients. Volumes of activity are increasing for all, except for hospital at home, which decreased by almost 35 percent.

Table1-36 - Day care and hospital at home

Year	Day Care		Hospital at home	
	Categories	*Attendances*	*Categories*	*Contacts*
2002/03	3	784,362	1	70,369
2003/04	3	798,197	1	46,072

Table 1-37 - Regular admission and ward attenders

Year	Regular Admissions		Ward Attenders	
	Categories	*Admissions*	*Categories*	*Attendances*
2002/03	260	70,383	49	646,981
2003/04	260	96,286	49	854,640

The last two NHS activities included recorded in the Reference Cost data are chemotherapy and radiotherapy. Activity data for the former was introduced in 2001/02 and was discontinued in 2003/04. Activity on radiotherapy was first reported in 2002/03.

Volume of activity for sight tests and courses of dental treatment are shown in Table 1-38. Information on both was made available by the Department of Health. Sight tests

are increasing throughout the period (except for 2002/03), whilst dental treatments are more or less stable.

Table1-38 - Ophthalmology and Dentistry

Year	Ophthalmology		Dentistry	
	Categories	*Tests*	*Categories*	*Courses of treatments*
1998/99	1	6,993,000	1	32,133,360
1999/00	1	9,399,000	1	31,819,636
2000/01	1	9,567,000	1	32,326,618
2001/02	1	9,808,000	1	32,269,602
2002/03	1	9,662,000	1	32,071,232
2003/04	1	9,846,000	1	32,347,793

1.8.5.2 Output growth index for all other NHS activity

Table 1-39 reports growth in all these activities, weighted by their average unit costs. The growth rate is positive. However, no clear pattern emerges. This is probably due to the fact that new activity is added every year, new categories are added within existing activity, and also that coverage of existing activity has improved over time.

Table1-39 – Output growth in other NHS activity

Year	Other NHS activity - unadjusted
1998/99 -1999/00	3.76%
1999/00 - 2000/01	1.93%
2000/01 - 2001/02	6.80%
2001/02 - 2002/03	0.58%
2002/03 - 2003/04	2.45%
Average growth	**3.11%**

1.8.6 NHS Direct, NHS Direct Online and Walk-In Centres

NHS Direct, NHS Direct Online and Walk-In Centres are recent innovations in the provision of first contact advice and information to NHS patients. These initiatives are designed to fulfil a role not previously offered by the NHS and to act as a substitute provider of advice and health information (e.g. diverting activity from general practice). Further, they are expected to reduce the costs of first contacts in the NHS.

NHS Direct is a 24 hour telephone service providing nurse advice and health information on (*i*) the steps to take if a person is feeling unwell; (*ii*) particular health conditions; (*iii*) local healthcare services, such as doctors, dentists or late night opening pharmacies; and (*iv*) self help and support organisations. Their Online service provides similar health information and advice; it is also supported by a 24 hour nurse advice and information helpline.

NHS Walk-In Centres offer a range of NHS services, including health information, advice and treatment for a range of minor illnesses and minor injuries. They are run by experienced NHS nurses, and are accessible every day of the week without an appointment.

Aggregate data on use of NHS Direct and NHS Direct Online were provided by the Economic and Operational Research (EOR) Division within the DH. Figures of volume of activity and their relative unit costs are reported in Table 1-40. These are available only from 2001/02 onwards.

Table1-40 - NHS Direct, NHS Direct Online and Walk-in-Centres, activity and cost data

	2001/02*		2002/03		2003/04	
	Activity	Cost	Activity	Cost	Activity	Cost
NHS Direct	5,356	20.35	5,938	20.04	6,427	18.98
NHS Direct Online	2,028	0.79	3,972	0.40	6,368	0.13
Walk-in-Centres	1,154	21.82	1,375	14.25	1,625	14.15

*Volumes of activity for 2001/02 will enter the calculations of the overall output growth index (see Section 7.2) only for the years 2001/02 and 2002/03.

The figures show a gradual increase in the volumes of activity reported by all three organisations. Unit costs, on the other hand, show a decreasing trend which will depress the impact of the increasing volumes of activity on the output growth measures.

1.8.6.1 Growth in NHS Direct, NHS Direct Online and Walk-in-Centres

Output growth figures are shown in Table 1-41. These show on average an increase in output of just less than 12 per cent per annum of the three year period for which activity data is available. The decrease in the last period reflects the decreasing unit costs, as shown in Table 1-40.

Table1-41 - Growth in NHS Direct, NHS Direct Online and Walk-in-Centres

Year	NHS Direct, NHS Direct Online & Walk-in-Centres
2001/02 - 2002/03	13.40%
2002/03 - 2003/04	10.23%
Average growth	**11.82%**

1.8.7 Overall Output growth

Table 1-42 reports output growth indices for the entire NHS. Output indices are reported in the Laspeyres form, which is also commonly used in the UK national accounts.

As has been reported in great detail in the previous sections, the reporting of Reference Cost data has increased substantially over time, with new categories being added to existing data and with improvements in the quality of reporting by NHS providers. Hence, care should be taken when interpreting output growth data, especially in the first years from the introduction of the Reference Costs in 1998/99.

Table1-42 - Output growth for the NHS

	CWOI, unadjusted	CWOI, 30-day survival adjustment	CWOI, quality adjusted
1998/99 - 1999/00	2.61%	2.33%	2.22%
1999/00 - 2000/01	2.11%	2.22%	2.26%
2000/01 - 2001/02	3.85%	3.83%	3.74%
2001/02 - 2002/03	5.07%	5.39%	5.78%
2002/03 - 2003/04	4.43%	4.62%	4.93%
Average growth	**3.62%**	**3.68%**	**3.79%**

The first column shows the simple cost weighted output growth measure. NHS output has increased on average by 3.62 per cent per annum. Adjusting NHS hospital output by 30-day post discharge survival, adds on average 0.03 per cent per annum to the output growth measure. Some volatility in the estimated figures exists in the earlier years, which results in smaller survival-adjusted output growth figures. The reduction is particularly important in 1998/99 – 1999/00. As the survival adjustment interest only hospital output data, one has to look at these data to find the main drivers of the reduced

figures. These can, in fact, be explained with a considerable decrease in emergency admissions, which are also associated with a decrease in survival rates.

The introduction of all remaining quality characteristics reduces the estimates of output growth in the first years. This negative adjustment is primarily due to the decrease in survival rates for a number of high activity high cost HRGs. Overall, incorporating all quality adjustments, that is survival with changes in health status and in life expectancy as well as improvements in waiting times, adds about 0.2 per cent per annum to the overall output growth measure compared to the unadjusted index and about 0.1 per cent per annum to the output index with 30-day post discharge survival adjustment. Thus, we conclude that failing to take into account improvements in survival rates would result in an underestimate in the true growth of NHS output.

1.9 Conclusions and implications for policy and future research

This chapter has considered the development of a measure of output growth for the healthcare sector. Three major challenges are involved in measuring output growth of the healthcare system:

It is necessary to identify and quantify **healthcare output** correctly. We distinguish between *activity*, *output* and *outcome*. We define output as courses of treatment that may require a bundle of *activities* (tests, surgery, drugs, etc.) and *outcome* as the quality characteristics of healthcare output that individuals value (health improvement, waiting time, being treated with dignity, etc.). We identified as the unit of output the patients treated. This requires the knowledge of all the services that were delivered to patients with particular conditions. The IT system in the NHS does not currently allow tracking patients across all of the settings in which they receive care (primary and secondary sectors, for example). However, and limited to hospital activity, the HES database includes information that enables us to at least track patients across consultants within providers and also across providers. We label this unit of NHS hospital output 'Continuous Inpatient Spell (CIPS) of NHS care'. All remaining NHS services are

included in the output growth in the units of activity that they are collected and reported in our various sources. These vary from number of tests performed to bed days, to attendances, etc.

It is important when aggregating all NHS services into a single index, to determine some way of assessing their relative **value**. In principle, marginal social values of different NHS outputs should be used. The standard assumption in the national accounting literature is that marginal social values are measured by the unit costs of production. This requires two assumptions: 1) average unit costs are equal to marginal costs and 2) that resources are allocated efficiently within the NHS. These two assumptions, if they hold, imply that marginal costs of different outputs are proportional to their marginal social values. These assumptions are highly questionable. However, in the absence of marginal social values, and until these data will become available some other measure is needed, and we decided to use unit costs derived from the National Schedule of Reference Costs.

Quality of healthcare goods and services is likely to be an important source of output growth. Two challenges are involved: 1) identifying and defining what constitutes the quality of healthcare and 2) develop a way of incorporating these quality characteristics into an output growth index. We have identified the following quality adjustors: survival rates, pre- and post-treatment health status for a limited number of hospital outputs, life expectancy and waiting times. These data are currently available only for patients admitted to hospitals as inpatients; hence, the quality adjustments will be carried out only for output delivered in the hospital sector. Further, waiting times data is available for a limited to number of outpatient specialties. All remaining NHS activity is included without being quality adjusted, weighted according to their average unit costs.

We have demonstrated how quality change can be accounted for in an output growth index, given current data availability. Further, we have analysed the effects on a cost weighted output index of introducing these quality adjustments. Given current data availability, it was possible to fully quality-adjust hospital output only, and to some extent outpatient activity; we recommend to extend the quality adjustments to other areas of healthcare; in particular, the primary care sector.

Quality-adjusting output adds on average about 0.2 per cent per annum to the simple cost weight output growth measure. In 2001/02 – 2002/03 and 2002/03 – 2003/04 alone, it adds between 0.50 and 0.73 percentage points.

Further, we strongly recommend that the NHS makes it a priority to start the routine collection of health outcomes data. These are important not only to be used in improved measure of healthcare output growth, but could also successfully be used in surveillance of clinical performance, resource allocation, and informing patient choice.

Although we maintain that health outcomes and waiting times are the most important elements of quality to incorporate in an output growth measure, we realise that other quality aspects of healthcare should be explored and included in the model, such as measures of patient experience.

[1] The 'Classification of the functions of government' or COFOG as provided in the System of National Accounts 1993 (UN, OECD, IMF, CEC and World Bank) identifies ten broad functions: General Public Services; Defence; Public Order and Safety; Economic Affairs; Environmental Protection; Housing and Community Amenities; Health, Recreation, Culture and Religion; Education and Social Protection.

[2] It is worth noting that the analysis carried out for the measurement of healthcare output and productivity is strictly related to that for social care, particularly because of the existence of so-called 'joint products' (Atkinson, 2005), especially in the area of community mental health services. Although we do not address the issue of 'joint products' and the effects that changes in the provision on goods and services in one area can have in another, it is important to be aware of these links and the potential effects that these may have.

[3] A methodological framework is presented in the Atkinson review (2005) to direct the National Statistician in the measurement of the goods and services produced by the public sector, the inputs used in the production process, and upon which to base a productivity measure. This is summarised in nine general principles, reproduced in Appendix 1-A.

[4] HMIC is made up of three different databases: Department of Health-Data, the King's Fund Database and HELMIS. DH-Data and the King's Fund database include all the major health related academic journals. EconLit is a comprehensive, indexed bibliography with selected abstracts of the world's economic literature, produced by the American Economic Association. It includes coverage of over 400 major journals as well as articles in collective volumes (essays, proceedings, etc.), books, book reviews, dissertations, and working papers licensed from the Cambridge University Press Abstracts of Working Papers in Economics.

[5] Scitovsky (1964) cited in Berndt *et al.* (2000).

[6] The difficulty in measuring and pricing healthcare goods and services is one that more generally relates to the output of the government sector.

[7] A QALY is "a generic measure of health-related *quality of life* that takes into account both the quantity and the quality generated by interventions" (Culyer, 2005).

[8] The categories of treatments and activity included in the healthcare output measure up to 2004 were: Inpatient and day case episodes; Outpatients, Accident & Emergency and Ward Attenders; Regular day patients; Chiropody; Family Planning; Screening; Health Visiting; District Nursing; Community psychiatric nursing; Community learning disability nursing; Dental (part); Ambulances; GP consultations; GP prescribing; Dental (part); Ophthalmic services (Pritchard, 2004b).

[9] The term 'feasible' attributed to this specific version of Dawson *et al.* value weighted output index is due to Castelli *et al.* (2007).

[10] The method is described in Section 6.2.

[11] The full recommendation to ONS on all four quality dimensions (recommendation 8.5) can be found in Appendix 1-A.

[12] A number of index formulations are usually employed in the National Accounts: Laspeyres index, Paasche index, Fisher index. In the Laspeyres formulation, activities are valued at unit costs in the base period (time t), whilst in the Paasche formulation, unit costs/weights of the current period ($t+1$) are used. The Fisher index is calculated as the geometric mean of the Laspeyres and the Paasche indices. The latter two can be seen as measuring similar entities but at the two extremes, with the Laspeyres index placing emphasis on the base period and the Paasche index on the current period. We choose to present our indices and results using the Laspeyres formulation as it is the most commonly used in the National Accounts.

[13] HRGs were first introduced in 1992. Since then they have had a number of revisions. The latest version - HRG4 -was introduced in 2006/07.

[14] For further information see http://www.statistics.gov.uk/ssd/surveys/general_household_survey.asp (last accessed 18/11/08).

[15] Further details on the GHS sample design and sampling errors can be found in Appendix B and Appendix C of the GHS Report for different years. The most recent (2007) is available at http://www.statistics.gov.uk/StatBase/Product.asp?vlnk=5756 (last accessed 21/05/2009).

[16] Other sources of data for primary care consultations are the QRESEARCH database and the Health Survey for England. The QRESEARCH database was explored in Dawson *et al.* (2005), and is currently used in the latest NHS output growth measures. For further details see Castelli *et al.* (2008).

[17] http://www.pssru.ac.uk/pdf/uc2003/uc2003.pdf (last accessed 19/11/08).

[18] http://www.ic.nhs.uk/pubs/gpworkload (last accessed 19/11/08). This is a link to the 2006/07 UK GP Workload Survey.

[19] See above.
[20] The reimbursements and remunerations do not apply to private prescriptions and to non-prescription drugs, Further details are available at http://www.ppa.org.uk/ppa/process_and_drug_charging.htm (last accessed 25/11/08).
[21] Dawson *et al.* (20050 estimated that only about 1 per cent of all patients admitted to hospital are transferred to a different provider at the end of an episode and within the same spell of healthcare.
[22] The most recent version of HRG (v 4.0) HRG version 4, is also spell based and assigns the HRG code on the basis of the dominant/most costly procedure within the spell (NHS, 2008).
[23] This statement is made in reference to the dismissal of the "output=input approach" in measuring non-market output growth.
[24] For the full list of identified drawbacks of using pre- and post-treatment health measures from clinical trails see Dawson *et al.* (2005)
[25] EQ-5D is a standardised instrument to be used as a measure of health outcome. Applicable to a wide range of health conditions and treatments, it provides a simple descriptive profile and a single index value for health status. EQ-5D was originally designed to complement other instruments but is now increasingly used as a 'stand alone measure' – from the EuroQol Group website (http://www.euroqol.org/, (last accessed 1/12/2008).
[26] We are aware that the Department of Health appointed the London School of Hygiene and Tropical Medicine to carry out pilot studies to elicit pre- and post-treatment health outcomes for the following procedures: cataract surgery, hip and knee replacement, varicose veins procedures and hernia repairs. The pilot uses several patient reported outcome measures with the aim of identifying those that could be best used for the purpose of measuring changes in health before and after an intervention.
[27] 'The SF36 (Short Form 36) is a multi-purpose, short-form health survey of thirty-six questions, which yields an eight-scale generic profile of health status and psychometrically base physical and mental health summary measures and a *preference*-based health *utility* index (quality-adjusted life–years)'. (Culyer, 2005)
[28] The Hospital Trust collected data using both SF36 and SF12 instruments. However, the Hospital Trust changed the instrument administered to patients part way through the data collection exercise. As a consequence some patients completed the SF36 questionnaire during their pre-operative appointment and the SF12 questionnaire post-operation. In order to identify time trends, which is part of the objective of this chapter, we have considered it important to retain in our analysis only those patients, who had completed the same questionnaire (SF36) before and after receiving the intervention were retained.
[29] Vf14 (Visual Functioning) is a condition-specific index of functional impairment for patient that are affected by cataracts (Steinberg *et al.*, 1994). The instrument assesses a patient's ability to perform fourteen different activities that are vision-dependent, such as reading or watching television.
[30] These are both calculated from mortality rates, as 1 – mortality rate.
[31] Atkinson suggests that this quality indicator should be measured as the time period between when the first symptoms of ill-health were addressed through to the completion of the treatment. This is currently infeasible.
[32] The term 'charging' is used to reflect the monetary costs associated with having to wait. The higher the wait, the higher the premium paid by the NHS and the lower the weight attached to hospital output. The choice of an interest rate of 1.5 % is taken from Dawson *et al.* (2005). A sensitivity analysis carried out in Dawson *et al.* (2005, p.91) comparing the effects of including waiting time adjustment in the output index with an interest rate equal to 1.5% and 10%. The results show that no significant differences emerge.
[33] http://www.performance.doh.gov.uk/waitingtimes/index.htm, last accessed 21/11/08.
[34] Unit cost data for GP consultations and Practice Nurse consultations were provided by the Department of Health. These can be found in the publication 'Unit Costs of Health and Social Care' by the PSSRU at the University of Kent. We have used the same unit costs for the years between 1998/99 and 2002/03. Subsequently, we have become aware that unit costs data for each year were available and we have since been using them in more recent work in this area.
[35] Re-groupings of NHS activities take mainly two forms: aggregation of existing data and disaggregation into more detailed categories.

2 Circulatory disease in the NHS: measuring hospital output and productivity

2.1 Introduction

There is increased interest in measuring the productivity of health systems, defined as the ratio of healthcare outputs to the associated levels of inputs. In the English National Health Service (NHS) this has been manifest at the micro-level in the work of the National Institute for Health and Clinical Excellence (NICE), at the meso-level in the increased attention to programme budgeting in primary care trusts (PCTs) and at the macro-level in the work of the Office for National Statistics (ONS) in the development of whole system productivity measures.

This chapter examines macro-level national productivity for a single programme of care – circulatory disease – in the hospital setting. Circulatory disease is defined as problems relating to the heart and the circulation of blood in central and peripheral vessels. It includes both coronary heart disease (CHD) (problems relating to atheroma of the coronary arteries) and cerebrovascular disease (problems due to interruptions to the blood supply to the brain).

We use the output growth index developed in Dawson *et al.* (2005) to calculate output measures for all circulatory diseases in England, for the time period 1998/99 to 2003/04. Hospital output is adjusted for survival rates, both in-hospital and within thirty days of discharge. Patient-reported outcome measures are used for two procedures – coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) – to highlight the potential of introducing more general health outcomes into the output growth index. Using average unit costs data from the Reference Costs, we are able to account for inputs used in the production process for the treatment of all circulatory diseases. Finally, we determine productivity growth for circulatory diseases.

2.2 Background and literature review

According to the World Health Organisation (WHO, 1997, p.7), diseases of the heart and circulation account for about 30 per cent of overall deaths in the world, every year. In the UK, coronary heart disease (CHD) and cerebrovascular disease are responsible for 29.2 per cent of total deaths (Office of Health Economics, 2003).

There has been substantial attention from the Department of Health (DH) towards the reduction of deaths from circulatory diseases. In the White Paper "*Saving Lives: our healthier nation*" (DH, 1999) the DH sets out an action plan for tackling poor health in a number of priority areas and for improving the health of everyone in England. Regarding the area of circulatory diseases the aim is to reduce the "death rate from coronary heart disease and stroke and related diseases in people under 75 years by at least two fifths by 2010[36]".

It is, therefore, important to be able to track and measure whether substantial improvements in the area of circulatory diseases have occurred as a consequence of the introduction of new policy strategies. The measurement of NHS output growth in this particular area of healthcare constitutes a useful instrument for researchers and policy-makers alike as it can 1) help in tracking and measuring the amount of (extra) resources dedicated to a specific programme of healthcare; 2) show whether health outcomes (mainly in terms of survival rates) have improved over time; and ultimately and most importantly 3) show whether the extra money spent in tackling diseases related to circulatory diseases has produced value for money.

The measurement of healthcare output (and productivity) can be achieved by either considering overall health system measures or disease specific measures. As set out in the previous chapter, overall measures aim at assessing and valuing the output and productivity of an entire health system. Disease-specific or patient-based measures focus on single diseases or areas of healthcare.

In this section, we review the literature on disease-specific and patient-based measures of healthcare output and price indices. Price indices have been developed mainly in the US, where the focus is on how to obtain disease specific measures of value for money.

These measures are usually developed in the context of price indices for healthcare, but the literature is closely related to the problem of calculating output indices.

As discussed in chapter 1, Sections 1.3 and 1.4, there are a number of challenges involved when dealing with the pricing of healthcare goods and services, making it a more difficult task that that of pricing private goods and services. The review below considers how these challenges have been met and recommendations implemented for the following diseases: heart attack and more generally chronic heart conditions, mental health and cataract surgery.

2.2.1 US literature on disease-specific and patient-based price indices

2.2.1.1 Heart attack

The 'cost of living' (COL) approach was developed in Berndt *et al.* (2000) for the medical sector as a whole and is used in Cutler *et al.* (2001) in pricing heart attack treatments. The COL index is suggested as an alternative to the so-called 'service price index[37]', which prices the physical outputs of the healthcare sector. Examples of 'service price indices' are the Consumer Price Index (CPI) and the Producer Price Index (PPI), which are constructed and published annually by the US Bureau of Labor Statistics (BLS) for a variety of healthcare goods and services or components of them. As Cutler *et al.* (2001) point out one of the limitations of the CPI/PPI is that it is not based on a welfare concept, but simply calculates the amount of money required in every time period to purchase the same bundle of goods and services. Applied to the healthcare sector, this requires identifying a representative bundle of healthcare goods and services and observing it through time. However, if the quality of the bundle of goods and services changes over time or, as Cutler *et al.* (2001) put it in their paper, "if the same number of units of good produces greater utility", the SPI will not be able to capture it[38]. Therefore, there is a need to develop an index that allows one to measure not only the volume of healthcare goods and services at a given point in time, but also changes in the quality of these goods over time.

The cost of living index applied by Berndt *et al.* (2000) and Cutler *et al.* (2001) is based on patients' welfare where consumers purchase goods and services to maximise a

certain utility function. Utility is affected directly by some goods and services that are directly beneficial to them, such as cars, computers, and clothes. Healthcare goods and services also yield utility to consumers, but indirectly as consumers value the indirect (beneficial) effects that these goods and services have on their health. Healthcare goods and services are only one of a number of elements that enter the production function for health. Other factors include knowledge[39] of how to use medical treatments, time spent in seeking and receiving treatments and in recovery, lifestyles (e.g. eating and drinking habits, smoking, exercise) and the environment (e.g. pollution). Hence, an individual's utility function will include health, the other factors affecting health and non-health related consumption goods. Many of the elements affecting health also appear in the health production function, so that these have both direct and indirect impacts on an individual's utility.

Consider a representative consumer choosing between the consumption of goods and services (different from healthcare goods) and health, and where for simplicity there is only one disease[40]. To cure this disease an individual receives medical care treatment, a set of constant-quality treatments. Any change in the quality of a treatment or any new development in the medical field is registered as an addition to the available set of treatments. The utility function can, thus, be written as:

$$U = U[Y - P_M M - P_I I, H(M, K, E), L - T_M] \tag{3}$$

where Y denotes an individual's exogenous income; M indicates medical treatment with price P_M; I represents the quantity of a constant-quality insurance policy with price P_I. L is leisure time and T denotes time devoted to medical treatments. H represents the individual's health state, which is a function of medical treatment M, medical knowledge K and the environment E.

The first term of the utility function represents non-medical care consumption, the second represents health and the third is non-medical care time. It is also worth noting that the equation does not make any assumption about the way medical treatment decisions are taken or medical prices are set.

As medical care and its price, medical knowledge, the environment and the time dedicated to medical care all change over time, Cutler *et al.* (2001) pose the question: what is the correct price index for changes between periods 0 and 1, assuming that the consumer optimises in each period of time? Hence, they introduce an amount of money C that the consumer needs in period 1 so as to make her indifferent between living in period 1 and 0. In the Laspeyres form, C will be the solution of the following expression:

$$U[Y - P_{M1}M_1 - P_{I1}I_1 + C, H(M_1, K_1, E_1), L - T_{M1}] = \\ = U[Y - P_{M0}M_0 - P_{I0}I_0 + C, H(M_0, K_0, E_0), L - T_{M0}] \tag{4}$$

C can be considered as the change in the cost of living. A positive C indicates an increase in the cost of living. Scaling C by income to produce utility in period 0 attains the price index

$$\text{cost of living} = 1 + C/Y \tag{5}$$

Using a first order difference approximation, we can differentiate (4) and after rearranging we get:

$$C \cong d(P_M M + P_I I)/dt - \frac{U_H}{U_X}\{H_M(dM/dt) + H_K(dK/dt) + H_E(dE/dt)\} \\ + \frac{U_L}{U_X}(dT_M/dt) \tag{6}$$

where U_H is the marginal utility of health, U_X is the marginal utility of non-medical consumption, U_L is the marginal utility of leisure, assuming $dC/dt = U_X$. The change in the cost of living is made up of three parts: the additional spending on medical care and insurance; the dollar value change in health over time; and the change in the time cost of receiving medical care.

The first term on the right-hand side of equation (6) is additional spending on medical care and insurance services over time. Medical care spending may change over time because of either an increase in quantities or prices. However, it is only an increase in the cost of healthcare goods and services, *ceteris paribus*, that will increase the cost of

living. If the medical environment changes because a new disease appears, medical care expenditure will likely increase, but in Cutler *et al.* (2001) this is not considered as a change in the cost of living, because this assumes an unchanged environment. Similarly, and because outcomes are being held fixed, if a treatment becomes obsolete, in curing a disease having been replaced by a treatment (e.g. drug) that is more effective and also more expensive, the price index should increase as it now reflects 'the reduced efficacy (quality deterioration) of the older drug' (Cutler *et al.*, 2001).

The second term of equation (6) captures the monetary value of the change in health over time. As one can see, a change can occur through any of the following channels: (a) changes in the quantity of medical care, (b) changes in knowledge or (c) changes in the environment. Any improvement in health will lower the cost of living, *ceteris paribus*. The monetary value of the change in health can be calculated by using the marginal rate of substitution between health and other goods (U_H/U_X) and multiplying the health change by this amount.

The last term in equation (6) captures the change in the time cost of receiving medical care. If patients' travel time and waiting time are reduced because of the introduction of more efficient delivery, or if less invasive surgery reduces substantially the recovery time of a patient, then *ceteris paribus* the cost of living decreases.

Estimating the values of the variables in the cost of living equation is problematic, but not impossible. Four alternative methods are presented in Berndt *et al.* (2001): 1) hedonic price analysis used to separate prices changes over time into changes in the value of services to patients from pure price effects (as in studies for mental health below); 2) hedonic regression on insurance plans alongside willingness to pay techniques (Pauly, 1999); 3) making specific assumptions on how medical treatment decisions are taken (e.g. Cockburn and Anis (2001) for prescription drugs) and 4) using a direct measurement method of a single disease and using empirical estimates of changes in treatment costs and medical outcomes associated with that disease. This latter method is used in Cutler *et al.* (2001) for pricing heart attacks.

Cutler *et al.* (2001) use an outcome adjusted index that takes account of changes in treatment and medical practice and incorporates improvements in the length of life after

a heart attack and the extension of life expectancy due to new treatments. Quality changes are introduced via changes in mortality rates[41]. A monetary value[42] is attached to additional years of life gained. Further, they estimate the expected number of quality-adjusted life years for a person after heart attack. All these different elements are used in the construction of the cost of living index. They use two sources of medical care and medical costs data for all heart attack patients treated between 1984 and 1994. The first data source comes from a major teaching hospital and provides them with a complete set of services offered, list prices (charges), demographic information and discharge data. The second data source covers mostly the elderly population treated under the Medicare programme. These two datasets are very rich in information and allow them to produce both a disaggregated and an aggregate service price index, which they compare with their new price measure.

Table 2-1 - Service price indices and the cost of living indices for heart attacks

	Real Annual % change
*Disaggregated price index**	
Fixed basket index	2.8
Five-year chain index	2.1
Annual chain index	0.7
Aggregated price index	
Fixed basket index	2.3
Annual chain index	1.7
Cost of living index	
Years of Life [**]	-1.5 [-0.2, -13.7]
Quality of Life [**]	-1.7 [-0.3, -16.8]

Source: Cutler *et al.* (2001) Table 8.4, p.321
* includes data from both the major teaching hospital as well as Medicare;
** based on higher and lower estimates of the net value of a life year and a quality-adjusted life year

Their results presented in Table 2-1 show 'substantial reductions in the cost of living for people with a heart attack'. It falls by 1.5 percent per annum under the benchmark assumption that the value of an additional life year is $25,000, with a range of -0.2 in the conservative estimate ($10,000) of the value of an added year of life to -13.7 in the higher value $ 100,000. The cost of living index with the quality-adjusted life years measure falls even further by 1.7 percent per annum in the benchmark case where an additional QALY is valued at $23,431 (in 1994). Their results contrast markedly with

those obtained using the CPI approach, which show increases in the price index from about 0.7 percent to 2.8 percent.

The authors interpret the contrasting results as being driven by the shortcoming of the service price indices to take into account of changes in health outcomes. Even if there is huge variability in the estimates of the cost of living index due to the sensitivity of the index to the value placed on additional year of life and quality-adjusted year of life, the authors claim that these are less misleading than the upward bias inherent in the traditional price indices.

2.2.1.2 Mental Health

There have been substantial increases in expenditure on mental care in recent years. This type of healthcare is also one that poses significant challenges due to the difficulties in defining outcomes and outputs. Most studies suggest the use of a direct measure of the medical costs of treating an episode of illness, rather than measuring the changes in the prices of input used. This is due to the fact that although input costs are rising in this area of healthcare, the composition of treatments is constantly changing making it possible for the cost of treatment episodes to fall. (Berndt, 2003). For example, a number of studies conducted by Berndt, Busch and Frank found that the composition of treatment of depression has dramatically changed in recent years, with depression being treated more and more frequently with the use of serotonin-reuptake inhibitors (SSRI) drugs[43], rather than with psychotherapy and tricylic antidepressants (TCAs). Further, it is also clear that some adjustment needs to be made for quality of care and outcomes.

Three areas of mental health care, in particular, have been investigated: major depression, schizophrenia and bipolar disorder. For all three disorders, the analysis suggests that the price of treating an episode or individual has declined in recent years, despite the rising healthcare expenditure reported. Berndt (2003) maintains that the reason behind the discrepancies with official statistics is that the latter do not allow for changes in the composition of treatment over time. It still remains to be established how quality of care ought to be incorporated in prices indices for mental health; this is especially so because of the lack of data on quality and patient outcomes.

Depression

Depression accounts for approximately half of mental health expenditure in the US (Berndt, Busch and Frank, 2000/01). There have been a number of studies investigating the pricing of its treatment. Although they do not use identical methods, there is a considerable degree of similarity in both the methods employed and the conclusions reached. The studies have focused on the episode of illness, which involves developing a set of what Frank, Busch and Berndt (1998) term 'treatment bundles'. These group together therapies that are *ex ante* expected to lead to similar mental health outcomes. Frank *et al.* use results from a range of clinical trials and medical literature to form these 'bundles'. They focus on acute-phase treatment only.

Demand and supply price indices for the treatment of major depression based on the cost of an episode of illness are formed using the identified 'treatment bundles' for the period 1991-1995. Retrospective medical claims data from four large self-insured employers are used to identify nine major classes of treatment which have shown to be "efficacious" (Frank *et al.*, 1998) in the treatment of acute-phase major depression. Subsequently, closely related treatment bundles were aggregated, resulting in the use of five bundles. As some of the treatment bundles may be considered substitutes, the authors examine 4 index formulations, which incorporate differing assumptions on the extent of substitutability across treatment bundles. Hence, the authors use 1) a base-period Laspeyres index and an 2) end-period Paasche index, which both assume that there is no possibility of substitution among treatments; 3) the Cobb-Douglas index, which assumes that the elasticity of substitution is unity (perfect substitution) and 4) a Törnqvist index, which makes no *a priori* assumption about the substitutability of any of the treatment bundles, as it employs average shares across adjacent time periods.

All four indices showed that both the demand and supply price of treating depression had fallen between 28 and 32 per cent between 1991 and 1995. These results are opposite to the estimates published by the BLS, whose price indices over the same period increased by 20 per cent. The average annual differential in price changes is approximately 15 per cent - three times the differential found by Cutler, McClellan and Newhouse (1999) for heart attack treatment. Frank *et al.* conclude that employing standard price indices – which do not allow for changes observed in treatment

composition – may lead to changes in quantity being misinterpreted as changes in price, which is a cause for concern.

Several extensions to this work have since been carried out by Berndt, Busch and Frank and other authors (for example, Berndt *et al.*, 2002; Berndt *et al.*, 2001). Berndt *et al.* (2001) included a greater number of episodes and increased the number of treatment bundles to seven. Using a Laspeyres price index, this resulted in a decline of only 0.6 per cent per annum, compared to the 9.1 per cent per annum decline reported by Frank *et al.* (1998). Berndt *et al.* (2001) suggest that the primary difference of their results compared to those obtained in Frank *et al.* (1998) derives from the fact that the new dataset includs a greater number of patients. Moreover, their dataset includes a more varied type of patients with an increasing share of them with '(1) more complicated conditions, (2) greater severity of illness, and (3) elements of longer term treatments' (Berndt *et al.* (2001))

Berndt *et al.* (2002) add to the previous research by using a method that combines clinical evidence and expert opinion. The advantages of this method are twofold. First, it enables the calculation of treatment price indices that include variations over time in the proportion of 'off-frontier' production, which increases the number of observed episodes. Second, it allows for different expected outcomes to be incorporated, as well as considering patients that are on waiting lists or receive no treatment, who often experience remission even without treatment. By doing so, Berndt *et al.* (2002) are able to assess the incremental outcome[44] gains as a result of treatment compared to no treatment outcomes.

Using retrospective medical claims data (for 1991-6), the authors identified and classified episodes of acute phase depression according to treatment and patient type. Information on expected treatment outcomes was gathered using a two-stage modified Delphi procedure. Ten panellists were asked to provide opinions on expected treatment outcomes, using the Hamilton Depression Rating Scale (HDRS) score (a standard clinical measure for this illness). For each of the 120 patient-treatment cells, a literature review of clinical research was provided. The experts were asked to consider a group of 100 patients and provide an estimate of how many patients would fall into four given categories: 'no depression', 'mildly depressed', 'moderately depressed' or 'no change'.

However, for 39 per cent of the cells, substantial disagreement among the experts was noted. Each expert was then shown the group's rating for those cases where there was disagreement, and after meetings they were given the option to revise their own rating. After this process, no substantial disagreement remained.

The framework under which expected outcomes data were obtained allowed Berndt *et al.* (2002) to consider results for both full and partial remission. The probability of a full remission varies from 0.15 to 0.35, whilst the probability of partial remission is higher. One particularly interesting finding is that approximately 40 per cent of the treatment episodes make use of medical treatment with no or little effectiveness over the no treatment option, accounting for 20 per cent of total spending on treatments.

Average expenditure indices for full or partial remission varies according to the treatment of those cases where there is no expected outcome rating. Berndt *et al.* (2002) calculate alternative expenditure indices for full or partial expected remission, using observed prices and quantities of the treatment/patient cells for the period 1991-6. Their estimation show that the average spending for both full and partial expected remission remains unchanged in 1996 compared to 1991 when only rated cases are included. If unrated cases are assigned the worst possible outcome, the average expenditure index falls from 100 in 1991 to 84 for full remission and 86 for partial remission in 1996. The explanation offered for this decline is that the proportion of rated cases increases from 62 per cent in 1991 to 73 per cent in 1996, thus reducing the proportion of cases being assigned the worst outcome. If the median outcome is assigned to unrated cases, then the average expenditure index for full remission remains unchanged in 1996 compared to 1991, whilst the one for partial remission falls from 100 in 1991 to 90 in 1996. However, expenditure per incremental expected full or partial remission is preferred. Generally, the expenditure indices per incremental remission fall more rapidly than average expenditure.

A base-period Laspeyres, an end-period Paasche and a Fisher Ideal price index were constructed. The treatment price index falls for all three. However, when incremental remission (both full and partial) is taken into account all three price indices show a slight increase. The authors conclude that the slight sensitivity of the price indices to

expected outcomes may be due to a changing patient mix (along with changes in the treatment bundles), thus affecting both expected outcome and costs.

Hedonic equations were estimated to account for this potential change in patient population. Eight patient categories were identified, depending on the presence of medical comorbidity, gender, age if female and comorbid substance abuse. Three alternative hedonic equations for the price per expected full remission were estimated by OLS. The results suggest that patient categories have significant and sizeable effects on treatment costs; comorbid substance abuse and comorbid medical conditions are particularly likely to increase treatment costs. Also, treatments having higher probability of full remission have higher costs *ceteris paribus*. All three equations estimate reductions in price. Estimates for partial remissions lead to similar findings. Overall, the results obtained from estimating hedonic equations are different from those shown by the price indices, a reflection of the changing mix of patients over time. In particular, the cost of treating episodes of depression, conditional on expected outcome, has generally declined between 1991 and 1996, a fall between -1.66 per cent and -2.13 per cent per annum over the time period considered.

The use of expected outcomes data has been demonstrated by Berndt *et al.* (2002) to be helpful in constructing price indices for medical treatments that allow for variation in expected outcomes and patient populations. However, it is acknowledged that the reliability of the outcome measures is a key determinant of the usefulness of this method, and validity checks are carried out to assess this. The main conclusion that can be drawn from this research on acute-phase depression is that the principal source of the recorded increased level of expenditures over the period studied are due to increases in the volume of treatments managed, given that the cost of treating an episode of depression seems to have fallen.

Schizophrenia

The method of pricing an episode of care has also been implemented for other mental health disorders. Frank *et al.* (2003) investigate the changing costs of treating schizophrenia. Data from two counties in Florida over the period 1994/5 to 1999/00 are used to determine 1) the annual cost of treating an individual affected by schizophrenia; 2) the composition and quality of healthcare and how these varied over time; and 3)

changes in treatment costs if quality of care is controlled for. As the 1990s saw the introduction of significant new treatments, Frank *et al.* suggest that considerable changes in treatment patterns were likely to have taken place, impacting on both the price and quality of care.

Producer price indices are constructed based on annual episodes of care. Quality of healthcare is incorporated in Frank *et al.*'s study using the recommendations made by the Patient Outcomes Research Team (PORT). Five of the PORT quality indicators referred to types of treatment that are observable in the claims data. Frank *et al.* use these to construct bundles of treatment that are considered to have a positive impact on patients affected by schizophrenia. Four of these treatment bundles were 'single treatment' bundles, such as the use of any type of antipsychotic medication. Other treatment bundles consisted of more than one form of treatment, e.g. combined use of one type of medication and one type of therapy. The authors also created another category which comprised 'all other treatments'. Each person-year observation was then categorised to one or more of the treatment bundles as appropriate. A shortcoming of this type of quality measure – acknowledged by the authors – is that it only reveals whether a patient has received treatment, whilst failing to indicate whether the amount of treatment received was sufficient. Further, the authors state that their quality measure reflects only minimum standards of care, as it is "reasonable to expect that a high proportion of patients with [.....] schizophrenia should receive **at least one** of these services" (Frank *et al.*, 2003).

Multivariate regression equations were estimated, using the natural log of annual mental health direct medical costs as the dependent variable. Regressors included patient characteristics, enrolment and medical histories and indicator variables for the treatment bundles. As the period under investigation saw significant changes in treatment, the authors applied Chow tests for parameter stability. The results show that treatments administered are indeed different, and hence it was decided not to pool the data across years. In order to compare predicted spending, quality and patient characteristics were held constant at a point in time. The results show that fixed weight and chained Laspeyres price indices fall more rapidly than the comparative Paasche indices, which is contrary to what one would normally expect. The authors interpret this unconventional finding as reflecting doctors' learning about the efficacy of new and more costly

treatments over time, which leads them to prescribe these more costly pharmaceuticals and hence, to positive correlations between price and quantity. This would be consistent with patients not being price sensitive, because of subsidisation of drugs.

Frank *et al.* reveal that there have been significant changes in treatments given to patients with schizophrenia, with a significant increase in atypical antipsychotics. These findings are in line with PORT guidance. At the same time, there has been a substantial decline in the use of therapy and psychosocial rehabilitation, which raises the authors' concern over the fact that a substantive part of current clinical practice is actually not supported by any form of clinical evidence.

This study also demonstrates the importance of controlling for quality. As in previous studies, not adjusting for quality would result in mean mental health-related treatment costs increasing by 2.4 per cent over the time period under investigation or about 0.5 per cent per annum. When treatment quality is held constant, both the fixed weight and chained Fisher Ideal indices showed cumulative price falls of more than 22 per cent over the period, equivalent to an average treatment cost fall of 5.5 per cent per annum between 1994/95 and 1999/2000. Overall, Frank *et al.* conclude that as the cost of treating an individual per annum has declined, the observed increase in overall expenditure is an indication that there has been an increase in the number of individuals being treated.

Bipolar disorder

Research by Ling *et al.* (2002), discussed in Berndt (2003) investigates the changing costs of treating bipolar I disorder. Like schizophrenia, there is at present no known cure for bipolar I disorder, so the focus of medical care in this case is to try and improve symptoms, including the prevention of recurrences. In contrast however, there has not been such a dramatic change in the composition of treatment.

Ling *et al.* (2002) estimate a multivariate regression model, similar to that used by Frank *et al.* (2003), based on five mutually exclusive and exhaustive treatment bundles. The results suggest a fall of 31% in the cost index between 1991 and 1995, compared to a decline of 12% if no allowance is made for changes in patient mix and treatment composition.

2.2.1.3 Cataract Surgery

Important innovations have characterised cataract surgery in recent years. This has resulted in a significant increase in the overall number of operations performed, and in cataract patients now receiving surgery at an earlier stage of the disease. Shapiro *et al.* (2001) address the issue of correctly evaluating a price index for this type of surgery. Significant quality improvements are identified by the authors as a result of improved and earlier interventions. Thus, they focus on the visual improvements as the "good" to be valued and on the net benefits associated with the treatment. The net benefits are equal to the difference between the visual function following surgery and the visual function without surgery. The authors allow this to vary with differing stages of the disease (serious, progressive or mild cases). Shapiro *et al.* maintain that the benefits accruing from treatment and early treatment of cataract disease have a long-lasting impact[45] on well-being and this should be taken into account. In other words, the future value of not having to endure a period of deteriorating quality of life needs to be incorporated in a price index. As the current technology allows for patients with early cataract conditions to be treated, the authors allow for a (endogenous) change in the patient mix. The value that patients place on a treatment for receiving it sooner or receiving it when they previously would not have is very important. However, these benefits are also very difficult to estimate as different patients place different valuations on them. Nonetheless, benefits derived from cataract surgery need to be valued and quality adjusted life years (QALYs) may be used, although this will call for a specific value to be placed upon the QALY. Willingness to pay (WTP) methods could also be used to value either a QALY or the cataract surgery directly.

As seen for other conditions, Shapiro *et al.* recommend measuring the cost of healthcare in terms of the unit values for treating cataract disease (or any other condition) and then measuring cost in terms of the current inputs required for the treatment[46]. They construct two price indices for measuring the monetary cost of cataract surgery: a hypothetical CPI and a prototypical cost index. Inputs are physician and hospital services. In the CPI, weights are applied to the price indices for individual inputs reflecting their relative importance. 1969 and 1979 are chosen as benchmark years. The component indices are then weighted by the shares in these years. A major disadvantage of the CPI method is that technical progress is reflected only in the rate of growth of the index. In the specific case of cataract surgery, therefore, where there has been a

significant fall in the hospital services required for treating a patient, this will not be reflected in the level of the hypothetical CPI.

The prototypical cost index was calculated by $\sum(q_{it}p_{it}/q_{i0}p_{i0})$, where q refers to the quantity of each input i, p refers to the CPI for input i, and 0 indicates the base year. An advantage of this index over the hypothetical CPI is that it is able to incorporate changes in the level of inputs, and therefore reflect the decline in the quantity of hospital services used.

The results show that the hypothetical CPI index grows more rapidly than the prototypical index. Over the period 1969 to 1994, the prototypical index increased by 4.1 per cent per annum, compared to growth of 9.6 per cent per annum in the hypothetical CPI. If one compares overall growth over the time period considered, it emerges that the prototypical index has actually declined. In conclusion, it appears that the monetary cost of treating cataracts has been increasing at a slower rate than the general price level over this period even without taking improvements in quality into account and the value of undergoing surgery at an earlier stage of the disease.

2.2.2 Technological change in medical care: how does it affect output growth?

2.2.2.1 Chronic Heart (Artery) Disease

As highlighted in Shapiro *et al.* (1999), technological progress is endemic in healthcare and should be taken into account when constructing a price index. Cutler and Huckman (2003) are particularly interested in investigating the effects that technological development in angioplasty has on cost growth and how medical innovation impacts on improving the quality of care. Ultimately, the authors would like to find out whether the technological innovation in the medical field has produced 'value for money' "in terms of increasing the level of quality-adjusted output per-unit of cost". Cutler *et al.* (2003) observe that many medical innovations appear to reduce unit costs whilst at the same time increasing total costs. They find that increasing medical costs are usually associated with the introduction of new or improved medical technologies, be they surgical procedures or pharmaceuticals. This seems to be the case also when

innovations have lower unit-costs than the existing technologies that they are meant to substitute. **Treatment substitution** by which patients are shifted from more- to less-intensive interventions is usually associated with cost savings. These seem, however, to be offset by a very common phenomenon known as **treatment expansion**; that is the extension of more intensive treatment to patients with milder symptoms and who would have undergone a different type of treatment (usually simple medical management) prior to the medical innovation.

The authors suggest that these two phenomena occurred with the introduction of percutaneous transluminal coronary angioplasty (PTCA, now known also as PCA) – a less intensive and less costly surgical treatment of coronary artery disease – in the late 1970s/early 1980s. Prior to the introduction of PTCA, patients affected by coronary (heart) artery disease (CAD or CHD) and with mild symptoms would be treated with medical management only, whilst patients with severe CAD would have received coronary artery bypass graft (CABG) surgery. This was precisely the situation described by Williams (1985) in his classic article about QALYs. PTCA made it possible to treat patients that would have previously undergone CABG (**treatment substitution**); but, it was also administered to patients who would have otherwise received only medical management (**treatment expansion**). Although a less costly procedure when compared to CABG, PCTA is more costly than simple medical management. Hence, the combined effect on costs and outcomes of both treatment expansion and treatment substitution effects is hard to predict.

Cutler *et al.* use patient-level data from New York's Statewide Planning and resource Cooperative System (SPARCS), which provide patient demographic (e.g. age, sex, payer type) and medical (e.g. diagnosis, procedures performed, and total charges) information for all inpatient hospital discharges for the period 1982 to 2000[47]. They supplemented this dataset with 3 years of clinical data from the cardiac surgery reporting system (CSRS) and coronary angioplasty reporting system (CARS), which both provide detailed clinical data for every patient that receives either a CABG or a PTCA procedure in the State of New York.

Crude data show that annual rates of CABG and PTCA procedures for all New York residents increased between 1982 and 2000, with PTCA procedures increasing at a

much faster rate than CABG, although from a lower level, up to 1997. After this year, CABG and PCTA rates move in opposite directions, which the authors suggest is an early indication of a substitution effect between the two procedures. An alternative explanation is also provided, whereby the increasing rate of PCTA procedures is for patients which would have otherwise previously received only medical management. In order to register a substitution between CABG and PCTA, Cutler *et al.* require that the marginal patient, that is one with medium-severity CAD, would become more likely to receive PTCA relative to CABGS over time. To test this, they divide patients into three severity categories: low, medium and high using an index developed by Mark *et al.* (1994).

The authors focus their analysis on county-level data to estimate changes in the degree of substitution between CABG and PTCA over time. They use a fixed effect model, with the CABG rate per person age 45 years and older as the dependent variable. The key regressors are the interactions of PTCA rate per 1000 population age 45 and older with year. The coefficient vector on this interaction reflects the degree of substitution, with a negative (positive) value indicating that the two procedures are substitutes (complements). Further, a vector of controls is introduced consisting of the demographic characteristics of a given county, such as total hospital discharges per 100,000 population of all ages and the percentage of hospital discharges for county residents that are covered by Medicare, Medicaid and HMO. It also includes county fixed effects and year fixed effects, to control for time-invariant factors that may affect the use of CABG in any given area and to control for state-wide changes in the average CABG rate over time. Estimates of the variables are shown both in their natural units (levels) and in logarithmic form (changes).

The results show that there is indeed a substitution effect between CABG and PTCA, with substitution accounting for about 25 per cent of the increase in PCTA volumes in 1998-2000 compared to 1986-1988 in the levels model. The results for the changes model are similar to that for the levels model, with about 32 per cent of the increase in PTCA volume in 1998-2000 compared to 1989-1991 being attributed to substitution between the two surgical procedures.

Cutler *et al.* then proceed to determine the effect that this has on costs. In particular, they are interested in estimating the "net costs" associated with an additional PTCA, where these are defined as the cost of an additional PTCA minus the savings due to the fact that some PCTA are substituting for CABG procedures. As SPARCS does not include cost data, Cutler *et al.* utilise costs found in Hlatky *et al.* (1997), which show that the average 5 year cost of a CABG procedure is nearly $2700 greater than that for a PTCA procedure administered to patients with multi-vessel CAD. Combing cost data by Hlatky *et al.* with their findings on the degree of substitution, Cutler *et al.* conclude that as a result of substitution the increase in total costs associated with additional PTCA fell by 11 per cent (in the levels model) and by 16 per cent (in the changes model) between 1989-1991 and 1998-2000.

In order to determine whether the introduction of PCTA has produced 'value for money', Cutler *et al.* first consider outcomes in terms of mortality rates. These are calculated separately for the case of treatment substitution and treatment expansion as the clinical profiles of patients receiving PTCA over CABG (substitution) are different from those receiving PTCA instead of medical treatment (expansion). Their estimates show no significant differences in long-term mortality for patients receiving CABG versus patients receiving PTCA in the treatment substitution cases.

Outcomes related to treatment expansion cases are more difficult to evaluate. The main outcome in these cases cannot be measured in terms of decreased mortality rates but rather should be measured in terms of increased quality of life associated with being relieved from angina. Cutler *et al.* make assumptions about the utility value, in terms of QALYs, of being relieved from angina and the monetary value to be attached to a QALY. Using clinical studies, they set a value of 0.2 QALYs per patient-year on being relieved from angina. Using further studies, Cutler *et al.* set the value of a QALY at $100,000. Thus, the average value of being relieved from angina for one year amounts to $20,000 per patient at 1997 prices.

As CABG and PTCA have similar outcomes in long-term mortality, Cutler *et al.* focus only on the net benefits that derive from treating with PTCA patients that would have previously received only medical management. They found that the net benefit

associated with an additional PTCA is positive and between $19,000 and $22,000. So, essentially PTCA offers 1 year of angina relief over medical management.

The authors note two shortcomings with their analysis. First, the net benefit calculations do not include the fixed cost of developing PTCA. Second, the increase in the level of angina relief is assumed to be linear up to 1992 and to remain constant afterwards (a conservative assumption on the incremental effects of PTCA procedures on angina). Sensitivity tests confirm the productivity benefits associated with the PTCA treatment expansion.

Following Cutler and other US researchers, Mai (2004) proposes a diagnosis-based approach to measure healthcare output growth for coronary heart disease (CHD) in the UK. In particular, he proposes two alternative index measures of healthcare output which are aggregated by patient and diagnosis respectively. The two indices take into account technological change and the introduction of innovations in existing treatments, and use cost shares to weight together volumes of output. These are compared to the practice of measuring healthcare output growth by means of a cost weighted activity index (CWAI).

The construction of the proposed two new measures requires more complex data than simple counts of activity, which constitute the basis for the cost weighted activity index. The cost weighted patient index (CWPI) uses as the volume measure the number of patients that receive a given treatment. In fact, patients may be administered a number of "activities", when undergoing a particular course of treatment. Hence, in the CWPI the weights will reflect the average cost share of not just a single activity, but the total average cost of the range of activities involved in delivering the course of treatment.

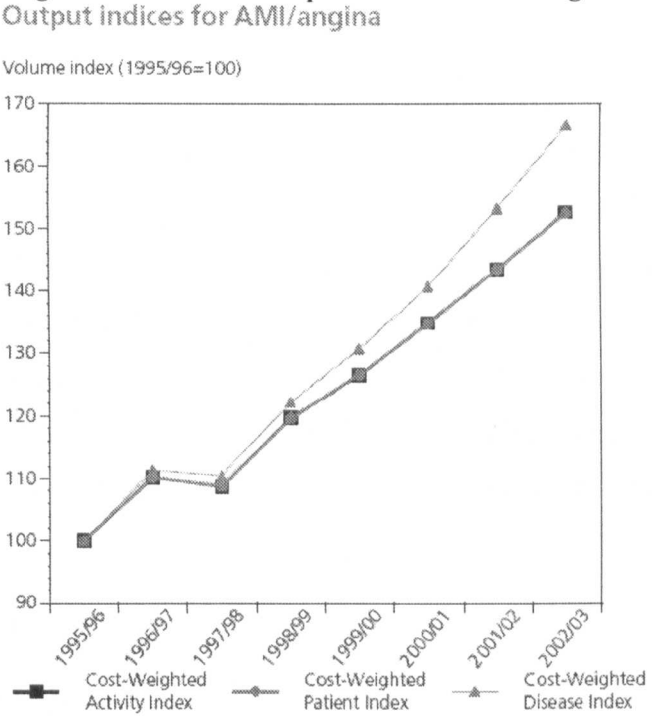
The cost weighted disease index (CWDI) allows for the possibility that a disease may be treated with different types of treatments. Hence, simple counts of patient numbers undergoing a particular treatment cannot be used as the volume measure as it would fail to adjust for the substitution of treatments that may occur over time. In the long term, the substitution of treatments may likely shift patients from a particular treatment course to another and a simple count of patients would not allow for this substitution effect. Further, as different treatments may have different outcomes on patients' health, these

should be added using 'quality adjustment weights' (Mai, 2004). These could incorporate aspects such as health outcomes (such as mortality rates), patient experience factors and waiting times.

Mai uses data from the Hospital Episode Statistics (HES) and the Reference Cost datasets for the period from 1995/96 to 2002/03. Health outcomes associated with the treatment of coronary heart disease are taken from existing literature. This shows that both CABG and PTCA are associated with similar mortality rates and re-occurrence of non-fatal myocardial infarction in the long term; CABG has lower re-admission rates and lower recurrent angina; and that PTCA, being a less invasive procedure, is associated with lower risks of death in the operating theatre. Overall, the two procedures appear to be similar in terms of their health outcomes; thus leading Mai to set the quality adjustment weights equal to one in his analysis.

His results show that the output of treating AMI/angina grows over time in all measures (see Figure 2-1). However, it grows much faster when using the disease based index. According to Mai, this shows that, over the time period considered, there has been substitution from CABG to PTCA, that is, from a more expensive treatment to a cheaper one. In the CWAI, a substitution between CABG and PTCA would translate into a negative growth, as the cost weight attached to CABG is higher than the one attached to the cheaper PTCA, although they are the same in terms of outcome. CWDI overcomes this drawback by assigning a common weight to both alternative interventions; hence, it implicitly increases the weight given to PTCA which had also seen the highest increase in its volume measure.

Figure 2-1 - Trends in output indices for AMI/angina



Source: Mai, 2004.

Mai studied the sensitivity of the growth rates of both CWAI and CWDI to various assumptions about the substitutability of PTCA and CABG and in the quality adjustment weights. Results show that the indices are sensitive to different assumptions but that failing to take account of the possibility of substitution between treatments would result in lower growth rates of the output index for AMI/angina. Further, allowing the quality adjustment weights to be different from one – that is moving away from the assumption that the two treatments are perfect substitutes in terms of their health outcomes – make the cost-weighted disease index very sensitive to the value chosen, although the growth in the CWDI over the time period considered remains higher than the one measured with the CWAI.

2.2.3 Conclusions

The price index literature has shown the importance of focussing on the direct medical costs of treating an episode of an illness, rather than changes in the prices of the inputs used in treatment, and that there needs to be some allowance for quality improvements. Rising input costs do not necessarily imply that the costs of treatment episode are increasing, if changes in the composition of treatment have occurred over time. In most

cases improvements in the composition of treatments are related with observed endogenous changes in the patient mix. Quality aspects can be incorporated in a price index in various ways, and do not necessarily require the construction of complicated algorithms. However, it is not straightforward to allow for improvements in outcome to be fully captured in the index. Triplett (1999) maintains that health outcomes data derived from cost-effectiveness research can be and should be used to identify medical care outputs that adjust for quality change. His suggestion is to combine information on prices and quantities and outcome measures such as QALYs to derive price indices that take account of new treatments with different QALY implications. Changes in QALYs for existing treatments can readily be incorporated into this general framework.

2.3 Methodology

We use the output growth index developed in Dawson *et al.* (2005) and Castelli *et al.* (2007b) and described in chapter 1 to calculate NHS hospital output measures for all circulatory diseases in England, for the time period 1998/99 to 2003/04. Activity is adjusted for survival rates and patient-reported outcome measures are used for two procedures – coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) – to highlight the potential of introducing health outcome measures into the output growth index.

The first type of index that we calculate is the simple unadjusted cost weighted output growth index. The index aggregates activity by weighting it by average CIPS based unit costs, which is equivalent to multiplying the ratio of outputs by their cost shares. The base-year Laspeyres formulation (Dawson *et al.*, 2005) is given by equation (9).

$$(9)\quad I_{ct}^{x} = \frac{\sum_j x_{jt+1} c_{jt}}{\sum_j x_{jt} c_{jt}}$$

Where x_{jt} is the amount of output undertaken in period t and c_{jt} is the average unit cost of output j in time t.

We then introduce survival rates so that the Laspeyres formulation (Dawson *et al.*, 2005)of the index becomes

$$(10)\ I_{ct}^{xa} = \frac{\sum_j x_{jt+1} c_{jt} \left(a_{jt+1} / a_{jt} \right)}{\sum_j x_{jt} c_{jt}}$$

The ratio a_{jt+1}/a_{jt} represents the proportionate increase in surviving treatment for output j between period t and period t+1. *Ceteris paribus* and assuming that mortality rates have been improving over time, quality adjusting the output growth measure should yield higher growth rates over the time period under investigation. The magnitude of the survival adjustment on the overall output growth measure depends clearly on the initial survival rate a_{jt}; if the majority of NHS patients survive their treatments, then the overall effect of this quality adjustment on output will be minimal. Even so, as we have seen in the US literature, failing to incorporate this quality adjustor would mis-represent the true output growth index, particularly if survival rates change over time.

The final adjustment involves incorporating patient reported health outcomes. In principle, health outcome refers to the value added to each individual's health as a result of contact with the health system. To construct this type of measure, ideally one should observe with and without treatment measures of health. However, health status is rarely observed in the absence of an intervention, as nobody is denied medical care in this country. Pre- and post-intervention measures of health status are a potential substitute. The formula of the cost weighted output index incorporating both survival and health adjustments is (Dawson *et al.*, 2005):

$$(11)\ I_{ct}^{xak} = \frac{\sum_j x_{jt+1} \left(\frac{a_{jt+1} - k_j}{a_{jt} - k_j} \right) c_{jt}}{\sum_j x_{jt} c_{jt}}$$

Where k_j represents the ratio of average health reported outcome before (h^0_j) and after treatment (h^*_j), that is $k_j = h^0_j / h^*_j$. Note that k_j is time-invariant in this application as data on patients' health status before and after treatment are currently not routinely

collected on an annual basis. The before and after health status measures used in the cost weighted output index are snapshot measures; thus, activities that have a low survival rate or small post-treatment health level can then produce large changes in the cost weighted output index. Indeed there may be circumstances when the survival rate is so low that $a_j - k_j$ is negative. For example, the survival rate for acute myocardial infarction (E12) is 0.79 in 2002/03, but the ratio of the average health outcomes is 0.8. This means that the survival with health outcome adjustment would be negative (-0.00334). Procedures like this one create a problem in the health effect adjusted cost weighted output index. So, if either $a_{jt+1} - k_j$ or $a_{jt} - k_j$ are small or negative for a healthcare output, we will use the pure survival adjustment a_{jt+1}/a_{jt} for that specific procedure. A cut-off point to $a_{jt+1} - k_j$ and $a_{jt} - k_j$ equal to 0.1 is introduced[48]. In our application, we conduct a sensitivity analysis to look at the effects on the cost weighted output index of different values for the cut-off point.

Ceteris paribus and assuming that the patient reported health outcome after treatment is higher than the before treatment one – a realistic assumption for the type of conditions considered here (though not when treating terminal care) – then the introduction of this further quality adjustment should have the effect of increasing the output growth estimates over and above the simple survival adjustment.

2.4 Data

2.4.1 Data sources

The Hospital Episode Statistics (HES) database and the National Schedule of Reference Costs database, as described in chapter 1 (Section 1.6), are our primary source for data. We present data on elective and day cases inpatient stays and non-elective (emergency) inpatient stays.

Output data and one of the quality characteristics (survival rate) are derived from the Hospital Episode Statistics database, whilst total expenditure of inputs used in the production process is derived using the Reference costs database. Measures of health

outcome for circulatory diseases are provided by a private health insurer, an independent healthcare provider (Vallance-Owen *et al.*, 2004).

For the purpose of this study, a series of diagnoses and procedures that are commonly known to belong to the broad category of circulatory diseases are identified using the the DH Programme Budget[49] classification for the area of 'circulation'. The DH Programme Budget categorisation presents three separate lists of diagnosis codes under the area of 'circulation':

- coronary heart disease (PB-10A)
- cerebrovascular disease (PB-10B)
- other problems of circulation (PB-10X).

Diagnosis codes are based on the International Classification of Disease codes version 10. However, hospital activity and average unit costs data are organised by healthcare resource groups or HRG; thus, all those identified ICD-10 needed to be mapped to the relevant HRGs. An online HRG explorer[50] was used to map diagnosis to up to five alternative base HRGs. The mapping procedure allowed us to produce a first list of HRGs, to which a further list of HRGs that are believed to fall under the broad definition of circulatory diseases was added. The total number of identified HRGs related to circulatory diseases is 57[51].

2.4.2 Continuous Inpatient Spell (CIPS)

Atkinson (2005) and Cutler and Huckman (2003) advocate that disease-based or patient-based output measures are used as the appropriate way to improve the measurement of output and productivity growth of a health system. Currently, however, routine administrative data do not directly track patients, and hence the resources used by them, in their journey within the NHS. An interim measure is suggested by Lakhani *et al.* (2005) and used in Dawson *et al.* (2005): continuous inpatient spells of NHS care. These, in fact, more clearly correspond to the journey that patients undergo across NHS hospital settings, and are also "[...] less vulnerable to being miscounted if transfers among providers vary over time or if there are changes in 'how being under the care of a consultant' is defined (Dawson *et al.*, 2005, Lakhani *et al.*, 2005).

A summary of how to identify CIPS of NHS care and how to attribute average unit costs, based on Reference Costs, to CIPS can be found in chapter 1, Section 1.7.1.

2.4.3 Quality adjustments

Quality characteristics of NHS care are captured in this chapter through survival rates and health outcomes. In particular, we use two measures of survival rate[52]: 'in-hospital' survival rate and 'in-hospital and 30-days post discharge' survival rate. A description of these two measures can be found in chapter 1, Section 1.7.3.1.

Patient-reported outcome measures are rarely applied outside clinical trial settings. We describe and discuss the various sources available to obtain patient pre- and post-treatment health outcomes in chapter 1, Section1.7.3.1. We are able to identify pre- and post- intervention measures of health status for only two of the 57 HRGs attributed to circulatory diseases, namely coronary artery bypass graft (CABG) surgery and percutaneous transluminal coronary angioplasty (PTCA). We recognise that this constitutes an un-representative sample; however, we use this information as an example to illustrate the potential advantages and better estimation of NHS output growth measures that could be obtained were more data on patient-recorded outcome measures to be collected on a routine basis.

2.4.4 Inputs

Inputs in the NHS constitute the resources used in the production of NHS activities and outputs. Together these contribute to the production of health outcomes. Inputs can be disaggregated into three different categories: labour, intermediate consumption (also called procurement) and capital consumption. Each of these contributes to the production of healthcare.

We use the Reference Costs as the source of data to account for total expenditure on inputs used by NHS hospitals to treat patients affected by problems of the circulatory system. The costing methodology of all NHS activity is standard across all NHS hospitals and is calculated on a full absorption basis (NHS Costing Manual, 2007). Costs are matched to services delivered and these should reflect the full and true costs

of services provided, they should be allocated and apportioned by maximising direct charges and where this is not possible they should be attributed and apportioned using a standard method and matched to the services that generated them to avoid cross-subsidisation. The methodology followed is a step-down one where hospitals should first determine overall aggregate costs and then apportion them to the different costing pools (a group of different hospital facilities). Costs are divided into direct, indirect and overhead costs. Direct costs are those for which the cost centre of patient is directly identifiable and hence should be directly allocated to the services that generated them. Indirect costs represent all those costs that cannot be allocated to one particular cost centre but which are shared over a number of them, e.g. Pharmacy, laundry. In this case, costs should be allocated to specific cost centres in proportion to the use made of that particular activity. The last type of costs is the costs of support services, which are incurred in the effective running of the hospital provider. These may include cost of business planning, general maintenance of ground and buildings, etc. The step-down process continues until all costs are allocated and apportioned to all clinical services by point of delivery such as inpatient, day cases, outpatient, etc.

For inpatient and day case activity the costs are disaggregated into HRG, which is the chosen 'unit of currency'. NHS providers need to select the HRGs that cover at least 80 per cent of cost and activity at each point of delivery (either elective, non-elective or day case) in order to identify what are called 'key HRGs' within each "treatment function", i.e. patient group. Within each HRG the main conditions and/or procedures are identified for each individual patient.A resource profile is then created by the nurse managers/ward managers which should include relevant and main cost drivers for each diagnosis/procedure within an HRG. These cost drivers include time spent on ward, time spent in theatre and therapies administered. An illustrative example for a resource profile is given in Table 2-2, where we look at a condition/procedure administered for a non elective (emergency) case of stroke or cerebrovascular accident.

Table 2-2 - Illustrative example of a resource profile for non-transient stroke or cerebrovascular accident <70 w/o cc (HRG A22) (treatment function: general medicine/point of delivery: inpatient non elective/ICD code: I634 Cerebral Infarction due to embolism of cerebral arteries

Costing Pool	Pool Type	Measure	Units	Cost per measure (£)	Total cost (£)
Ward	Time	Bed days	9	100	900
Nursing	Event	Admission	1	20	20
Ward	Time	Bed days	9	70	630
Diagnostics:					
-MRI	Event	Event	1	170	170
- Other radiology tests	Event	Banded tests	2	20	40
- Pathology tests	Event	Banded tests	10	6	60
Therapies:					
- Occupational therapy	Event	Session	2	25	50
- Speech Therapy	Event	Session	2	25	50
- Physiotherapy	Event	Session	5	27	135
Total Cost					**£2,055**

Source: NHS Costing Manual 2007

The (activity) weighted average cost for an HRG is then calculated by 1) multiplying the cost of each procedure/condition that falls under the relevant HRG by the total number of episodes for each procedure/condition; 2) adding up all the total costs of the procedure/condition and 3) dividing this total cost by the number of episodes in that HRG. This average cost is then applied to all episodes for the HRG within the hospital. Table 2-3 provides an illustrative example of the estimation of a weighted average unit cost for a hypothetical NHS hospital.

Table 2-3 - Illustrative example of estimation of unit cost for non-transient stroke or cerebrovascular accident < 70 w/o cc (treatment: general medicine/point of delivery: inpatient non-elective/HRG

Number	ICD code	Description	Cost (£)	Episodes	Total cost (£)
1	I634	Cerebral infarction due to embolism of cerebral artery	2,055	40	82,200
2	I650	Occlusion and stenosis of vertebral artery	1,748	20	34,960
3	I661	Occlusion and stenosis of anterior cerebral artery	2,147	10	21,470
4	I672	Cerebral atherosclerosis	2,239	10	22,390
Total				**80**	**£161,020**
Weighted average cost for **HRG22: Non-transient stroke or cerebrovascular accident < 70 w/o cc**					**£2,013**

Source: NHS Costing Manual 2007

This costing methodology allows for all three types of relevant inputs to be accounted for. Although we acknowledge that Reference Costs may suffer from shortcomings associated with most routine costing data (Jacobs and Dawson, 2003), we believe that they still remain a valuable and reliable source of information to calculate total NHS hospital expenditures for all circulatory disease. These figures are used to determine productivity growth of this programme of NHS hospital care (See section 2.6.3).

2.5 Descriptive Statistics

This section presents some descriptive statistics on volume of output (CIPS), unit costs and survival rates. We focus here on stroke and coronary heart disease (CHD) only. We selected the HRGs that correspond to these diagnoses and their related procedures. To populate the lists of HRGs for stroke and CHD, we used a list of all HRGs related to stroke available on line at http://hcna.radcliffe-oxford.com/stroke.htm and the National Service Framework on coronary heart disease (Department of Health, 2005). The full list of all relevant HRGs is shown in Table 2-4.

Table 2-4 - List of HRGs related to stroke and coronary heart disease

	HRG code	HRG description
Stroke	A01	Intracranial Procedures Except Trauma - Category 1
	A02	Intracranial Procedures Except Trauma - Category 2
	A03	Intracranial Procedures Except Trauma - Category 3
	A04	Intracranial Procedures Except Trauma - Category 4
	A19	Haemorrhagic Cerebrovascular Disorders
	A20	Transient Ischaemic Attack >69 or w cc
	A21	Transient Ischaemic Attack <70 w/o cc
	A22	Non-Transient Stroke or Cerebrovascular Accident >69 or w cc
	A23	Non-Transient Stroke or Cerebrovascular Accident <70 w/o cc
Coronary Heart Disease		
	E04	Coronary Bypass
	E07	Pacemaker Implant for AMI, Heart Failure or Shock
	E11	Acute Myocardial Infarction w cc
	E12	Acute Myocardial Infarction w/o cc
	E13	Cardiac Catheterisation with Complications
	E14	Cardiac Catheterisation without Complications
	E15	Percutaneous Transluminal Coronary Angioplasty (PTCA)
	E16	Other Percutaneous Cardiac Procedures
	E18	Heart Failure or Shock >69 or w cc
	E19	Heart Failure or Shock <70 w/o cc
	E22	Coronary Atherosclerosis >69 or w cc
	E23	Coronary Atherosclerosis <70 w/o cc
	E28	Cardiac Arrest
	E29	Arrhythmia or Conduction Disorders >69 or w cc
	E30	Arrhythmia or Conduction Disorders <70 w/o cc
	E33	Angina > 69 or w cc
	E34	Angina < 70 or w/o cc
	E35	Chest pain > 69 or w cc
	E36	Chest pain < 70 or w/o cc

2.5.1 Stroke

The World Health Organisation defines stroke as 'a focal (or at times global) neurological impairment of sudden onset, and lasting more than 24 hours (or leading to death), and of presumed vascular origin'[53]. Three major sub-categories are identifiable and they are: ischaemic stroke, intracerebral haemorrhage and subarachnoid haemorrhage.

Table 2-5 - Elective and Emergencies output for Stroke

Year	Volume of output		Volume of output	
	Elective and day cases	*% change*	*Emergencies*	*% change*
1998-99	11,908		97,728	
1999-00	11,384	-4.40%	86,227	-11.77%
2000-01	11,073	-2.73%	83,479	-3.19%
2001-02	10,584	-4.42%	83,749	0.32%
2002-03	11,755	11.06%	99,582	18.91%
2003-04	12,546	6.73%	105,225	5.67%

Overall, elective and non-elective (emergencies) output for stroke has increased over the time period considered. However, as appears from Table 2-5, there is year on year variation in the volumes of output recorded. Elective output registers a decrease in the first three years of the time series, before recovering in the later two years. Emergency output also sees a decrease in the first two years, followed by an increase in the later years. We expect this volatility to be reflected in the output growth indices.

Output weighted average unit costs show a progressive increase over the time period considered for elective and day cases (see Table 2-6). Emergency output also shows growing costs up to 2001-02 before the trend is reversed in the last two years.

Table 2-6 – Costs of hospital output for Stroke

Year	Output weighted average unit costs	
	Elective and day cases	*Emergencies*
1998-99	3,045	2,380
1999-00	3,099	2,705
2000-01	3,550	2,893
2001-02	3,868	3,201
2002-03	4,245	3,044
2003-04	4,352	2,983

Output weighted average in-hospital survival rates have improved for both elective and day cases and emergencies throughout the period (with the exception of 2002-03 where a slight decease is recorded compared to the previous year for both types of hospital output) (see Table 2-7).

Table 2-7 - In-hospital and 30-day post discharge survival rates for Stroke

Year	Mean in-hospital survival rate		Mean 30-day survival rate	
	Elective and day cases	*Emergencies*	*Elective and day cases*	*Emergencies*
1998-99	0.9612	0.7934	0.9525	0.8243
1999-00	0.9680	0.7814	0.9610	0.7606
2000-01	0.9704	0.7859	0.9619	0.7667
2001-02	0.9773	0.7888	0.9699	0.7716
2002-03	0.9709	0.8196	0.9649	0.8057
2003-04	0.9766	0.8365	0.9707	0.8243

Mean 30-day survival rate has also improved for both elective and emergencies in the time period considered, with the exception of 2002-2003 (see Table 2-7).

2.5.2 Coronary Heart Disease (CHD)

Coronary Heart Disease (CHD) is the condition that occurs when the constant supply of oxygen to the heart muscle is blocked partially or completely. Oxygen is carried to the heart muscle in the blood and flows to it through the coronary arteries (heart's blood vessels). Coronary arteries are placed both to the left and to the right side of the aorta and supply the tissues of the heart itself. The reduced supply of oxygen can be caused either by the presence of a blood clot – thrombosis – or by the arteries becoming thick and hard – sclerosis. Different types and severity of CHD may occur according to the degree of blockage of the coronary arteries. If they are completely blocked then the patient may experience a heart attack (myocardial infarction) and if the block is only partial, then this can cause chest pains otherwise known as angina. Acute Myocardial Infarction (AMI) refers to the complete cessation of the heart muscle, whilst heart failure or shock refers to a condition in which the pumping action of the heart is inadequate. Coronary Artery Bypass Grafting (CABG) and Percutaneous Transluminal Coronary Angioplasty (PTCA) are procedures performed when patients suffer from a chronic CHD.

Table 2-8 - Elective and non-elective output for Coronary Heart Disease

Year	Volume of output		Volume of output	
	Elective and day cases	*% change*	*Emergencies*	*% change*
1998-99	124,573		469,503	
1999-00	127,683	2.50%	453,992	-3.30%
2000-01	135,901	6.44%	464,657	2.35%
2001-02	143,042	5.25%	459,704	-1.07%
2002-03	154,855	8.26%	509,938	10.93%
2003-04	166,600	7.58%	539,689	5.83%

Volumes of output for elective and day cases have continuously increased throughout the period. Overall emergency output shows an increase over the period considered, with some volatility in the early years (see Table 2-8). It is well known that emergency output is subject to large year-on-year variations, the reasons for which are not fully understood but are thought to relate to 1) particularly severe atmospheric conditions (exceptional cold winters or hot summers) (Bagust et al., 1999) and 2) reporting behaviour, particularly if providers increase coding of short stay emergencies to attract more funding (Farrar et al., 2007).

not possible to pin down the exact nature of the volatility recorded in HES at is routinely collected administrative data. Some variation in volumes of output However, it is important to detect it and to correctly report it so that oddities in output growth estimates can be easily identified and interpreted.

Unit costs for both electives and emergencies show a gradual increase up to 2002-03, before decreasing in the last year (see Table 2-9).

Table 2-9 - Cost of hospital activity for Coronary Heart Disease

Year	Output weighted average unit costs	
	Elective and day cases	*Emergencies*
1998-99	1,453	1,087
1999-00	1,463	1,161
2000-01	1,531	1,221
2001-02	1,655	1,323
2002-03	1,744	1,302
2003-04	1,681	1,286

Average output weighted in-hospital and 30-day post discharge survival rates for elective and day cases output have remained constant over the time period considered. A slight improvement is registered for emergencies in both measures of survival.

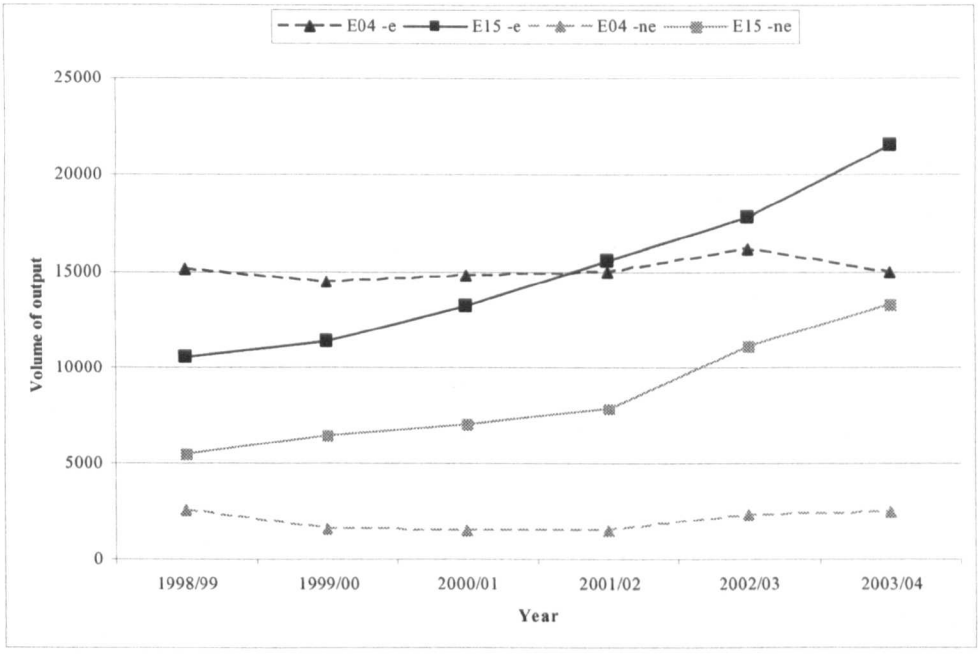
Table 2-10 - In-hospital and 30-day post discharge survival rates for Coronary Heart Disease

Year	Mean in-hospital survival rate		Mean 30-day survival rate	
	Elective and day cases	*Emergencies*	*Elective and day cases*	*Emergencies*
1998-99	0.9916	0.9335	0.9883	0.9220
1999-00	0.9935	0.9373	0.9906	0.9261
2000-01	0.9943	0.9444	0.9913	0.9345
2001-02	0.9954	0.9453	0.9929	0.9361
2002-03	0.9950	0.9517	0.9926	0.9438
2003-04	0.9960	0.9562	0.9941	0.9494

In the remainder of this section, we present trends in output, unit costs and survival rates for CABG and PTCA procedures. These two procedures are in fact of particular interest to us as patient-reported health outcomes are available for them and these will be used in the construction of our output growth measures.

Figure 2-2 show respectively trends in elective and non-elective inpatient spells for patients treated with CABG (E04) and PTCA (E15). Rates of CABG have remained stable throughout the period, whilst PTCA rates have increased rapidly, with more than a doubling in output over the six year period. In the final year, there is some evidence of what might be considered as treatment substitution, when a large increase in PTCA procedures is accompanied by a quite sharp fall in CABG procedures. It is, however, possible that some of the increased output might be due to treatment expansion, that is the treatment with PTCA of less severe patients that might have previously treated with medical management only.

Figure 2-2 - Trends in Electives and Day cases (-e) and Non-electives (-ne) volumes of output for CABG (E04) and PTCA (E15)



Figures 2-3 and 2-4 show output weighted average unit costs respectively for electives and non-electives CABG and PTCA. Units cost have been deflated using both the GDP deflator and the NHS Pay and Price Index. First, it should be noted how average unit costs for non-elective procedures are consistently higher than their elective and day case counterparts. This may in some part be due to the higher dependency of patients that are admitted and operated as emergency cases. Second, PTCA is a consistently less costly procedure than CABG (for both electives and day cases and non-electives).

Figure 2-3 - Trends in output weighted unit cost for Electives and Day cases (-e) and Non-Electives (-ne) CAGB (E04) - in 1998/99 prices using NHS Pay and Price Index (a) and GDP deflator (b)

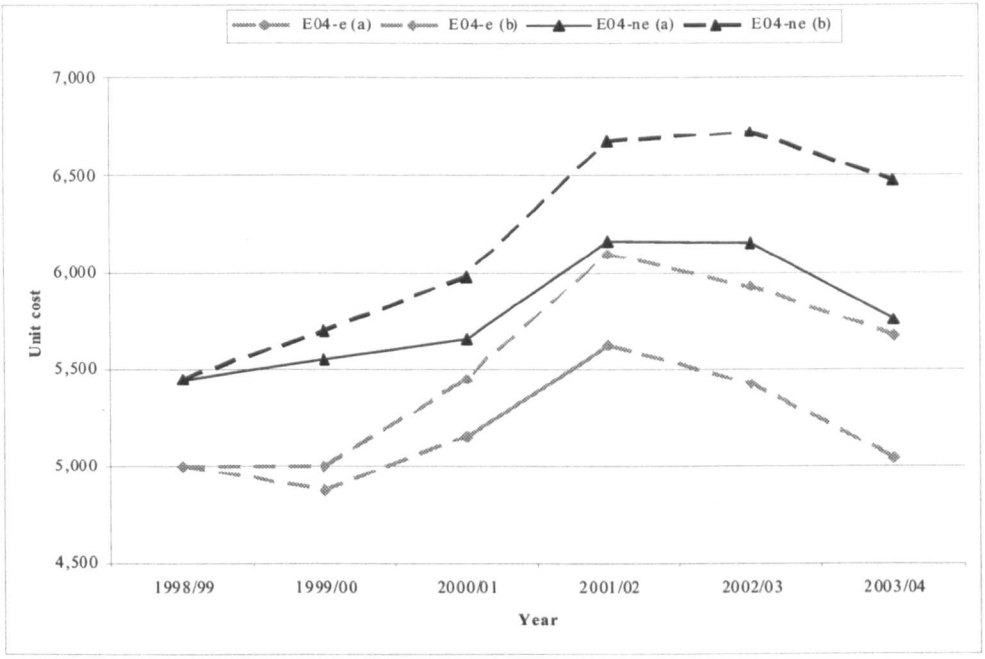
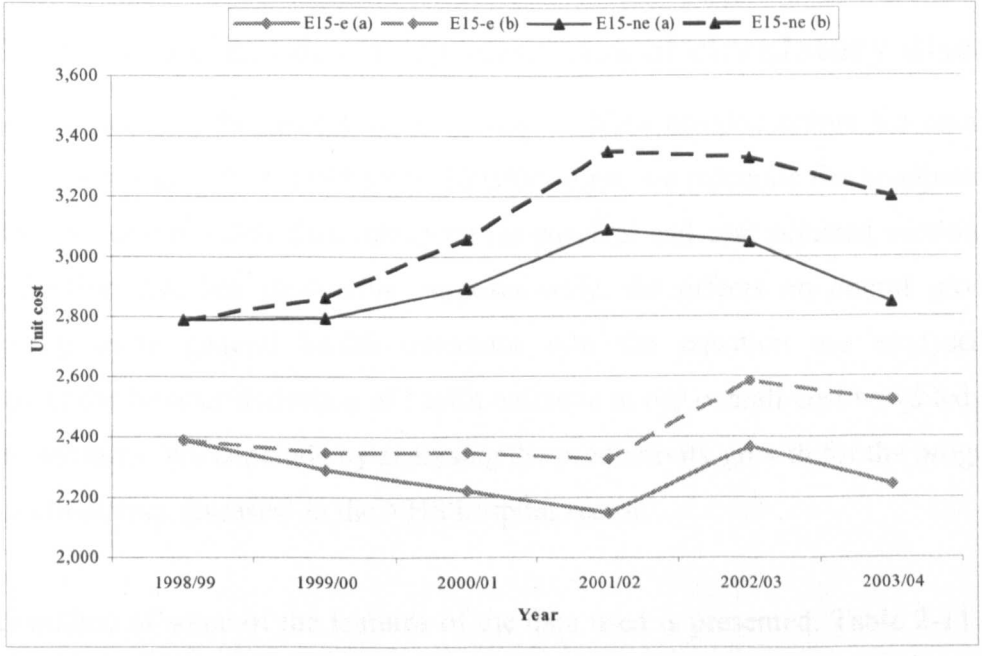
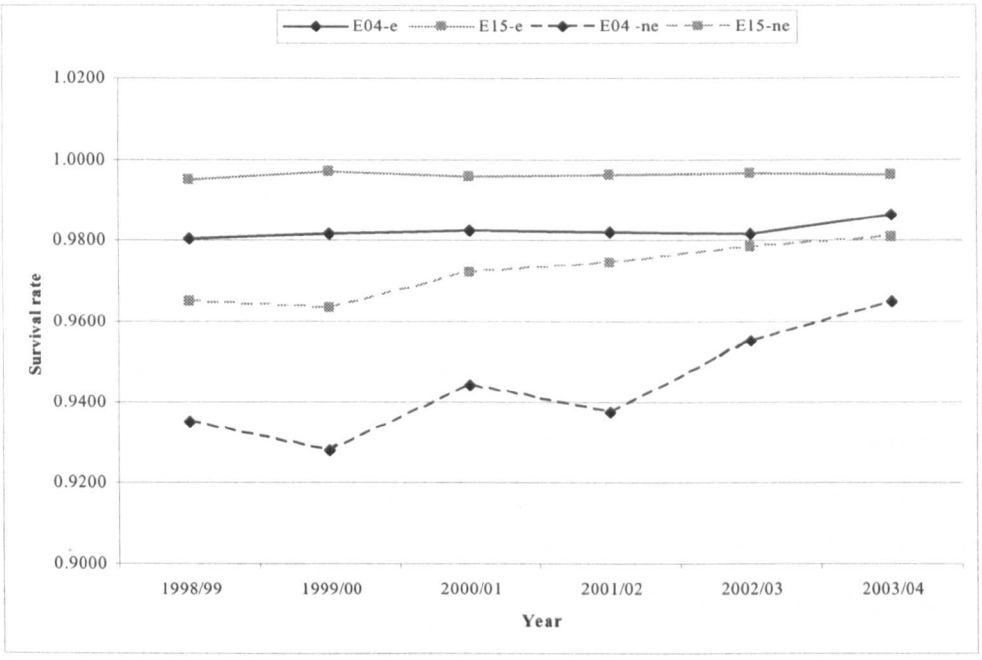


Figure 2-4 - Trends in output unit costs for Electives and Day cases (-e) and Non-electives (-ne) PTCA (E15) - in 1998/99 prices using NHS Pay and Price Index (a) and GDP deflator (b)



Survival rates for patients treated with CABG and PTCA (see Figure 2-5) are relatively high throughout the period, and there is some evidence of improvement in non-elective outcomes.

Figure 2-5 - Trends in Electives and Day cases (-e) and Non-elective (-ne) survival rates for CABG (E04) and PTCA (E15) - 30-day post discharge



2.6 Output and productivity measures of circulatory diseases

This section presents the results of the growth in NHS hospital output for circulatory diseases in the period from 1998/99 to 2003/04. First, we calculate the unadjusted cost weighted output index. We then introduce the survival and cost adjusted version as set out in Section 2.3. For illustrative purposes only, the effects on output growth of introducing more general health outcomes into the equation are analysed. We incorporate the broader definition of health outcome in our overall cost weighted output growth measures. We conclude by analysing the productivity growth for the programme of care 'circulatory diseases' in the NHS hospital sector.

A brief outline of some of the features of the data used is presented. Table 2-11 shows volumes of output for both elective and day cases and non-electives.

Table 2-11 - Elective and day cases and non-elective output for all circulatory diseases

Year	Volume of output		Volume of output	
	Electives and day cases	*% change*	*Non-electives*	*% change*
1998-99	189,805		754,125	
1999-00	192,431	1.38%	717,097	-4.910%
2000-01	202,121	5.04%	727,002	1.381%
2001-02	209,076	3.44%	723,410	-0.494%
2002-03	229,169	9.61%	810,200	11.997%
2003-04	246,564	7.59%	862,735	6.484%

Elective and non-elective output has increased over time. Electives and day cases show a steady increase throughout the period (with the exception of the years 2001-02 and 2003-04 where the rate fell); whilst non-electives show a more volatile picture in terms of their growth up to 2001/02 with a high growth in the last two years of the time series.

Table 2-12 - In-hospital and 30-day post discharge survival rates

Year	Average in-hospital survival rate		Average 30 day post discharge survival rate	
	Electives and day cases	*Non-electives*	*Electives and day cases*	*Non-electives*
1998-99	0.9864	0.9084	0.9818	0.8942
1999-00	0.9887	0.9097	0.9846	0.8953
2000-01	0.9899	0.9162	0.9858	0.9031
2001-02	0.9917	0.9168	0.9881	0.9045
2002-03	0.9911	0.9249	0.9880	0.9144
2003-04	0.9925	0.9318	0.9899	0.9227

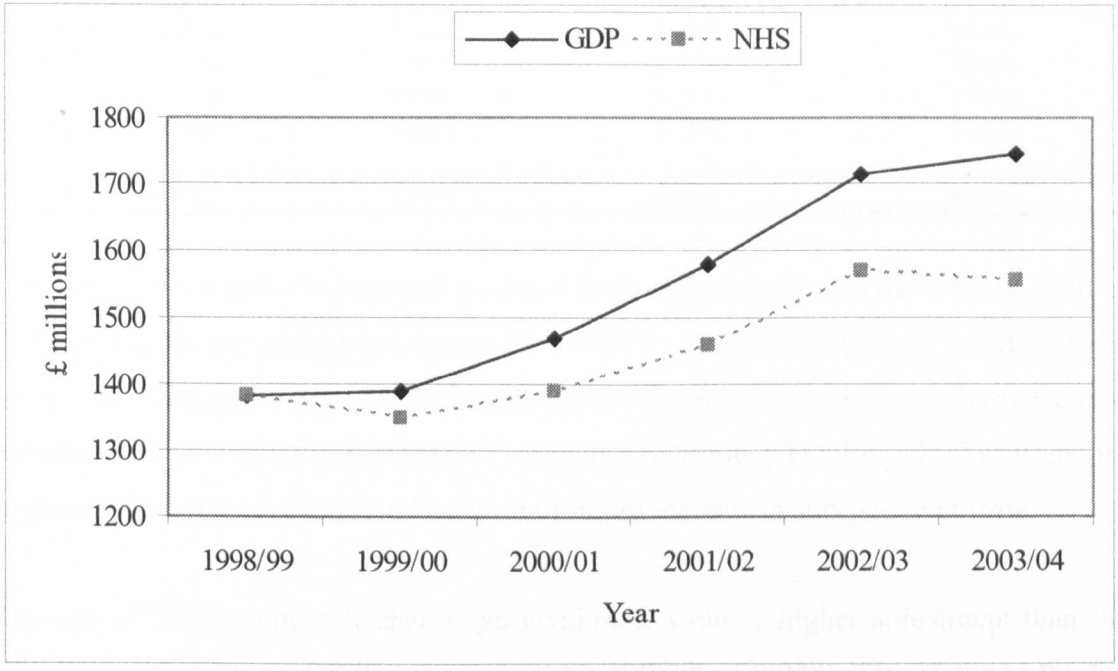
In-hospital and 30-day post discharge survival rates have improved throughout the period. Elective and days case procedures are usually associated with higher survival rates than their non-elective counterparts (see Table 2-12).

In 2002/03, unit costs for elective procedures varied from £394 for deep vein thrombosis to just under £27,000 for heart and lung transplant procedures; unit costs for non-electives varied from £499 for chest pain to £34,000 for heart transplant.

Figure 2-6 shows the implied total expenditure on HRGs associated with circulatory disease across the six-year period. The results are presented in 1998/99 prices, deflated using both the GDP deflator and the NHS Pay and Prices Index. Both show a steady

increase in real expenditure from £1.4 billion in the first year. The GDP deflator is likely to be more appropriate for indicating the real increase in inputs used by the NHS as it reflects the price of goods and services throughout the entire British economy, rather than the cost of goods and service purchased by the NHS. It implies a growth of 5.3 per cent per annum in circulatory disease hospital inputs over the six-year period. This is in line with ONS estimates of total NHS input growth over the same period (between 4.8 per cent and 5.5 per cent depending on the methodology used) (UKCeMGA, 2006).

Figure 2-6 - Total expenditure on circulatory diseases using GDP deflator (GDP) and NHS Pay and Prices Index (NHS), 1998/99 – 2003/04



2.6.1 Simple CWOI and CWOI with survival adjustment

The first set of Figures produced is the simple CWOI for our set of NHS hospital activity for circulatory diseases. This index aggregates activity by weighting it by unit costs, equivalent to multiplying the ratio of activities by their cost shares. The second set also includes survival rates in the cost weighted output growth measure. Results derived from using 'in-hospital' and 'thirty days' survival rates are shown separately. The output growth estimates can be found in Table 2-13.

NHS output for circulatory disease has increased over the time period from 1998/99 to 2003/04. The unadjusted output CWOI suggests an average annual growth in output of 3.9 per cent, although there is annual variation in the estimated amount of growth, with growth particularly pronounced at the end of the period. This is due to exceptional increases in output in a number of HRGs, for both electives and day cases, and non-electives.

Table 2-13 - Cost Weighted Output Index simple and with survival adjustment

Years	CWOI - unadjusted	CWOI with in-hospital survival adjustment	CWOI with 30 day post discharge survival adjustment
1998/99 - 1999/00	2.23%	1.47%	1.36%
1999/00 - 2000/01	2.86%	3.22%	3.33%
2000/01 - 2001/02	3.24%	3.31%	3.42%
2001/02 - 2002/03	6.28%	8.03%	8.37%
2002/03 - 2003/04	4.88%	5.73%	5.93%
Average growth	**3.90%**	**4.35%**	**4.48%**

Introducing the quality adjustment produces higher growth rates in the indices, both on average and for any given year, except for 1998/99 - 1999/00. The lower growth rate for the survival adjusted output index for these years can be explained by the sharp decrease registered for non-elective inpatient in 1999/00 (see Table 2-11). For all other years, the higher growth rates are expected because of improvements in survival over time.

The use of '30-days post discharge' survival rates yields a higher adjustment than 'in-hospital' survival rates for all years except for 1998/99–1999/00. This is due to the fact that the rate of improvement in 30-days post discharge survival rate is greater than that of the in-hospital survival, for any year and on average. The lower growth rate of the output index in 1998/99 – 1999/00 using 30 days post discharge survival rate is due to the multiplicative effect of a negative growth rate in non-elective inpatient activity in 1999/00 and a higher 30 day survival rate.

Overall, using 'in-hospital' survival rates leads to an average annual increase in the estimates of output growth of 0.45 per cent compared with the unadjusted CWOI, while the '30 days post discharge' measure of survival adds 0.58 per cent compared to the unadjusted CWOI. The increase reflects the gradual improvement in survival rate registered over the period under study.

Our preferred measure for survival adjustment is the '30 days post discharge survival rate' as used in many other studies (Lunn *et al.*, 1987;, Kosecoff *et al.*, 1990; Rogers *et al.*, 1990; Baker *et al.*, 2002; Dawson *et al.*, 2005, Castelli *et al.*, 2007). We will use this in the remainder of this chapter.

2.6.2 CWOI with survival and health outcome adjustments

We now consider the introduction of health effects in measuring NHS output growth for circulatory diseases. In the first part of this section we explore the impact that the introduction of health outcomes has on our cost weighted output growth measure for the two procedures for which we have patient reported health outcomes. We then proceed in Section 6.2.2 to calculate the cost weighted output growth index with both quality adjustments for all HRGs for circulatory diseases. Assumptions will need to be made about the value to be given to the ratio $k_j = h^0_j/h^*_j$ and attributed to those HRGs (the majority) for which no health outcome measures are currently available.

2.6.2.1 Introducing patient-reported outcome measures

The health outcome measures were made available by a private health insurance provider. Table 2-14 shows before (h^0_j) and after (h^*_j) treatment measures of health outcomes for CABG and PCTA, respectively. The private health insurance provider reports data at procedural level, and not by HRG which is the 'unit of currency' used in this paper. It is, therefore, necessary to map the provider's procedural codes to their appropriate HRG. A presumption is made that experience of patients undergoing the private health insurance provider's procedures are representative of all patient classified within the specified HRG. This presumption is less likely to hold the more heterogeneous the HRG. The before treatment health outcome measure was obtained from a sample of 747 patients undergoing CABG and from a sample of 85 patients undergoing PTCA. The sample sizes change slightly for the after treatment health outcome measures, which are now equal to 725 and 75, respectively for patients treated with CABG and PTCA. Average before and after treatment health outcomes data are estimated from the full sample for whom data are available.

Table 2-14 - Before and after health outcomes

HRG description	HRG	Health outcome h_j^0	Health outcome h_j^*
Coronary Artery Bypass Graft	E04	0.50	0.73
Percutaneous Transluminal Coronary Angioplasty (PTCA)	E15	0.54	0.79

These health outcomes measures are attributed to elective inpatient and day case procedures. Health status before treatment for patients undergoing PTCA is slightly better than that recorded for patients undergoing CABG. This is in line with evidence from clinical practice, which shows that CABG has historically been used more frequently in patients affected by more severe cases of chronic heart conditions (Cutler *et al.* 2003). Studies on the efficaciousness of both CABG and PTCA procedures (e.g. Henderson *et al.*, 1998 and Cutler *et al.*, 2003) maintain that both have comparable outcomes in terms of survival rates. That said it is not implausible to assume and find that patients' reported health outcomes after treatment are better for patients treated with PTCA than those treated with grafting. After all, PTCA is a far less invasive procedure than CABG.

As Mai (2004) points out, CABG and PTCA procedures administered to patients in an elective setting should be considered as completely different procedures to those administered in emergency cases. Hence, some assumptions need to be made about the value to assign to patient's reported health outcomes before and after an emergency procedure. It is not implausible to assume that in general the health status before treatment as an emergency case is lower than that of an elective and day case.

A sensitivity analysis was undertaken to investigate the impact that different values of before and after health status for non-elective procedures have on the output growth index. In the first instance, we changed the values of both the before and the after health treatment health statuses for non-elective procedures. Results show that the output growth index is not particularly sensitive to these changes. See Appendix 1-B.1 for further details.

Secondly, we made the more realistic assumption that only the before treatment health status of patients that are treated as an emergency differs. In particular, we decided to set these equal to half the value of their correspondent elective counterparts, as follows:

(12) $h^0_{CABG,non-elective} = 1/2 * h^0_{CABG,elective}$

(13) $h^0_{PTCA,non-elective} = 1/2 * h^0_{PTCA,elective}$

Further, we assume that the post-operative health outcome for CABG and PTCA is left equal to their correspondent elective and day case counterparts. See identities (14) and (15):

(14) $h^*_{CABG,non-elective} = h^*_{CABG,elective}$

(15) $h^*_{PTCA,non-elective} = h^*_{PTCA,elective}$

These assumptions will be used throughout the remainder of this section. Results for cost weighted output growth for CABG and PTCA only are shown in Table 2-15.

Table 2-15 - Cost Weighted Output Index simple, with survival and health adjustments – time series for CABG and PTCA -

Years	CWOI	CWOI with 30-day post discharge survival adjustment	CWOI with survival and health outcome adjustment
1998/99 - 1999/00	-0.70%	-0.67%	-0.47%
1999//00 - 2000/01	5.37%	5.65%	5.86%
2000/01 - 2001/02	7.23%	7.20%	7.14%
2001/02 - 2002/03	15.43%	15.68%	15.81%
2002/03 - 2003/04	4.66%	5.01%	5.58%
Average growth	**6.40%**	**6.58%**	**6.79%**

The unadjusted CWOI suggests an average output growth for CABG and PTCA of 6.4 per cent per annum. However, these results demonstrate the volatility inherent in using a small sample, as it is shown by the large increase in the index of 15.43 per cent between 2001/02 - 2002/03. This large increase is driven by an increase in activity for non-electives CABG and PTCA procedures of 61 per cent and 42 per cent respectively between 2001/02 - 2002/03.

On average, the introduction of survival adjustment adds 0.18 per cent per annum to the simple CWOI. Survival rates for these two HRGs did not change much in the time

period considered, and they are quite high. Nevertheless, the incorporation of survival rates in the index equation shows the extra value that is captured by this quality adjustor. Failing to incorporate it would have resulted in an underestimate of the output growth figure.

The last column shows the introduction in the measurement of the output growth index of both survival and health outcomes. On average it adds 0.38 per cent to the unadjusted CWOI and 0.21 per cent to the CWOI with survival adjustment.

2.6.2.2 Cost weighted output index with all quality adjustments

This section concludes the analysis of output growth for NHS hospital treatment of circulatory diseases by incorporating all quality adjustments in our output growth index. Some assumptions need to be made about 1) the value of the k_j to be given to all the HRGs for which we do not have health outcome measures and 2) whether to differentiate this value for elective and day case treatments and non-elective treatments.

Regarding the first point, our preferred value for k_j is equal to 0.8 for every j. This value is equal to the average value for a sample of procedures where data on before and after treatment outcomes are available (Castelli *et al.*, 2007). We recognise that the average above might not be representative of the effects of all NHS hospital treatments and that it is a very strong assumption. We investigated whether different values for k_j have an impact on the output growth measures. We explored the two alternative values of 0.7 and 0.9[54].

We explore whether differentiating the value of k_j for elective and non-elective activity also has an impact on the output growth measures. Our preferred value for k_j for non-electives is equal to 0.4 when k_j for electives is equal to 0.8. This is similar to making the assumption that the before treatment health status of emergency cases is equal to half the value of the before health status for elective cases. We believe that this is a realistic assumption. We also explore two alternative values: 0.35 and 0.45[55]. These are used alongside the preferred value k = 0.8 for elective HRGs.

Cost weight output growth indices when k_j is equal to 0.8 and 0.4, respectively for elective activity and non-elective activity except for CABG and PTCA are shown in Table 2-16.

Table 2-16 - Cost Weighted Output Index, with survival and health outcome adjustments - time series for all circulatory diseases

Years	CWOI - unadjusted	CWOI with survival adjustment	CWOI with survival and health outcome adjustment
1998/99 - 1999/00	2.23%	1.36%	0.25%
1999/00 - 2000/01	2.86%	3.33%	3.86%
2000/01 - 2001/02	3.24%	3.42%	3.72%
2001/02 - 2002/03	6.28%	8.37%	11.16%
2002/03 - 2003/04	4.88%	5.93%	6.96%
Average growth	**3.90%**	**4.48%**	**5.19%**

Introducing the survival and health outcome quality adjustment produces higher in-year growth rates in the indices, both compared to the unadjusted CWOI and the CWOI with survival adjustment. The only exception is for the years 1998/99 - 1999/00, where the quality adjusted output growth measure is much smaller. The same explanation given in section 2.6.1 applies here. There is in fact a sharp decrease in non-elective inpatients activity in 1999-00 compared to the previous year (see Table 2-11), which combined with both survival and health outcome effect dampens the output growth between 1998/99 and 1999/00.

Overall, using the CWOI with survival and health outcome adjustment leads to an average increase in output growth for all circulatory diseases of 5.19 per cent per annum. Thus, adding 1.29 per cent and 0.71 per cent respectively to the unadjusted CWOI and CWOI with survival adjustment only.

2.6.3 Productivity growth

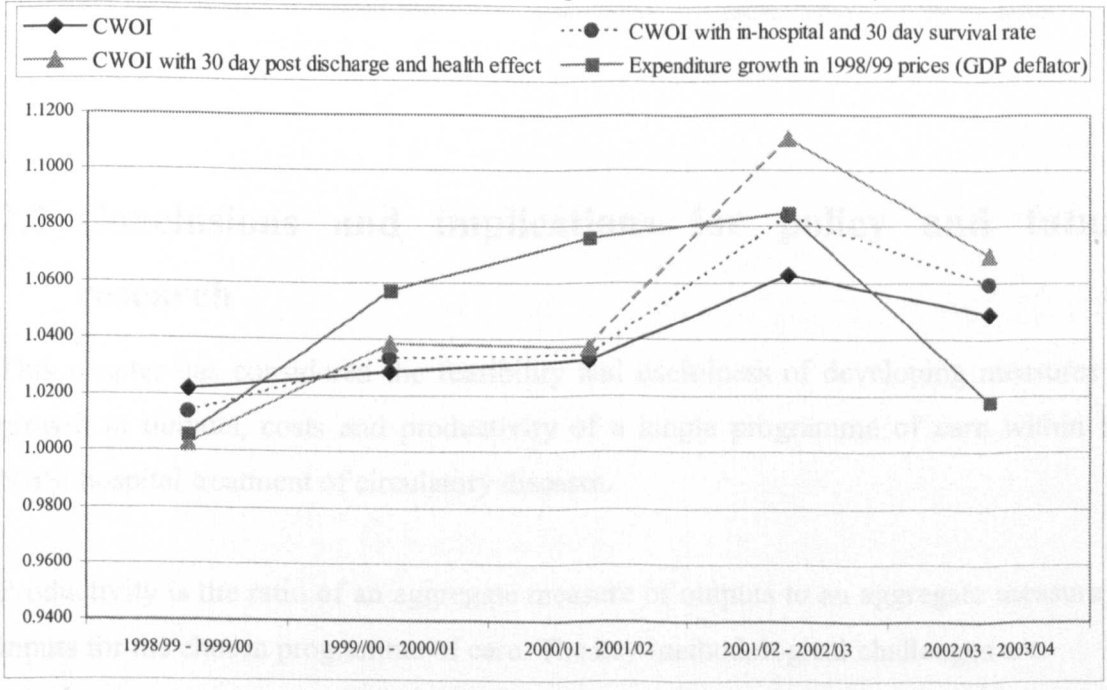
Measuring productivity over time requires the calculation of a volume measure of output change and compare it to an estimate of a volume measure of input change. As indicated below.

Productivity change = Change in volume of outputs/Change in volume of inputs.

As described in Section 2.4.4, we use average unit cost data from the Reference Cost database to account for inputs used in the production process for the treatment of all circulatory diseases. We produce two estimates of total expenditure using both the GDP deflator and the NHS Pay and Price Index, to account for real changes in expenditure. Total expenditure growth is expressed in terms of 1998/99 prices.

The total costs of hospital treatment of circulatory diseases have increased by 4.84 per cent per annum in real terms. If this estimate is correct, it would imply that the cost-effectiveness of this programme of care has been marginally falling over the period under scrutiny if one considers the CWOI with survival adjustment only. Productivity growth has fallen in this case by -0.325% on average. However, if one compares the average growth in CWOI with survival and health outcome adjustment with the average growth in expenditure a different picture emerges. Our results suggest that output has grown marginally more relative to inputs measured at constant GDP prices, with annual improvements in physical productivity of up to 0.318% per annum.

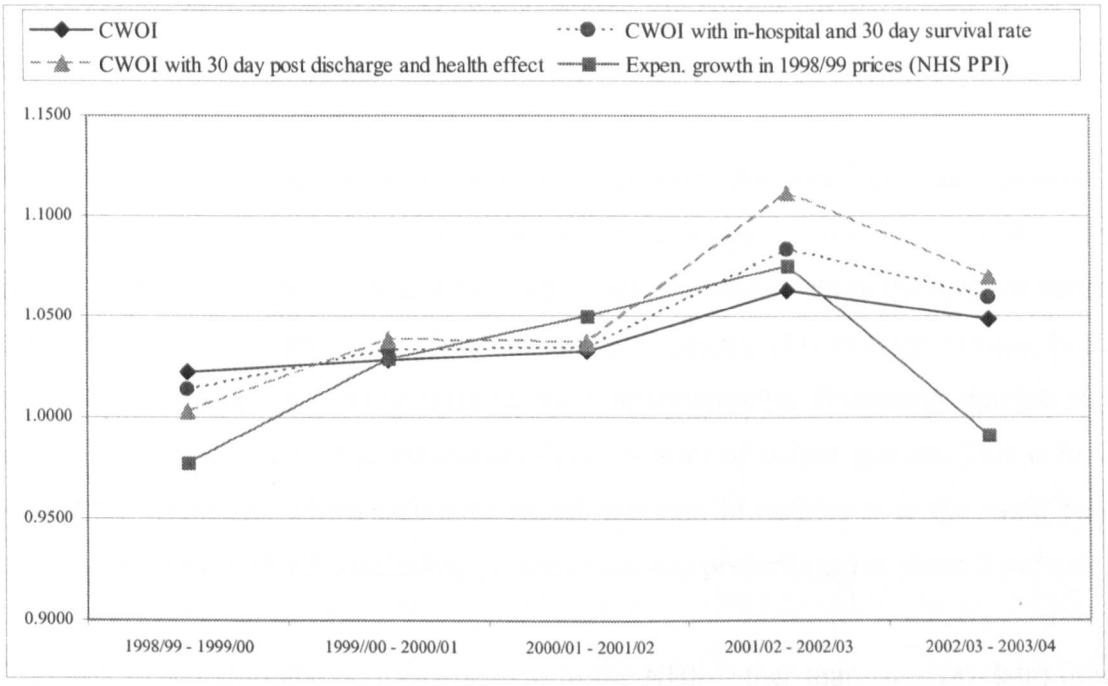
Figure 2-7 - Trends in output growth and total expenditure for all circulatory diseases



Using the NHS price deflator implies an even larger growth in outputs relative to inputs measured at constant NHS prices. A tentative conclusion is that the NHS has used its

physical resources in this disease programme more efficiently to secure annual improvements in physical productivity of up to 2.02 per cent per annum when compared to the CWOI with survival adjustment only and up to 2.7 per cent per annum when compared to the CWOI with survival and health outcome adjustment.

Figure 2-8 - Trends in output growth and total expenditure growth using the NHS Pay and Price Index



2.7 Conclusions and implications for policy and future research

This chapter has considered the feasibility and usefulness of developing measures of growth in outputs, costs and productivity of a single programme of care within the NHS: hospital treatment of circulatory diseases.

Productivity is the ratio of an aggregate measure of outputs to an aggregate measure of inputs for the chosen programme of care. The key methodological challenges are:

- choosing the appropriate measures of NHS output
- adjusting those measures for the quality of care
- aggregating the measures into a single measure of output

- identifying the associated inputs and aggregating them into a single measure
- tracking these measures consistently over time.

We have demonstrated that it is feasible, using hospital spells as the unit of output, to develop quite refined models of the output of a programme of care. The development of HRGs has assisted greatly in this endeavour, yielding meaningful counts of output. For programmes of care outside hospitals future challenges will include developing analogous measures of output in a community and primary care setting.

Output growth for hospital treatment of all circulatory diseases has increased over the time period we considered. In actual cost-weighted volume terms, the increase is of the order of 3.9 per cent per annum, but incorporation of quality data in the form of survival rates implies an increased rate of 4.5 per cent per annum. This is clearly crude, but the recent improvement in survival rates in many procedures for circulatory disease yields quite a large improvement in estimates of annual rates of output growth. This is in line with ONS estimates, which estimates annual increase in outputs over the same period for the whole of the NHS (including primary care and prescribing) at about 5 per cent.

The lack of health outcome measurement in the NHS (other than survival data) means that we are unable to say much about the quality of life after treatment. However, we have demonstrated how this might be incorporated into an output index using health status measures of before and after treatment from a private health insurer. Health outcome data were available for CABG and PTCA elective procedures. For all other procedures/diagnoses of circulatory disease we attributed an average value to the ratio of before and after health outcome measures ($k_j = h_j^0/h_j^*$) for electives and non-electives activity (See Castelli *et al.*, 2007a). Sensitivity analyses were carried out to determine the effect of different values on the cost weighted output growth indices. In the first instance, we calculated output growth measures for CABG and PTCA procedures only, finding that consideration of the quality of health outcomes added about 0.2 per cent per annum to the estimates of output growth. Incorporating health outcomes measures for all circulatory diseases activity yields a higher increase in average output growth of about 5.19 per cent per annum, adding about 1.3 per cent per annum to the unadjusted CWOI and 0.71 per cent annum to the survival adjusted CWOI.

Figure 2-9 – Changes in output growth index with different quality adjustment specification baselined to unadjusted CWOI, by year

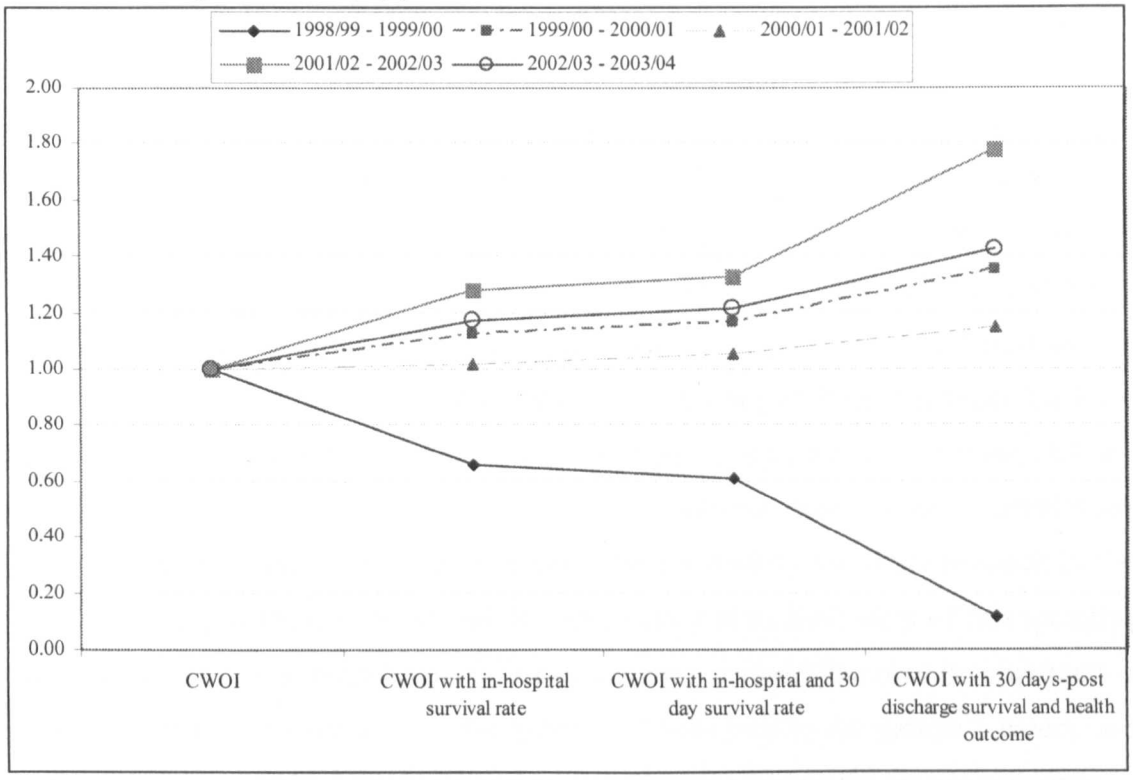


Figure 2-9 shows how the baseline estimate of output changes as each subsequent adjustment is made by year. It appears clearly that in the period 1998/99 – 1999/00, quality adjusting output in circulatory diseases lead to worse estimate in output growth compared to the case with no adjustment. As discussed in Sections 2.6.1 and 2.6.2.2, this is largely due to the multiplicative effect of a negative growth rate in non-elective inpatient activity in 1999/00 which combined with both survival and health outcome effect dampens the output growth between 1998/99 and 1999/00. For all remaining years, the introduction of different quality adjustors has a positive impact on the baseline estimate, as these are always higher than the baseline output growth estimate.

In our view, routine collection of measures of health outcomes by the NHS should be an urgent priority for numerous reasons, such as improved patient care, informing patient choice, surveillance of clinical performance and resource allocation. It would also permit the development of more secure measures of output growth, based on the health improvement experienced by patients as a result of NHS treatment.

At this stage of development we also consider health outcomes to be the most important element of quality to incorporate into the model of NHS output growth. However, there is also a case for exploring the feasibility and usefulness of incorporating non-health aspects of NHS quality into the model, such as measures of the patient experience and waiting time. Regarding patient experience, it is known that patients value other attributes of the provision of health care that are strictly speaking not directly related to the curative aspects of it. These are for example cleanliness, food quality and being treated with dignity and respect. We have been made aware that the Picker Institute has conducted surveys collecting patients' views on a number of these attributes for NHS patients and service user in a number of settings (eg primary care and inpatient) and also for specific disease groups such as stroke and chronic heart disease (Healthcare Commission, 2004 and 2005). It will be considered a priority for future research in this field to investigate these surveys and the data collected to find ways of incorporating them into a measure of output growth. Other aspects of output that may be important in some programmes of care include the benefits of treatment to the patient's carers, and the implications of NHS activities for labour productivity and social care expenditure.

A crucial methodological consideration concerns the weights to be applied to the separate NHS output activities. The diverse hospital spells that make up this programme of care do not necessarily confer equal patient benefits. We have followed the conventional practice in weighting treatments according to their estimated costs, acknowledging that these are imperfect measures of marginal social value.

It has also been shown that substantial improvements in survival rates for stroke and coronary heart disease have occurred throughout the time period considered. These improvements are spread across all circulatory diseases, thus meeting the health policy targets set out in 1999 by the Department of Health of achieving substantial reduction in mortality rates in this area of healthcare.

[36] Although the White Paper mentions specifically coronary heart disease and strokes as priority areas, elsewhere in the document it states that "[...] all references to coronary heart disease and stroke should be understood to cover all diseases of the circulatory system" (DH, 1999, chapter 6).
[37] A 'service price index' can be constructed either at a disaggregated level, where the market basket is given, for example, by the cost of operating time, or at an aggregated level, where the market basket consists of different treatment procedures, such as for example a hip replacement.
[38] The CPI and PPI try to incorporate quality changes.
[39] Knowledge should be considered here as different from the knowledge included – *embodied* – in new technologies that are included in new treatments. This type of knowledge refers to say medical knowledge and know-how and is characterised to some extent by public good attributes.
[40] Cutler *et al.* (2001) extend this case to one of multiple diseases with consumers having probabilities of contracting various illnesses.
[41] They also explore the use of quality adjusted life years (QALYs). A QALY is "a generic measure of health-related *quality of life* that takes into account both the quantity and the quality generated by interventions" (Culyer, 2005).
[42] The assumption on the monetary value of health improvement is derived from existing US literature, which places the value of a life year gained between $10,000 and $100,000. Cutler *et al.* (2001) use the benchmark assumption of $25,000 for every year of additional life.
[43] Sometimes in combination with therapy.
[44] In particular, Berndt *et al.* define incremental remission "as the difference between the expected outcome and the outcome that would be expected if he patient received no treatment".
[45] This is called in the paper the 'problem of durability' and is typical of many goods, not just healthcare.
[46] Unfortunately, data limitations prevent the adoption of a unit value approach for cataract surgery similar to that in Cutler *et al.* (2001).
[47] Cutler at al. exclude from their time series both the years 1983 and 1984 as the number of reported CABG procedures in these years is significantly higher than that in 1985.
[48] A sensitivity analysis was carried out to look at the effects of different values for the cut-off point on the output growth estimates. Using our preferred values for k = 0.8 for elective HRGs and k =0.4 for non-elective HRGs, the estimates of the output growth indices are not very sensitive to values of the cut-off point equal to 0.05 and 0.2.
[49] The guidance spreadsheets can be obtained from http://www.dh.gov.uk/en/Managingyourorganisation/Financeandplanning/Programmebudgeting/DH_4117326 (last accessed 30/10/2008).
[50] Available at http://www.ic.nhs.uk/our-services/classification-and-standards/casemix/hrgv35/hrgv35-toolkit/grouper/on-line-hrg-v35-explorer. Last accessed 1/10/2008.
[51] See Appendix 2-A for the full list of HRGs complemented with volumes of activity and unit costs (Table 2-A.1), and survival rates – both 'in-hospital' and 'in-hospital and 30 days' (Table 2-A.2) – for the last year of the time series studied (2003/04).
[52] These are both calculated from mortality rates, as 1 – mortality rate.
[53] The WHO STEPwise approach to stroke surveillance – Manual (2006).
[54] The full set of results of the sensitivity analysis can be found in Appendix 2-B.2.
[55] The full set of results of the sensitivity analysis can be found in Appendix 2-B.2.

3 Equity in the delivery of healthcare in Great Britain: the impact of decentralisation

This chapter addresses the issues of income-related inequality in health and inequity in healthcare utilisation for the constituent countries of Great Britain in an attempt to elicit possible directions of changes in the above as a consequence of the devolution reform introduced in 1998. After introducing the issues at hand, we briefly review the theory of decentralisation in Section 3.2. In the same section, we summarise the process of the British devolution of the healthcare sector. Section 3.3 contains a brief discussion of what is usually meant by "equity" and how the concept is studied and measured in the economic literature. In Section 3.4 we present the methodology used in this study. Data description and descriptive statistics are presented respectively in Sections 3.5 and 3.6. Finally, results are analysed and discussed in Sections 3.7 and 3.8, respectively for income-related inequality in health and inequity in healthcare utilisation.

3.1 Introduction

Over the last decade or so decentralisation of the health care sector has received substantial attention as a policy reform in many countries. Even so, the effects of this reform are neither thoroughly investigated nor completely understood.

We believe that in public health systems, there is the risk that equity will be undermined by a policy of decentralisation. In particular, decentralisation of the healthcare sector can jeopardise equity if individuals who are "equal" in every respect but the 'jurisdiction'[56] in which they happen to live are treated differently than they would be in a more centralised structure.

In 1998 the Labour Government passed an important reform which transferred political power and responsibilities from Westminster to Scotland, Wales and Northern Ireland. Health is the most important responsibility that has been devolved to constituent countries in the UK, representing about 70 per cent of the budget that the devolved governments have control over. Prior to devolution[57] , health services in the constituent

countries of the United Kingdom were administered as part of the National Health Service, which was designed to achieve common standards across the whole of the UK. However, since devolution, each constituent country[58] has been granted freedom to organise aspects of their NHS differently, subject to overarching criteria and constraints.

In this part we investigate how decentralisation of the healthcare sector affects equity in the delivery of healthcare within a decentralised system, using the constituent countries (England, Scotland, Wales) of Great Britain as a case study. Data are taken from the General Household Surveys (GHS) administered in 1995/96 and 2001/02. In particular, we test for income-related inequity in healthcare utilisation within and across the three constituent countries of Great Britain, by means of a concentration curve index. The level of health is captured through different measures of self-assessed health. The utilisation of primary and secondary care is proxied by GP consultations, outpatient visits and inpatient stays. Self-assessed health, however measured, and the utilisation of health care resources is standardised by age and sex for individuals reporting morbidity, following the direct standardisation methodologies outlined in O'Donnell and Propper (1991).

3.2 Decentralisation: a review of the theory and the case of the British devolution

3.2.1 A review of the economic literature on decentralisation

Decentralisation is a very broad concept whose definitions vary according to the particular discipline within which it is studied. In its broadest sense it refers to the transfer of political, administrative and fiscal powers and responsibilities for public functions from the central government to sub-national levels of government. Different types of decentralisation can be envisaged according to the degree and type of powers and responsibilities that are transferred. The fullest form of decentralisation is usually referred to as "devolution" and is attained when the central government cedes not only political and administrative responsibilities to local governments but also financial responsibilities regarding the levying of taxes with which to finance the devolved functions and responsibilities.

For the purpose of this paper, we briefly summarise the economic literature on Decentralisation (or Fiscal Federalism, as it is usually termed) by focussing on its potential advantages and disadvantages[59].

The economic literature on Decentralisation/Fiscal Federalism studies the optimal assignment of different governmental functions to different levels of government. Further, it studies the appropriate fiscal instruments that need to be devolved to local governments in order for them to carry out the assigned functions. Musgrave (1959) identified three major governmental functions or responsibilities and analysed whether and to what extent the transfer of any of the three functions to a sub-national level of government would be appropriate. The functions identified are: (a) macroeconomic stabilisation, (b) income redistribution and (c) resource allocation.

Jurisdictions at any sub-national level should play no role in macroeconomic stabilisation, as it is believed, Musgrave stresses, that their relative openness may be detrimental for the implementation of anti-cyclical fiscal policies at this level. Further, it is argued that were sub-national levels of government allowed to fully control money supply, these would be tempted to finance their current public expenditure by creating a new monetary base rather than financing it through taxation. This policy definitely entails a high political cost.

As regards income redistribution, Musgrave also assigns this function primarily to central government. Income redistribution should be considered here not only in terms of inter-jurisdictional redistribution but also in terms of personal income redistribution. Redistributing income across jurisdictions is assumed to be better performed at a central level because of the relatively high mobility of households and firms. The ultimate negative effect of a highly redistributive programme carried out at local level would be to attract poor income households from other jurisdictions, whilst driving away high income households from the jurisdiction. However, a marginal role in income redistribution can and should be also played by local governments as these have a better knowledge of local needs and who constitute the poor. This role was particularly stressed by Pauly (1973), who showed that the redistribution of income when performed by local governments (of any level) may result in a Pareto superior outcome (or at least not Pareto

inferior) to a centrally performed re-distribution[60]. It is worth noting that, as envisaged by Pauly, individuals are interested in income redistribution not solely for altruistic reasons, noting particularly how poverty is usually associated with some negative externalities (such as increased crime rates), which individuals may be keen to minimise. Further, Pauly stresses the local dimension of income redistribution by emphasising how the proximity to and the "frequency of contact" with poverty explains why individuals are willing to engage in and promote poverty relieving programmes at a local level.

Musgrave concludes that a positive role for a sub-national level of government can be envisaged only with regard to resource allocation and yet only in those cases where the production and delivery of goods and services can be ascribed to a specific geographical area. Oates (1972) reinforces the importance of local governments in resource allocation with his decentralisation theorem. In particular, Oates shows that welfare gains may be attained with fiscal decentralisation when the demand for public goods and services, that is when citizens' preferences over these goods and services differs between jurisdictions, and when production costs also differ at the local level.

Our focus being on health sector decentralisation, we will now proceed by addressing the usual arguments brought forward by the supporters/advocates for decentralisation of the healthcare sector. In particular, the World Bank plays an important role in this respect as it has strongly supported the decentralisation of the healthcare sector (especially in the developing world) and investigated some of its potential effects.

In particular, it is argued that the transfer of administrative, political, and/or fiscal authority over healthcare production and delivery from the central government to sub-national level of governments should improve overall healthcare performance (World Bank, 1993). The benefits that can accrue from a policy of decentralisation can be thought of in both efficiency and equity terms. In particular, decentralisation is thought to improve (i) "allocative" efficiency by allowing local governments to adapt the production and delivery of services, and also expenditures, to local preferences; and (ii) 'technical' efficiency through greater cost consciousness at the local level (Oates, 1972 and 1999).

Equity may be improved as well, if we think that local governments are closer to their

citizens, and hence may be more aware of the specific local needs. Local governments may be able, therefore, to respond to local needs in more appropriate ways than a central government or agency (Pauly, 1973). Further, advocates of decentralisation argue that the closeness of individuals to their local governments and hence, their increased participation in the decision making process leads to greater and improved quality, transparency and accountability (Bossert, 2002). It is also maintained that local autonomy may trigger local innovations and specilisations in the production and/or delivery of a public service.

The main disadvantage derives from the fact that individuals who are "equal" in every respect but the jurisdiction in which they happen to live may end up being treated differently. Decentralisation may give rise to "unacceptable" variations across the country as a whole.

3.2.2 An introduction to devolution in the United Kingdom

In the UK the decentralisation reform is more commonly known as devolution. Political devolution began in 1998 with the Scotland Act 1998, the Government of Wales Act 1998 and the Northern Ireland Act 1998. The administrative, executive and legislative arrangements for England are untouched by the devolution process. The UK system is often described as asymmetrical, in that each constituent country has different levels of devolved responsibilities and has developed its own specific arrangements. The differences relate to the extent to which administrative, executive and legislative powers have been objects of the devolution process in each country.

The settlements for Scotland and Northern Ireland have similar characteristics; both countries have been accorded legislative power to pass primary and secondary legislation in areas not reserved to Westminster alongside their powers over the so called "devolved" matters. These countries also have a separate executive accountable to that legislature, whilst Wales has not. Differences between Scotland and Northern Ireland do exist and are mainly restrictions imposed on Northern Ireland on issues such as criminal justice, law and policing. These restrictions will be kept in place until the peace process in Northern Ireland is fully completed.

In contrast, Wales' National Assembly is a single corporate body, in which both legislative and executive functions are grouped together. Plans have been made to separate these functions into two independent bodies. However, what really differentiates the Welsh Assembly from its Scottish and the Northern Irish counterparts is that the former can pass only delegated legislation, e.g. regulations, within the framework of Acts of the UK Parliament. So, in effect, both Scotland and Northern Ireland (when the peace process is completed) have been ceded more powers than Wales.

The peculiarity of the U.K. devolution system compared to other devolved systems can also be seen in that the United Kingdom Parliament[61] retains its superiority over the Scottish Parliament, the National Assembly for Wales and the Northern Ireland Assembly, which are all constitutionally subordinate to Westminster. In particular, Westminster is able to amend or repeal the Acts devolving power to Scotland, Wales and Northern Ireland. The legislative supremacy of the Westminster Parliament is expressively stated in both the Scottish and Northern Irish devolution Acts, respectively in section 28 (7) and 5 (6).

Finally, the financial arrangements have not been touched by the devolution reform, as all countries' public expenditure is still mainly funded by block grants from the UK Government. Scotland, however, has been granted the power to vary the standard rate of income tax levied, thus being able to either raise additional or less income.

Table 3-1 summarises the particulars of the devolution's arrangements made in Scotland, Wales and Northern Ireland, separately for each country.

Table 3-1: Devolution structure for Scotland, Wales and Northern Ireland

Scotland	Wales	Northern Ireland
	Devolution arrangements	
Negative list: identifies the subjects that are reserved to Westminster	Positive lists: details all subjects devolved	Extended, excepted and transferred subjects
	Devolved matters	
Local government	Local government	-
Housing	Housing	-
Transport	Transport	-
Planning	Town and country planning	Enterprise, trade and investment
Sports and the art	Culture	Culture, arts and leisure
-	-	Learning and employment
Police and fire services	-	-
-	Welsh Language	-
-	-	Agriculture and rural development
-	-	public safety
Tourism, economic development and financial assistance to industry	Economic development	Regional and social development
	Common to all three countries	
	Health, Education, Social services/work, Environment	

In Scotland[62], the "Negative list" specifically identifies those items that are reserved to Westminster, and automatically devolving all non-listed areas to the Scottish Parliament that can pass legislation on them. Further, and in contrast to Scotland, the Government of Wales Act contains a "Positive List" by detailing all the functions that are to be transferred to the Assembly. Finally, the Northern Ireland Act 1998 differentiates three categories of legislative powers: reserved, excepted and transferred. "Excepted" subjects are all those subjects that are reserved to the UK Parliament. These are listed in Schedule 2 of the Northern Ireland Act 1998[63] and include roughly the same subjects for Scotland. "Reserved" matters are those subjects which could be transferred if consent across communities is reached. These subjects include criminal law, policing and prisons.

3.2.2.1 The devolved National Health Service

The devolution process for the National Health Service started long before the actual political devolution was put into practice. Marked differences have in fact always existed between the constituent countries of the United Kingdom in key health indicators and also in total NHS per capita spending. Summary statistics presented in

Alvarez-Rosete *et al.* (2005) are used as an overview of the existing differences across the four countries of the UK in the years preceding the devolution reform. These are reported in Table 3-2.

The first row shows total NHS expenditure per capita and by country for 1996/07. England has the lowest per capita spending of all four countries, whilst Scotland has the highest. A caveat needs to be drawn as the expenditure figures are not adjusted for differences in need deriving from differential age, sex and morbidity structures of the population. Hence, the reported figures could well be under-stated, as suggested in Alvarez-Rosete *et al.* (2005).

Table 3-2: Total NHS expenditure per capita, key health indicators and provision of healthcare by country – 1996/07 (pre-devolution)

	England	Wales	Scotland	Northern Ireland
Expenditure per capita (£)	831	968	1047	944
Health Indicator				
Standardised mortality ratio				
Men	98	102	119	109
Women	98	102	116	108
Life expectancy (years)				
Men	74.5	73.9	72.2	73.8
Women	79.6	79.1	77.9	79.2
Proportion reporting illness (%)				
Longstanding illness	35	38	33	34
Limiting Longstanding illness	22	26	21	25
Provision of healthcare				
Hospital beds/1000 population (all specialties)	4.1	5.3	7.7	5.7
Hospital beds in acute specialties (% of tot. beds)	76.2	78.1	68.2	71.2
Staff/1000 population				
Medical and dental*	1.1	1.2	1.5	1.3
Nursing, midwifery, and health visiting*	5	5.9	6.9	6.9
General Practitioners**	0.56	0.6	0.72	0.62

* Whole time equivalent.
** Unrestricted principals.
Source: Own elaboration from summary statistics presented in Alvarez-Rosete *et al.* (2005)

In terms of key health indicators, citizen living in England have higher life expectancy (both for men and women) and lower mortality rates. Only in terms of self-reported morbidity, the proportions of people reporting a longstanding illness are higher in England than they are in Scotland and Northern Ireland (only exception is posed by Wales), whilst the proportion of people with a limiting longstanding illness in England is higher only compared to Scotland.

The last part of Table 3-2 shows some supply-side information for hospital and staffing. In general, England is the country which ranks last in terms of total number of hospital beds per 1000 population for all specialties and for the total number of staff per 1000 population (the only exception is given by the percentage of total beds in acute care).

Notwithstanding the existence of (in some cases marked) differences across England, Wales, Scotland and Northern Ireland, it is only since the election of the Labour Government in 1997 that differentiated white papers on the organisation of healthcare services for the NHS were produced in each constituent country. These were the English white paper *The New NHS: Modern-Dependable*, the Scottish white paper *Designed to Care*, the Welsh white paper *NHS Wales Putting Patients First*, and the Northern Irish consultation paper *Fit for the Future*[64]. Similar white papers tackling the issue of public health were also produced in 1998 by England (*Our Healthier Nation*), Scotland (*Towards a Healthier Scotland*) and by Wales (*Better Health Better Wales*). Northern Ireland produced only two consultation papers (*Investing in Health* and *Well into 2000*), which did not develop into a white paper.

In the remainder of this section, we report some key objectives of the new NHS, in England, Wales and Scotland, to reiterate the understanding that health and the health system, although now being a devolved matter, are nonetheless based on the same founding principles of the NHS as it was at its first inception in 1948. We leave Northern Ireland out of our analysis, as this paper addresses issues regarding the equitable distribution in health and healthcare utilisation for England, Scotland and Wales only. This is solely due to data unavailability for Northern Ireland.

In England, the Government's commitment is to ensure that 'if you are ill or injured there will be a national health service there to help: and access to it will be based on **need** (emphasis added) and need alone - not on your ability to pay, or on who your GP happens to be or on where you live'. This reinforced commitment is a consequence of what was believed to be a failure of the internal market in the NHS, which had brought upon the patients the feeling that their access to NHS services was determined more by the laws of competition than by the urgency of their conditions (Department of Health, 1997).

The Welsh white paper makes one of its key objectives to 'reduce health variations across

Wales and tackle inequalities in health and in access to healthcare'. Further on, we read that 'The NHS should be a service which embodies **fairness** (emphasis added), efficiency, effectiveness, responsiveness, accountability, integration and flexibility. Patients should receive the same level of service and quality of care for the same level of need. As health needs vary across Wales, so services need to be **tailored to local circumstances** (emphasis added) to deliver equity of access and treatment. Responsibility for decision-taking should be devolved as close to patients as possible to encourage responsiveness and innovation in service. Devolution of responsibility must be matched by mechanisms for accountability and control'.

The Scottish white paper reads similarly, where it states that 'The Government will ensure that the NHS remains true to its historic ideals, free at the point of use, funded through general taxation and available on the basis of need'. Further, in the white paper it is stated 'The Government believe the proposal in this Paper will result in an NHS in Scotland designed to put patients first, better equipped to take advantage of new technology to improve clinical effectiveness and the reliability of clinical care, and better able to develop distinctive solutions to Scotland's **health needs** (emphasis added) and to provide better value for money. It will keep faith to its founding ideals by delivering comprehensive services to promote good health, rapid diagnosis and treatment for those who are ill, and care for those with continuing needs, and it will be funded through general taxation so that nobody need worry about the cost of being ill'.

Although it clearly appears that England, Wales and Scotland are all firmly committed to the founding principle of the NHS when it was first created in the United Kingdom, devolution allows each country to apply their own interpretation of local needs and preferences within the overarching principle that "need and not ability to pay" should determine the access to healthcare resources.

3.3 Operationalising the concept of equity in the National Health System

The concept of equity lends itself to various interpretations, Mooney points out (1987)

equity in health is 'a value laden concept which has no uniquely correct definition'. He identifies seven alternative ways of defining equity in healthcare: 1) equality of healthcare expenditure per capita, 2) equality of inputs per capita, 3) equality of input for equal need, 4) equality of access for equal need, 5) equality of utilisation for equal need, 6) equality of marginal met need and 7) equality of health.

These different definitions of equity in healthcare have subsequently been studied and debated in theoretical health economic literature, with a fundamental division between some who argue that the intended aim of a national health system, as appears in many policy statements, is to achieve equity of access to health care services; and others who maintain that it is on utilisation of health care that studies on equity should be focussed (Le Grand, 1982; Mooney, 1983; Mooney et al., 1991, 1992; Culyer et al., 1992a and 1992b)

The pursuit of either of these two concepts is firmly grounded in the Aristotelian principle of 'horizontal equity', that requires the 'equal treatment of equals'. This principle is met when individuals who are similar with respect to a given set of characteristics are treated in exactly the same way. Translated to health and healthcare, the principle reads as the 'equal treatment of equal need'.

The concept of need, similarly to the concept of equity, can have several interpretations. Culyer and Wagstaff (1993) offer four alternative formulations. The first defines 'need' as an increasing function of the degree of ill-health of an individual; hence, individuals who suffer from the highest degree of ill-health are regarded as those to have the greatest need. The second formulation, defines 'need' as related to an individual's capacity to benefit from a particular treatment; consequently, individuals with the greatest capacity to benefit are identified as those with the greatest need. The third and fourth definitions of 'need' presented by Culyer and Wagstaff (1993) focus on the amount of health spending society reckons an individual 'ought' to have or the amount of healthcare expenditure that is necessary to reduce an individual's capacity to benefit from further healthcare spending to zero.

However, and leaving the theoretical debate on the preferred formulation of need aside, we have to recognise that in much of the empirical research on equity in health and healthcare,

need is often simply proxied by (a set of) health status variables.

In this part, we analyse the equal utilisation by individuals in equal need. In particular, we will investigate whether income-related inequity in the delivery of healthcare occurs within and across England, Wales and Scotland. The ultimate aim remains to establish the impact of devolution on income-related equality in health and income-related equity in healthcare utilisation.

3.4 Methodology

The concentration index (CI) provides a measure of inequality for a specific variable, for example health, with respect to a specified socio-economic status, such as income, occupation, etc. (Wagstaff et al. (1991, 2000). The CI is analogous to the Gini coefficient, which is commonly used as a measure of income inequality. Similar to the Gini Coefficient based on the Lorenz curve, the concentration index is based on the so called concentration curve, L(s). Applied to healthcare, this graphs on the x-axis the cumulative proportion (or percentage) of individuals (or groups) ranked by economic status, starting from the least well-off. On the y-axis the cumulative proportion (or percentage) of the population in health (population use of healthcare services) is plotted in correspondence to each cumulative proportion of the distribution of the economic status variable. The degree of inequality is captured by the vertical distance between the concentration curve and the line of equality. The latter is represented by the 45 degree line, which runs from the bottom-left corner to the top-right corner (see Figure 3-1).

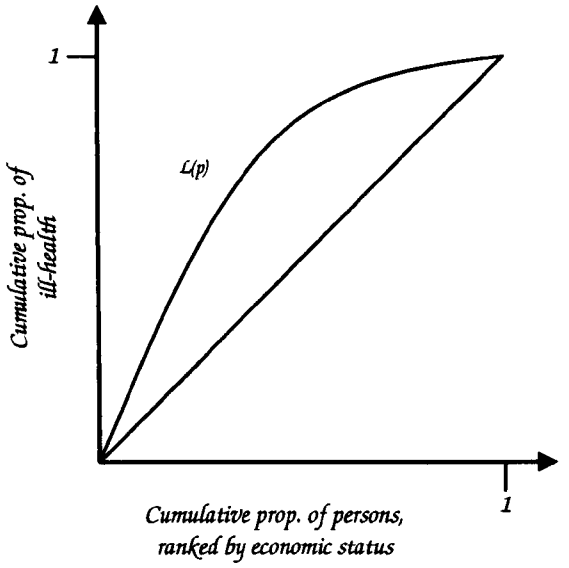


Figure 3-1: Concentration Curve for ill-health

The concentration index is equal to twice the area between the concentration curve and the line of equality. Formally, the index is defined as:

$$C = 1 - 2\int_0^1 L_h(p)dp$$

and is bounded between –1 and 1 (World Bank, 2008).

In the case of no income-related inequality the value of the concentration index is equal to zero. There are a number of special cases leading to the following values of the CI:

(1) the CI is equal to zero. In this case, we may well have a situation where the distribution of the health variable or the healthcare utilisation variable is equally distributed among all individuals ranked by income or income groups (or any other socio-economic variable against which we are measuring the inequality). It is worth noting, however, that a value of zero for the concentration index does not necessarily imply that the variable with regard to which the income-related inequality is measured is equally distributed across the population. A zero value may arise because the inequalities favouring the most advantaged individuals are exactly off-set by the inequalities favouring the least advantaged individuals. This situation occurs when the concentration curve

crosses the diagonal and the two areas between the concentration curve and the diagonal before and after the point of intersection are exactly the same.

(2) the CI is equal to 1 (-1). This corresponds to a situation where all the health[65] is concentrated in the hands of the least (most) disadvantaged individuals (or groups).

(3) the CI takes values between -1 and 1. The concentration takes a negative value when the curve lies above the line, this means that income-related inequality in the variable under investigation is favouring the worst off, a positive value of the concentration index occurs when the curve lies below the line of equality, meaning that income-related inequality is favouring the better off. In the case that the variable under investigation is a "bad", that is ill-health (as depicted in Figure 3-1), then negative values of the concentration index are associated with pro-rich inequalities and positive values are associated with pro-poor inequalities. The further away the concentration curve lies from the line of equality, the larger the degree of inequality.

The concentration curve can be used as a means to compare income-related inequalities in health and income-related inequities in healthcare utilisation (see van Doorslaer et al., 1997) across several countries and within the same country but across time. In order to be able to rank the distribution of health (or healthcare utilisation) of country A as strictly more equitable than that of country B, it is important that the concentration curve of the former lies everywhere closer to the line of equality than that of country B. When the two curves cross it is not possible to state which country has less or more inequality in the health variable in question, unless one makes further assumptions and/or value judgements about the inequalities experienced by different sub-groups of the population. The same holds when making comparisons through time for the same country.

In this paper, we are interested in assessing whether the distribution of health and healthcare utilisation has been affected by the recent devolution of the NHS in Great Britain (i.e. excluding Northern Ireland). The distribution of health and healthcare utilisation will be measured by means of the concentration index described above. In particular, because we decided to carry out the analysis by grouping individuals into income quintiles, the following formula[66] is used to compute the concentration index.

$$(1)\ CI = (p_1 L_2 - p_2 L_1) + (p_2 L_3 - p_3 L_2) + \ldots + (p_{i-1} L_i - p_i L_{i-1})$$

where p_i is the cumulative percent of the sample ranked by economic status and L(s) is the corresponding concentration curve ordinate, and i is the number of income groups, with i=5.

The CI allows us to measure the extent of inequalities in health and inequities in healthcare utilisation that are directly linked to income. However, as it is very likely that both age and gender are related to income, the reporting of health and healthcare utilisation, it is also necessary to age-sex standardise our data. This allows for the fact, for instance, that elderly people are more likely to report both worse health and lower levels of income. To address this, we follow the direct age-sex standardisation approach outlined in O'Donnell and Propper (1991).

In the case of the "health" measures, the formula used is the following

$$(2)\ std\_health_i = \sum_j \sum_k \frac{b_{ijk}}{n_{ijk}} \cdot \frac{(n_i)(n_{jk})}{N}$$

where b_{ijk} = number of individuals reporting morbidity in the *i*th income group, *j*th age group and sex *k*;
n_{ijk} = number of individuals in the *i*th income group, *j*th age group and sex *k*;
n_i = number of individuals in the *i*th income group;
n_{jk} = number of individuals in the *j*th age group and sex *k*;
and N = total number of individuals in the sample.

b_{ijk}/n_{ijk} measures the actual proportion of individuals reporting morbidity in each income group, by age group and sex. This is then weighted by the proportion of individuals in the whole sample that belong to the same income group, age group and sex. Thus, the standardisation formula allows the calculation of the number of individuals in each income group who would report morbidity if that income group had the same age-sex distribution as the whole sample.

In the case of the healthcare utilisation measures, the age-sex standardisation procedure extends formula (2) to incorporate adjustment for utilisation according to morbidity status:

$$(3)\ std\_health\_use_{mi} = \sum_j \sum_k \frac{a_{mijk}}{n_{ijk}} \cdot \frac{n_{mjk}}{N_m}$$

where a_{mijk} = healthcare use by individuals in morbidity group m, income group i, age group j, and sex k;
n_{mijk} = number of individuals in morbidity group m, income group i, age group j, and sex k;
n_{mjk} = number of individuals in morbidity group m, age group j and sex k; and
N_m = total number of individuals in morbidity group m.

a_{mijk}/n_{ijk} measures the actual proportion of healthcare use by individuals who are ill, for each income group, age group and sex. This figure is then multiplied by the proportion of all individuals who report morbidity in each age group and for each sex. In this way we are able to calculate for each income group the average utilisation of healthcare resources that would be made by each income group, if that group had the same age-sex distribution as the whole morbidity group. We use as the reference for the age-sex standardisation not the whole sample but the morbidity group, because the aim is to analyse "equal treatment for equal need", and need is proxied here by a self-assessed measure of health.

We also compute a standard error for the concentration index with grouped data following a formula given in Kakwani *et al.* (1997). We follow the steps set out in 'Quantitative Techniques for Health Equity Analysis - Technical Note #7' (World Bank, 2004). We denote with n denote the sample size, T the number of groups, f_t the proportion of the sample size in the t-th group, μ_t the mean value of the health variable amongst the t-th group, and CI the concentration index. R_t is the fractional of the t-th group, and is defined as

$$(2)\ R_t = \sum_{\gamma=1}^{t-1} f_\gamma + \frac{1}{2} f_t$$

This indicates the cumulative proportion of the population up to the midpoint of each group interval.

The variance of the concentration index is given by eq (14) in Kakwani *et al.* (1997):

$$(3)\ \text{var}(CI) = \frac{1}{n}\left[\sum_{t=1}^{T} f_t a_t^2 - (1+CI)^2\right] + \frac{1}{n\mu^2}\sum_{t=1}^{T} f_t \sigma_t^2 (2R_t - 1 - CI)^2$$

Where σ_t^2 is the variance of the health variable in the t-th group and μ_t is its mean,

$$a_t = \frac{\mu_t}{\mu}(2R_t - 1 - CI) + 2 - q_{t-1} - q_t$$

$$q_t = \frac{1}{\mu}\sum_{\gamma=1}^{t} \mu_\gamma f_\gamma$$

Which is the ordinate of $L(p)$, $q_0 = 0$, and $p_t = \sum_{\gamma=1}^{t} f_\gamma R_\gamma$.

As variances of the group means are unknown, the second term in equation (3) can be assumed to be equal to zero and the n is replaced by T in the denominator. Substituting the value of the CI in equation (3), we compute its variance and finally its t-statistics.

3.5 Data and variables

We are interested in both cross-country comparisons for any given year, and cross year comparisons for any given country. As the devolution of the NHS was introduced in 1998, we analyse two years' worth of data: selecting two years temporally equidistant from the year that devolution took place (1995/96 and 2001/02).

The General Household Survey (GHS) is a large scale multipurpose survey of individuals and households and it has been conducted in Great Britain annually since 1971[67]. The GHS contains several microdata on a range of core topics, such as household and family information, consumer durables, employment, and education. It also includes microdata on individuals' healthcare utilisation, self-assessed health (morbidity) and family

income.

Table 3-3 shows original and cleaned sample sizes of the General Household Surveys for the years under consideration.

Table 3-3: General household Survey, sample size

Country	GHS			
	1995/96		2001/02	
	Original	*Cleaned*	*Original*	*Cleaned*
England	19,928	12,779	18,341	15,732
Wales	1,195	671	1,063	873
Scotland	2,075	1,338	1,770	1,522
Great Britain	**23,198**	**14,788**	**21,180**	**18,127**

We deleted from our samples in each year individuals who did not answer any of the questions about their own health, their healthcare utilisation and income. Also, we dropped from our samples individuals whose reported income is equal to zero.

3.5.1 Health variables

Health variables are used as proxies for need. Different ways of measuring health have been utilised by health researchers in their studies. Usually, they are either a measure of mortality or a measure of morbidity. In this paper, we concentrate on morbidity measures only, as is the case of many recent studies (Contoyannis and Jones, 2004; van Doorslaer and Koolman, 2002).

The General Household Survey contains an Adult Health section[68], in which individuals are invited to answer questions relating to their health. This section provides sufficient information to construct various measures of health.

We concentrate on three different measures of health, which we call health state *(hstate)*, health status (*hstatus*) and self-assessed health (*sah*). All three measures of health are self-assessed, in the sense that individuals surveyed answer personally to questions relating to their general health. The GHS does not include objective measures of health, such as body weight or body mass index. The assumption supporting the use of these

measures of health is that individuals are, in general, believed to be able to assess and evaluate their own health[69].

The health state variable captures an individual's health relative to a period of time close to the date of the interview. In the GHS, individuals were asked whether they had to reduce their usual activity because of injury or illness in the two week period preceding the interview. The health status variable captures the existence of a long-standing illness, disability or infirmity of an individual. Both these measures of health are recorded with yes/no answers and hence are straightforwardly employable in our analysis as binary variables.

A more comprehensive measure of health is obtained by asking individuals to rate their overall health over the last twelve months; we call this variable self-assessed health or *sah*. Individuals are asked to rate their general health as either 'good', 'fairly good' or 'not good'. This measure of self-assessed health is the most frequently used in econometric studies. In order to estimate inequalities in health, it is necessary to transform this variable in either a dichotomous or continuous one. Following O'Donnell and Propper ((1991), we created a dichotomous variable grouping together individuals that responded that their overall health was either 'good' or 'fairly good'. We concentrate on those individuals that report 'not good' health.

3.5.2 Healthcare utilisation variables

The General Household Survey allows one to construct three measures of healthcare utilisation: inpatient stays, outpatient visits, and General Practitioner (GP) consultations. The first two measures correspond to the use of NHS secondary care resources and the last one refers to the use of NHS primary care resources. As our interest is in assessing the utilisation of these resources by individuals who are in "need" of them, we consider only the number of inpatient stays, outpatient visits and GP consultations received by individuals who report some form of morbidity.

The measurement of inpatient stays, excluding maternity stays, is based on the questions: "During the last year, that is, since (DATE 1 YEAR AGO), have you been in hospital as an inpatient, overnight or longer?" and "(Apart from those maternity stays) how many

separate stays in hospital as an inpatient have you had since (DATE 1 YEAR AGO)?". The first question allows one to determine whether the individual has had any inpatient stay over the twelve month period in question. And if so, the second question allows one to determine the number of inpatient stays an individual had, except those that one may have had to have a baby.

Outpatient visits are measured based on the questions "During the months of (LAST 3 COMPLETE CALENDAR MONTHS) did you attend as a patient the casualty or outpatient department of a hospital (apart from straightforward ante- or post-natal visit)?" and "How many times do you attend in (EARLIEST/SECOND/THIRD MONTH IN REFERENCE PERIOD)?". The GHS includes a variable created from the questionnaire which scales answers up to cover a twelve month period prior to the interview and we use this estimated measure of outpatient visits in our analysis.

The measurement of GP consultations is based primarily on the question "During the 2 weeks ending yesterday, apart from any visit to a hospital, did you talk to a doctor for any reason at all, either in person or by telephone?". Further questions are then asked to allow identifying the total number of consultations an individual had with an NHS GP.

3.5.3 Income

Income is measured using the gross family income variable recorded in the General Household Survey. This variable measures income before taxes and deductions take place. In the GHS, the family unit is defined as either of the following: (i) a married couple on their own, or (ii) a married couple/lone parent and their never married children provided these children have no children of their own.

In order to take account of differences in both the size and composition of families, we transform gross family income into equivalent family income. The disposable income of a family of four individuals cannot, otherwise, be compared with that of a single individual. The equivalence scale used is the modified OECD scale:

$$(4)\ equivalent\ \ family\ \ income = \frac{income}{1 + 0.5(household\ \ size - 1 - child) + 0.3(child)}$$

This equivalence scale assigns a weight of 1 to the first adult member of the family, and a weight of 0.5 to all subsequent adult members of the family. Children receive a weight of 0.3 each. The reference family is composed of one adult with no children. A family composed of two adults and two children will need, accordingly to the formula depicted above, an income 2.1 times greater than that of a single person family to have an equivalent family income.

Compared to the original OECD equivalence scale, which assigned a weight of 0.7 to each subsequent adult member of the family and a weight of 0.5 to children, the modified scale takes into account the economies of scale that larger families benefit from. The modified OECD equivalence scale is the most widely used to equivalise income. Other scales do, however, exist and are employed in the literature. Wagstaff *et al.* (2001) and van Doorslaer and Jones (2003) use, for example, the square root of the household size; Gravelle and Sutton (2003) use the square root of the sum of the number of adults with a weight of one and the number of children, which are given a weight of 0.5. The superiority of one particular income equivalising procedure/method has not yet been established.

3.6 Descriptive statistics

In this section, we present some summary statistics on the variables of interest to our analysis by country.

Table 3-4 provides the percentages of adults that report acute sickness, long-standing illness or 'not good health', for both 1995-96 and 2001-02.

Table 3-4: Distribution of morbidity by country, in percentage terms

Country	Percentage of adults reporting					
	acute sickness		*long-standing illness*		*'not good health'*	
	1995/96	2001/02	1995/96	2001/02	1995/96	2001/02
England	15.06	14.74	35.21	36.32	12.93	13.51
Wales	19.08	20.3	39.49	42.58	17.73	16.06
Scotland	16.07	15.85	36.55	35.65	14.13	13.88

Scotland is the only country for which the percentage of adults reporting any of the

three morbidities has decreased over time, suggesting a move towards a healthier nation. The situation in England and Wales is slightly different. England registers an improvement only in the percentage of individuals reporting acute sickness, whereas in Wales only the percentages of individuals reporting 'not good health' has decreased from 1995/96 to 2001/02.

Table 3-5 presents the summary of the distribution of healthcare utilisation by country. The use of healthcare services, be it either in the form of a GP consultation, an inpatient stay or an outpatient visit, has decreased in both Scotland and Wales in 2001/02. In Scotland this might be related to the improvement in health, but this explanation cannot be applied in Wales. The English sampled population seems to have made less use of both GP consultations and inpatient stays in 2001/02 compared to 1995/96. The opposite is true for outpatient visits.

Table 3-5: Distribution of healthcare use by country, in percentage terms

Country	Percentage of adults reporting to have had					
	GP consultations		*Inpatient stays*		*Outpatient visits*	
	1995/96	2001/02	1995/96	2001/02	1995/96	2001/02
England	15.86	14.35	9.73	7.53	15.64	16.07
Wales	18.93	15.00	11.77	9.7	18.78	15.61
Scotland	18.16	16.91	12.33	8.87	14.78	14.37

If we compare across countries, no clear-cut pattern of utilisation appears. Wales generally is the country with the highest percentage of individuals reporting to make use of healthcare resources, in both 1995/96 and 2001/02, followed by Scotland and at last England. However, this pattern does not hold across all measures of utilisation.

The basic statistics presented here provide us with an overall picture of the sampled population in terms of their self-assessed health and in terms of the use of both primary and secondary NHS healthcare resources. They do not tell us whether both (ill-) health and healthcare resources are distributed in each population equitably, with respect to income. This analysis is carried out in the following two sections.

3.7 Inequalities in (ill-) health

We explore in this section the distribution of self-reported health in England, Wales and Scotland. The analysis is carried out for all three measures of health presented in Section 3.5. This analysis will allow us to set the background on each country's level of ill-health and its distribution with respect to income and over time.

The first two tables summarise the number of individuals in each income group reporting morbidity as a percentage of all individuals reporting morbidity, respectively in 1995/96 and 2001/02 for the whole of Great Britain. The picture that emerges does not show any clear pattern in the distribution of any of the health measures in the population, once this is ranked by income. As we are interested in the income-related distribution of (ill-) health within each single country and across countries, we will not analyse the situation for Great Britain in greater detail. However, two points are worth making. Firstly, it appears that the percentage of individuals reporting 'not good' health is three times higher in the bottom income quintile compared to the top one, in 1995/96; and this result becomes even bigger in 2001/02 (see Tables 3-6 and 3-7, respectively), where the percentage of individuals reporting 'not good' health has not only increased in the lowest income group, but compared to the highest income group it is almost four times higher in the later period. Secondly, the number of individuals in the lowest income quintile reporting any of the three measures of morbidity has increased in 2001/02 compared to 1995/96. However, and interestingly, the opposite situation occurs for individuals belonging to the upper income quintile.

Table 3-6: Actual and age-sex standardised percentages of all adults reporting morbidity and relative Concentration Index, Great Britain – GHS 1995/96

Income group		Acute sickness (*hstate*)		Long-standing illness (*hstatus*)		'Not good' health (sah)	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	21.9	22.3	22.6	22.3	29.5	30.1
	2	26.2	24.3	27.1	24.2	32.8	29.3
	3	17.5	17.6	18.7	18.9	17.0	16.8
	4	16.8	17.3	16.0	17.3	11.4	12.5
Richest	**5**	17.5	18.5	15.6	17.3	9.3	11.2
CI		***-0.094***	***-0.080***	***-0.121***	***-0.089***	***-0.268***	***-0.239***

Table 3-7: Actual and age-sex standardised percentages of all adults reporting morbidity and relative Concentration Index, Great Britain – GHS 2001/02

Income group		Acute sickness (*hstate*)		Long-standing illness (*hstatus*)		'Not good' health (sah)	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	25.2	26.7	23.6	24.2	30.5	32.6
	2	25.5	22.6	26.4	22.7	31.7	27.2
	3	16.7	17.0	19.2	19.7	17.0	17.6
	4	17.0	18.0	16.4	18.0	12.7	14.1
Richest	**5**	15.7	15.7	14.4	15.4	8.1	8.5
CI		***-0.112***	***-0.109***	***-0.116***	***-0.092***	***-0.257***	***-0.247***

Actual numbers of individual reporting any of the three measures of ill-health by income group for the two years studied can be found in Appendix 3-A.

In the remainder of this section, we will analyse the results in income-related inequality in each of the three morbidity measures separately. Our primary objective is to elicit whether any changes in the distribution of morbidity have occurred after decentralisation was implemented in Great Britain for England, Wales and Scotland. There is an expectation formed on the basis of the existing economic literature (see Section 3.2.1), that policy makers may use information available at local level to tailor their public policies, both in terms of public health and provision of healthcare services, to address local variations in need. And that this may ultimately lead to improvements in the distribution of morbidity.

The distribution of morbidity across income groups is assessed by means of a concentration index and concentration curves. However, it is possible to elicit interesting results by looking at the percentage of individuals in each income group reporting an illness, however defined, and comparing it with their share of income in the population. We followed both approaches for completeness of analysis. We present here only the results relating to the concentration indices. The percentages of individuals reporting morbidity by income groups for England, Wales and Scotland can be found in Appendix 3-A.

3.7.1 Income-related inequalities in the reporting of acute sickness

The variable 'acute sickness', as described earlier, measures the level of health of an individual at a certain point in time. Hence, this measure reflects to a lesser extent the working of the National Health Services locally.

Table 3-8 shows the concentration indices (CI) for the distribution of acute sickness by country and year. The results suggest the existence of income-related inequality in the distribution of acute sickness favouring the better off. The inequality is, however, very small. The age-sex standardisation has the effect, as expected, to reduce the degree of the inequality in each constituent country of Great Britain.

Table 3-8: CIs for income-related inequality in the reporting of acute sickness - England, Wales and Scotland, 1995/96 and 2001/02

	1995/96		2001/02	
	Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
England	-0.089	-0.073	-0.108	-0.105
Wales	-0.149	-0.135	-0.110	-0.059
Scotland	-0.109	-0.099	-0.147	-0.166

In 1995/96, Wales is the country for which the income-related inequality in acute sickness is most prominent, with an age-sex standardised CI almost twice that for England, whilst Scotland lies somewhere in between the other two countries. In 2001/02, the CI for Wales is more than halved. It is worth noting, however, that the reduction in the degree of inequality in Wales is partly attributable to an increase in the reporting of acute sickness by individuals belonging to the top two income quintiles, rather than by an overall improvement in the distribution of sickness in the population (see Tables 3-A.2 and 3-A.3 in Appendix 3-A).

Figure 3-2 provides a graphical representation of how the CIs for the three countries have changed over time, by means of concentration curves. It appears clearly that the distribution of acute sickness in the three countries has been affected differently. England and Scotland both experience an increase in the income-related inequality in acute sickness as measured by their respective CIs, and as indicated by their concentration curves for 2001/02 lying everywhere above those for 1995/96; hence, making the distribution of

acute sickness in these two countries less equitable in 2001/02 compared to 1995/96.

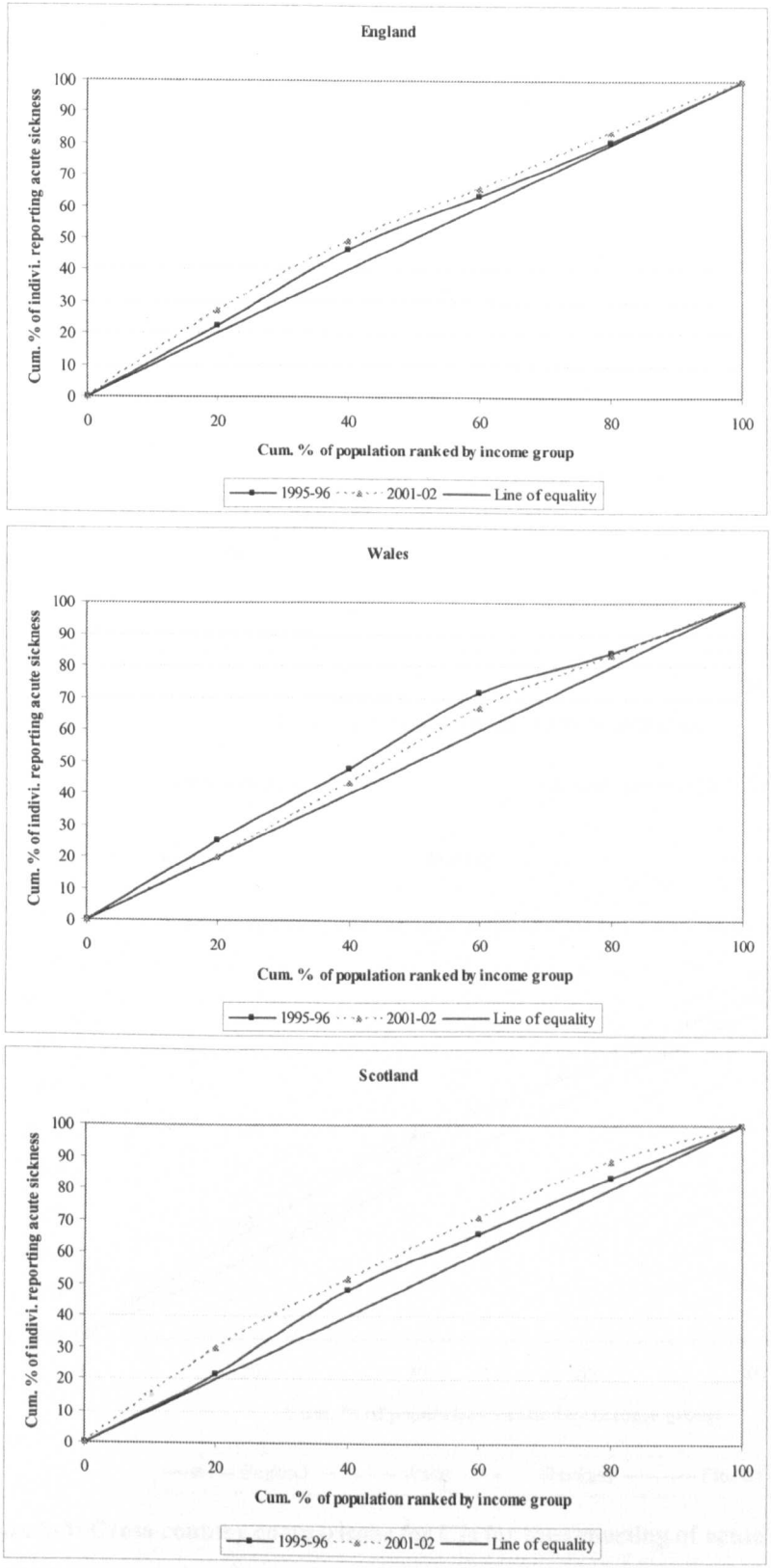


Figure 3-2: Concentration curves for the reporting of acute sickness in England, Wales and Scotland, 1995/96 and 2001/02

Figure 3-3 shows the concentration curves for the three countries, for 1995-96 and 2001-02. It is impossible to conclude which distribution of acute sickness is more equitable, as the concentration curves cross, in some cases more than once. However, it is possible to draw partial conclusions.

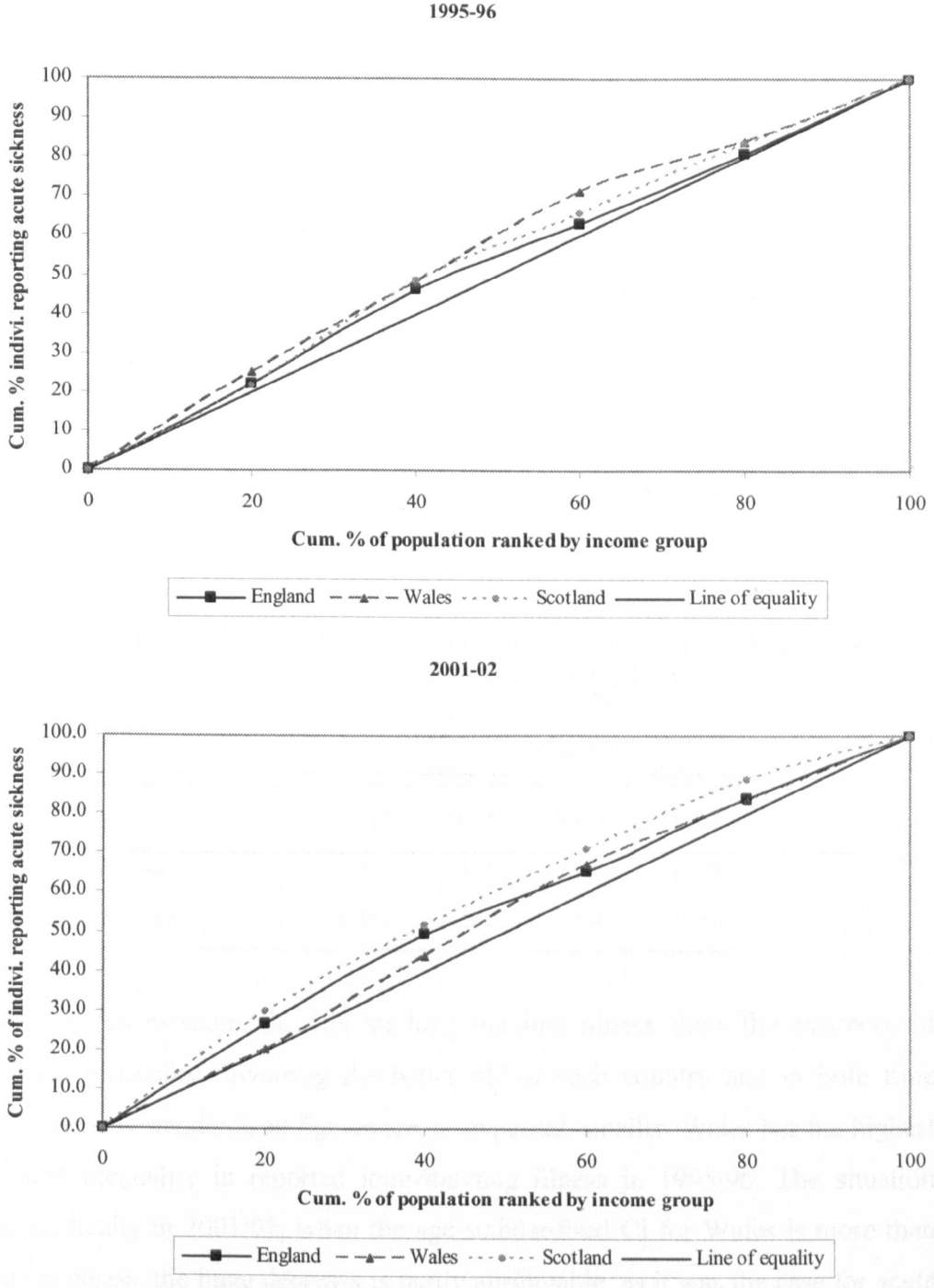


Figure 3-3: Cross-country comparisons for CIs for the reporting of acute sickness

In 1995/96, the concentration curves show that adults belonging to the lowest income group are better off in Scotland than they are in England and Wales. Adults belonging to

the highest income group are better off in England than they are in any of the other two countries. In 2001/02 the concentration curve for Scotland appears to lie everywhere above the ones for England and Wales. This suggests that the income-related distribution of acute sickness in more inequitable in Scotland than anywhere else.

3.7.2 Income-related inequalities in the reporting of long-standing illness

Long-standing illness captures a different aspect of a population's health. It represents, in effect, a measure of the existence and persistence of a continuous illness/disease in a given population, whereas acute sickness captures a snapshot of an individual's health. As the existence of a long-standing illness is very likely to be associated with a restricted ability to carry out a job, we expect a high degree of income-related inequality with respect to this measure of ill-health.

The concentration indices for long-standing illness for England, Wales and Scotland are shown in Table 3-9.

Table 3-9: CIs for income-related inequality in the reporting of long-standing illness - England, Wales and Scotland, 1995/96 and 2001/02

	1995/96		2001/02	
	Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
England	-0.118	-0.084	-0.112	-0.087
Wales	-0.157	-0.123	-0.109	-0.056
Scotland	-0.132	-0.108	-0.160	-0.165

As for the previous measure, the CIs for long-standing illness show the existence of income-related inequality favouring the better off in each country and in both time periods. The age-sex standardized figures are, as expected, smaller. Wales has the highest income-related inequality in reported long-standing illness in 1995/96. The situation changes dramatically in 2001/02, when the age-standardised CI for Wales is more than halved. Nevertheless, the huge decrease is partly attributable, as it was the case for acute sickness, to a substantial increase in the numbers of individuals with long-standing illnesses belonging to the highest and third-highest income quintiles (see Tables 3-A.4 and 3-A.5 in Appendix 3-A). An opposite pattern emerges for both England and

Scotland, both experiencing a small increase in income-related inequality. The situation for England changes so slightly, as to be almost unnoticeable (see Figure 3-4).

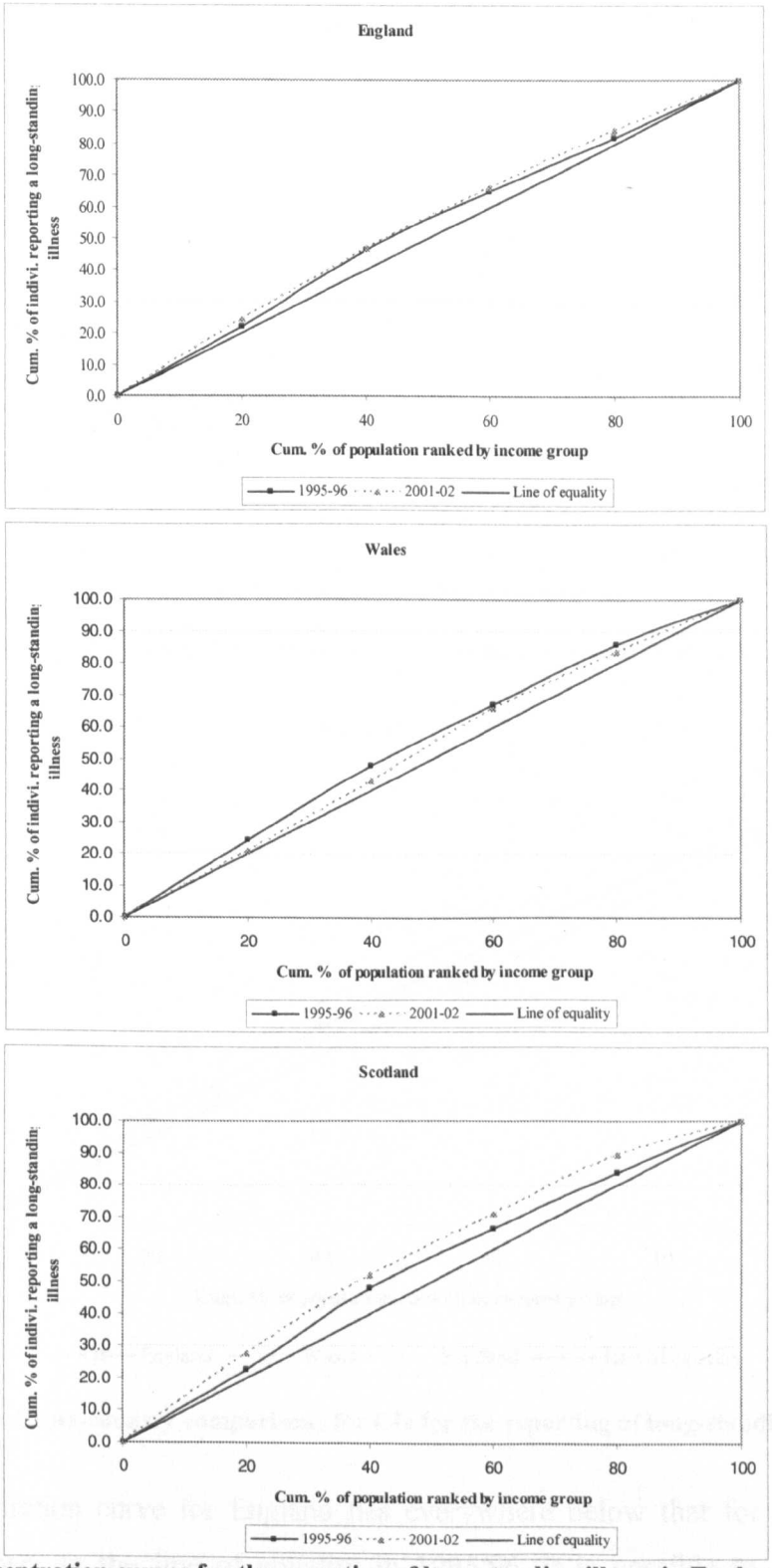


Figure 3-4: Concentration curves for the reporting of long-standing illness in England, Wales and Scotland, 1995/96 and 2001/02

Figure 3-5 shows the concentration curves for long-standing illness for all countries, separately for 1995/96 and 2001/02.

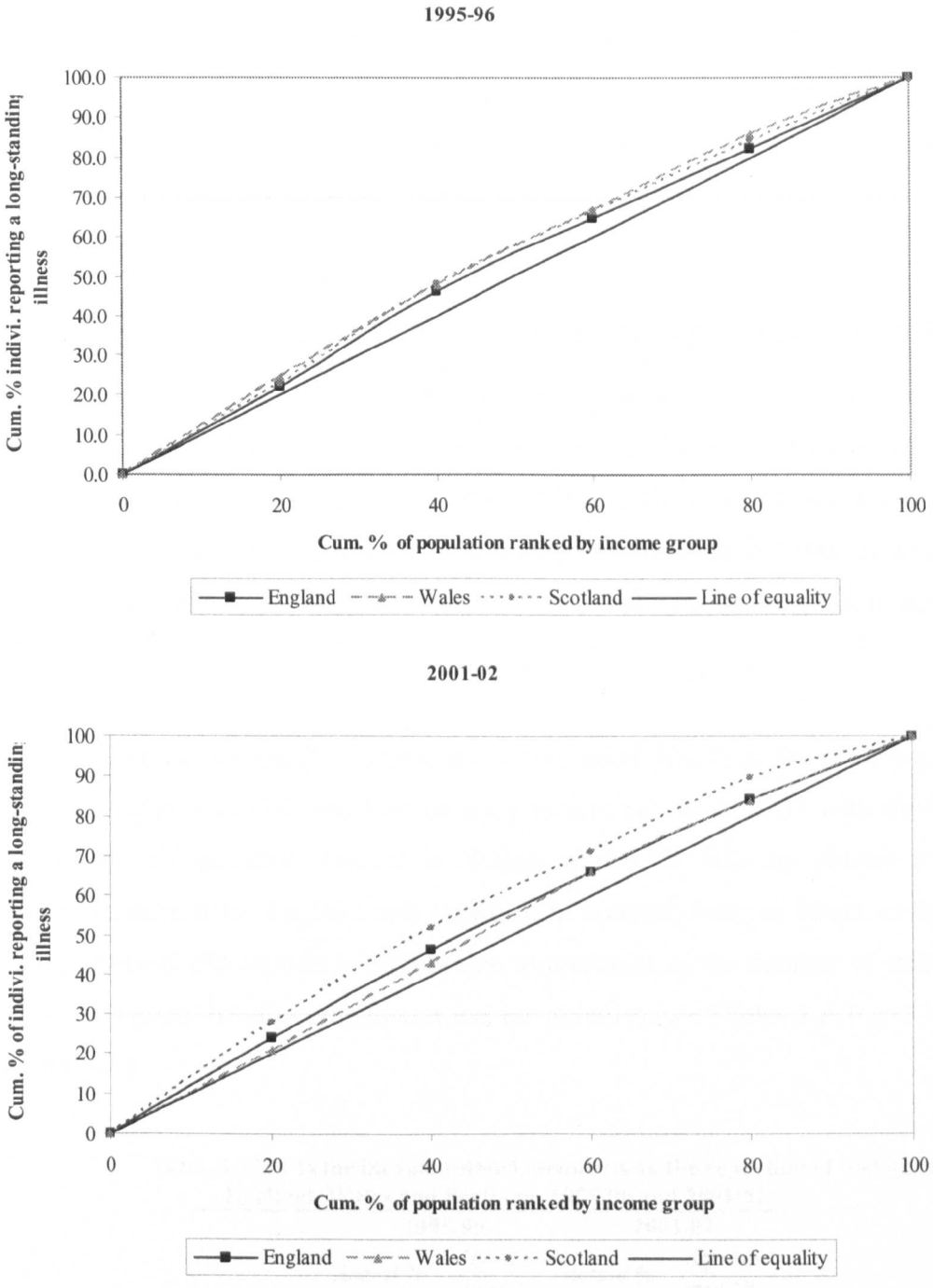


Figure 3-5: Cross-country comparisons for CIs for the reporting of long-standing illness

As the concentration curve for England lies everywhere below that for Scotland and Wales and closer to the line of equality in 1995/96, it is possible to state that the income-related distribution of long-standing illness was more equitable in England compared to Scotland and Wales in this particular year. The situation is not so clear cut

when comparing the remaining two countries. In 2001/02, the cross-country comparison becomes much clearer. Scotland's concentration curve is the furthest away from the line of equality and lies everywhere above the concentration curves for England and Wales, making it the country with the least equitable income-related distribution in reported long-standing illness. We can draw only partial conclusions when comparing England and Wales. In particular, we can only state that the individuals belonging to the bottom two income groups are better off in Wales than they are in England.

3.7.3 Income-related inequalities in the reporting of 'not good health

Table 3-10 shows the concentration indices for income-related inequality in the reporting of 'not good' health. These are considerably higher than that for the other two health measures. One reason behind this result may be that individuals when asked to assess their own health take into account not only their physical health but their overall well-being, which for example can stretch out as far as including more general aspects of quality of life.

Wales is the country where the distribution of 'not good' health in the adult population is the most unequal in 1995/96. The situation is reversed in 2001/02 with the highest improvement in inequality attained in Wales, whose CI falls by almost 0.1. The concentration indices for England and Scotland, in contrast, become larger in 2001/02. The more unequal distribution is mainly due to increases in the number of individuals reporting 'not good' health in the lowest income quintiles (see Tables 3-A.6 and 3-A.7 in Appendix 3-A).

Table 3-10: CIs for income-related inequality in the reporting of 'not good' health - England, Wales and Scotland, 1995/96 and 2001/02

	1995/96		2001/02	
	Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
England	-0.265	-0.233	-0.256	-0.247
Wales	-0.289	-0.286	-0.244	-0.198
Scotland	-0.266	-0.247	-0.270	-0.271

These changes in the concentration indices are shown in Figure 3-6 for each country and

for the two years under investigation by means of concentration curves.

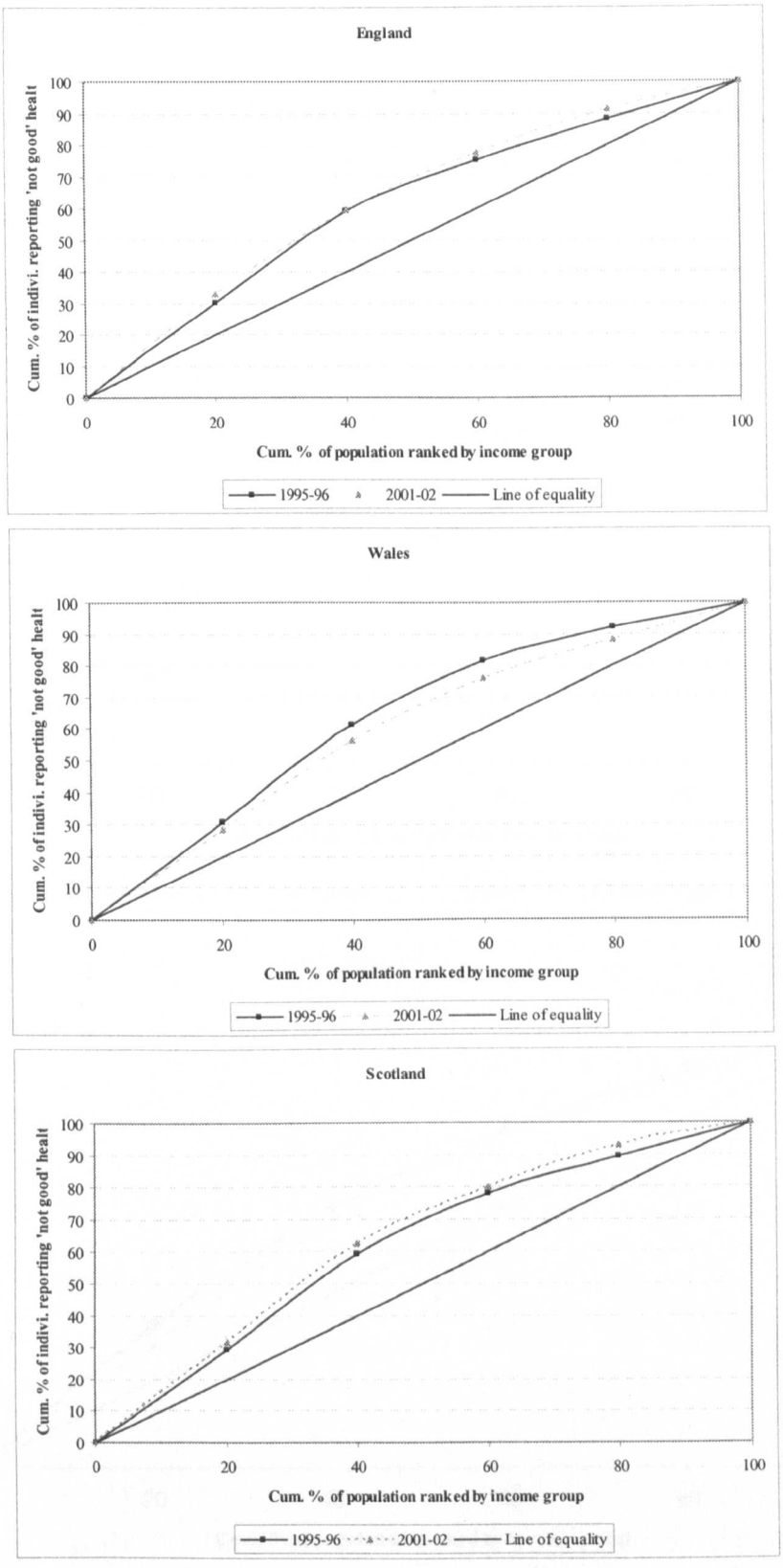


Figure 3-6: Concentration curves for the reporting of 'not good' health in England, Wales and Scotland, 1995/96 and 2001/02

Figure 3-7 shows cross-country comparisons of the concentration curves for the reporting of 'not good' health. In 1995/96, the concentration curve for Wales is the farthest away from the line of equality, thus suggesting that the distribution of individuals reporting 'not good' health is the least equitable in this country as far as the upper income groups are concerned. The concentration curves on the bottom end of the income distribution is not so clear cut.

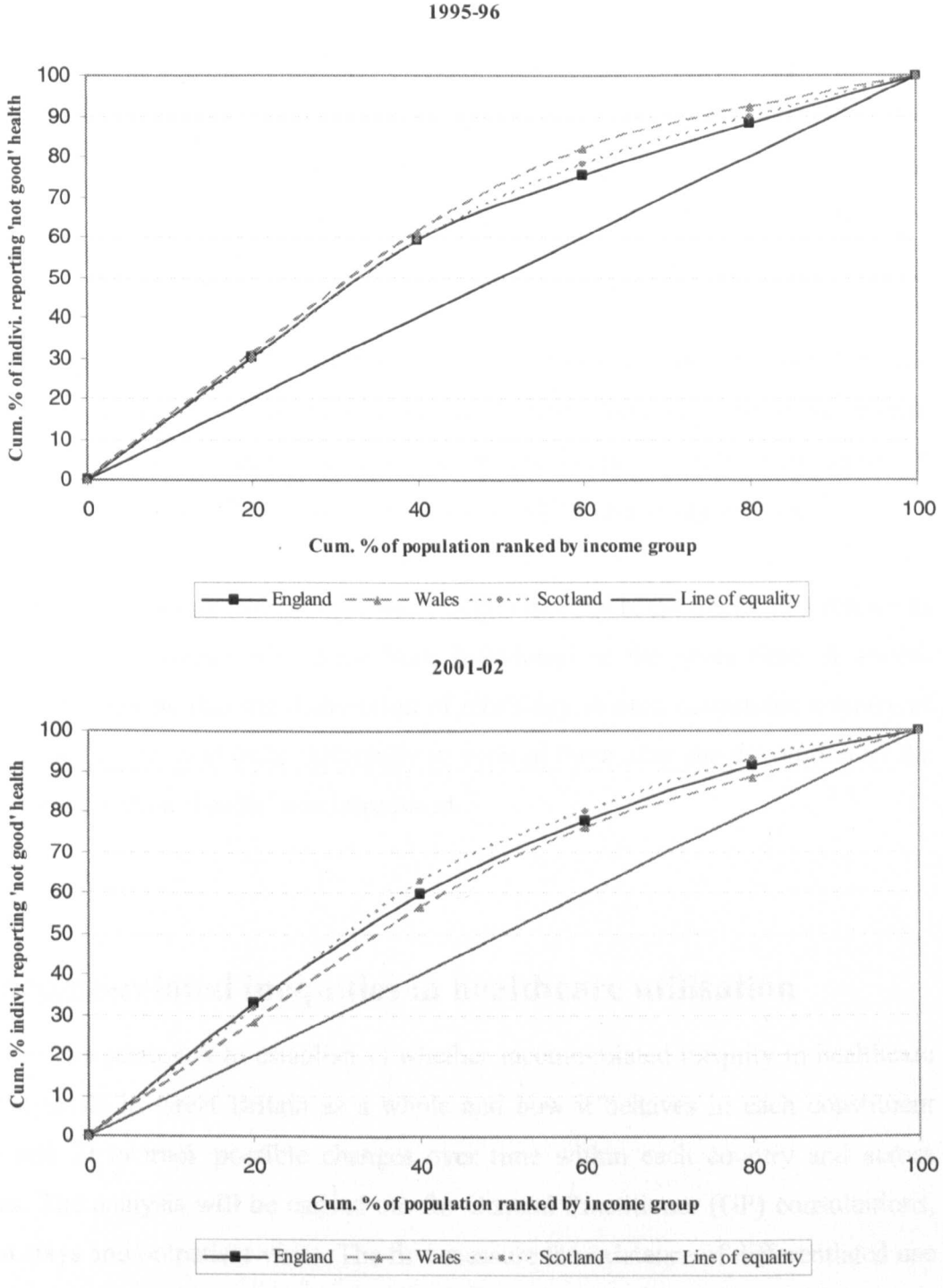


Figure 3-7: Cross-country comparisons for CIs for the reporting of 'not good' health

In 2001/02, Wales has the most equitable distribution of the three countries, although the income-related inequality in this measure of morbidity is still favouring the better off. That said, there appears to be considerable income-related inequity with this measure.

3.7.4 Conclusions

Our results highlight the existence of a certain degree of income-related inequality in all three measures of morbidity favouring the better off. This holds for every country. However, the magnitude of this inequality varies across countries, with England, in the pre-devolution year, scoring a smaller income-related inequality measure compared to any of the two other countries.

Further, Wales is the country with the highest income-related inequality in the distribution of ill-health, however measured, in 1995/96. After the devolution reform, the situation changes completely, with income-related inequality in the distribution of morbidity worsening in both England and Scotland, whilst improving in Wales.

Although it is not possible to attribute these changes directly to the devolution reform as other concomitant reforms may have been introduced at the same time, it seems, however, worth noting that the distribution of morbidity in each constituent country of Great Britain has changed quite differently in each of them after the devolution of the governmental function 'health' was introduced.

3.8 Income-related inequities in healthcare utilisation

Our aim in this section is to establish 1) whether income-related inequity in healthcare utilisation exists in Great Britain as a whole and how it behaves in each constituent country and 2) to track possible changes over time within each country and across countries. The analysis will be carried out for General Practitioner (GP) consultations, inpatient stays and outpatient visits. The first measure the existence of differentiated use of the NHS primary care resources, and the last two capture the use of NHS secondary care resources. As stated elsewhere we are interested in analysing the 'equal treatment

of equal need', where need is proxied by a morbidity measure.

As appears from the results shown in the previous section, the distributions of morbidity across income groups for each of the three measures used in this chapter are very similar. Hence, we will focus in this section on one measure of morbidity only, that is the one built on individuals reporting 'not good' health, and investigate whether income-related inequity in healthcare utilisation by individuals who reported not good health exists. The sensitivity analysis on income-related inequity in healthcare utilisation using the two remaining measures of morbidity can be found in Appendix 3-B.

Income-related inequity in healthcare utilisation is assessed by means of a concentration index. We report also the percentages of NHS healthcare utilisation by income groups.

3.8.1 General Practitioner (GP) consultations

First, we explore the distribution of GP consultation utilisation across income quintiles in the whole of Great Britain. Table 3-11 shows the percentage of GP visits (actual and age-sex standardised) reported by individuals whose health is not good, grouped by income quintiles.

Table 3-11: Percentages of GP consultations by individuals reporting 'not good health' by income groups and relative concentration indices, Great Britain - 1995/96 and 2001/02

Income group		1995/96		2001/02	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	29.94	30.22	30.90	29.70
	2	30.61	31.56	32.14	33.92
	3	17.46	17.53	16.69	15.86
	4	12.82	11.70	10.75	11.11
Richest	**5**	9.17	9.00	9.52	9.40
Concentration Index		***-0.237***	***-0.249***	***-0.259***	***-0.256***

The results show that income-related inequity in healthcare utilisation exists, and that this is favouring the poorest income groups (as indicated by the negative concentration

indices). Looking at the percentages of GP visits across income quintiles, we can conclude that the highest proportion (>60 per cent) of reported GP visits is concentrated in the bottom two income groups, in both years. Overall, income-related inequity in GP visits appears to be slightly increasing in 2001/02.

Tables 3-12 and 3-13 show the percentages of primary care consultations by income groups in England, Wales and Scotland, respectively for 1995/96 and 2001/02. Concentration indices of income-related inequity in GP consultation are also reported.

Also at the country level, concentration indices are negative and favouring the lowest income groups. The age-sex standardisation of GP consultations has the effect of increasing the concentration indices for every country. In 1995/96, for example in Scotland 37.96 per cent of individuals who reported to having had a GP consultation belonged to the lowest income group.

Table 3-12: Percentages of GP consultations by individuals reporting 'not good' health by and income group - GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	28.86	29.04	33.33	36.64	37.04	37.96
	2	32.58	33.50	28.33	26.06	25.93	25.94
	3	15.96	15.70	18.33	20.37	18.52	18.56
	4	13.03	12.24	6.67	6.31	12.04	11.51
Richest	**5**	9.57	9.51	13.33	10.62	6.48	6.04
Concentration Index		***-0.232***	***-0.241***	***-0.247***	***-0.287***	***-0.300***	***-0.313***

The majority of primary care consultations (>60 per cent) is concentrated amongst the two lowest income groups. This is in line with evidence suggesting that lower income groups make proportionally greater use of primary care, even though they are less likely to engage in health promotion/preventive activities and enjoy lower access to secondary care (Dixon *et al.*, 2008).

Concentration indices are all negative suggesting pro-poor inequity in GP consultations. The consistency of the results obtained across countries and years of data suggests the results are robust. However, t-statistics for all countries are very small and indicate that

some caution should be exercised when interpreting the inequality measures. See Appendix 3-B, Table 3-B.1.

Similar conclusions can be drawn for 2001/02 (see Table 3-13).

Table 3-13: Percentages of GP consultations by individuals reporting 'not good' health by and income group - GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	31.62	30.57	31.91	28.90	25.49	24.27
	2	31.16	32.58	36.17	38.98	35.29	38.52
	3	16.49	15.65	14.89	14.20	21.57	20.88
	4	10.59	11.14	10.64	10.56	9.80	9.74
Richest	**5**	10.14	10.07	6.38	7.36	7.84	6.59
Concentration Index		***-0.256***	***-0.252***	***-0.308***	***-0.288***	***-0.245***	***-0.259***

Comparing results across the two years by looking at the concentration indices for each country and in each year, it emerges that inequity in GP consultations slightly increases in 2001/02 for both England and Wales, whilst a slight reduction is registered for Scotland. No clear patterns emerge in the way changes in utilisation of primary care occur amongst income groups; in England, for example, the percentage of GP consultations reported by individuals belonging to the bottom two income groups increases in 2001/02, and this despite the fact that overall healthcare utilisation is more favourable to the worst off.

Further, no conclusions can be drawn on cross-country comparisons as the concentration curves for the three countries cross at least once (see Figure 3-B.1, Appendix 3-B).

After the decentralisation process, the utilisation of GP consultations is even more inequitably distributed amongst income groups, with the poorer ones usually reporting more consultations than the richer counterparts.

3.8.2 Inpatient stays

Table 3-14 shows the concentration indices and the percentages of inpatients stays across income groups, both actual and age-sex standardised, for Great Britain as a whole, and for the two years under investigation.

Table 3-14: Percentages of Inpatient stays by individuals reporting 'not good' health by income groups and relative concentration indices, Great Britain - 1995/96 and 2001/02

Income group		1995/96		2001/02	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	23.76	23.77	24.28	23.09
	2	33.44	34.13	36.35	36.46
	3	20.68	20.82	16.86	16.58
	4	11.44	9.67	13.08	14.41
Richest	**5**	10.67	11.60	9.43	9.47
Concentration Index		***-0.193***	***-0.195***	***-0.212***	***-0.197***

Inpatient stays are still inequitably distributed across income groups, with poorer income groups reporting a greater use of inpatient stays. The overall degree of income-related inequity, as measured by the concentration index, is less prominent for this healthcare service than it was for GP visits. A very marginal increase in income-related inequity is registered in 2001/02. Also for the concentration indices for inpatient stays, the t-statistics produced are very small, both for the ones for Great Britain as a whole and the one for single countries (see Table 3-B.2). Thus, suggesting that caution should be used in interpreting the results.

A quite different story appears when looking at the distribution of reported inpatient stays by country (see Tables 3-15 and 3-16). The concentration indices for England, in both years, are most similar to the one reported for the whole of Great Britain, whilst the results for Wales and Scotland are somewhat diverse. The income-related distribution for inpatient stays appears to be quite equitable in Scotland, after standardising reported inpatient stays by age and sex. The percentages of total inpatients stays reported by income groups 1, 2 and 4 are, in fact, very similar. However, the percentage of reported inpatient stays of the richest income group is very small. The situation in 2001/02 does not appear to be changing very much when looking at the

concentration index. It is, however, noticeable from the distribution of inpatients stays by income groups that these are now more concentrated in the income groups 2 and 3. The percentage of inpatient stays reported by the bottom income group is now smaller than their income share. This becomes even more apparent when looking at the concentration curve (see Figure 3-B.2, in Appendix 3-B).

The picture that emerges for Wales is very peculiar: 59.38 per cent of total reported inpatient stays is concentrated in the penultimate income group.[70] This figures increases to 62.35 per cent after taking into account the age and sex structure of the population. Further, it is worth noting that the poorest income group reports a percentage of inpatient stays smaller than their actual income share, an indication of the existence of income-related inequity at the poorest end of the income distribution. In 2001/02, however, the situation changes completely with income-related inequity in inpatient stays decreasing (see Table 3-16).

Table 3-15: Percentages of Inpatient stays by individuals reporting 'not good' health by and income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	23.85	23.17	17.71	19.07	27.03	27.24
	2	33.75	35.20	59.38	62.35	30.63	27.34
	3	21.20	20.78	10.42	9.67	13.51	13.47
	4	10.04	8.46	4.17	2.78	21.62	25.86
Richest	**5**	11.16	12.40	8.33	6.13	7.21	6.09
Concentration Index		***-0.196***	***-0.193***	***-0.296***	***-0.342***	***-0.194***	***-0.175***

Table 3-16: Percentages of Inpatient stays by individuals reporting 'not good' health by and income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	25.33	24.32	21.95	20.60	16.47	15.43
	2	34.32	34.95	39.02	39.93	42.35	38.65
	3	16.35	15.82	24.39	24.98	24.71	26.07
	4	13.40	14.38	7.32	9.61	11.76	14.54
Richest	**5**	10.60	10.54	7.32	4.88	4.71	5.31
Concentration Index		***-0.201***	***-0.192***	***-0.244***	***-0.247***	***-0.216***	***-0.177***

It is not possible to draw any general conclusion on which country has the highest level of inequity as the concentration curves underlying the concentration indices for the three countries cross at least once (see Appendix 3-B).

3.8.3 Outpatient visits

The last measure of healthcare utilisation investigated is outpatient visits. Table 3-17 shows the concentration indices and percentages of reported outpatient visits by income groups for the whole of Great Britain.

Table 3-17: Percentages of Outpatient visits by individuals reporting 'not good' health by ncome groups and relative concentration indices, Great Britain - 1995/96 and 2001/02

Income group		1995/96		2001/02	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	25.99	25.38	28.07	27.65
	2	31.07	34.29	33.09	32.25
	3	19.22	19.44	14.92	15.00
	4	13.83	10.62	15.51	14.25
Richest	**5**	9.89	10.26	8.41	10.85
Concentration Index		***-0.198***	***-0.215***	***-0.228***	***-0.206***

As indicated by the negative CIs, income-related inequity exists and this is favouring the lowest income groups.

Tables 3-18 and 3-19 show the same results but disaggregated by country, respectively for 1995/96 and 2001/02. The concentration indices are still negative in all three countries. In 1995/96, the majority (>60 per cent) of total outpatient visits in England and Wales are reported by individuals belonging to the bottom two income quintiles (in Wales, 47 per cent of outpatient visits are made by the second income quintile alone). Scotland is the only exception; the bottom two income groups partake to about 40 per cent of total outpatient visit (non standardised percentage), these being concentrated in the third and penultimate income group (about 50 per cent).

Table 3-18: Percentages of Outpatient visits by individuals reporting 'not good' health by and income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	26.93	25.14	18.24	19.91	25.50	29.82
	2	33.54	38.25	49.32	47.02	12.75	14.42
	3	16.35	16.02	16.89	18.96	28.29	28.95
	4	12.28	9.48	9.46	9.07	26.29	19.73
Richest	**5**	10.90	11.11	6.08	5.04	7.17	7.09
Concentration Index		***-0.213***	***-0.227***	***-0.257***	***-0.271***	***-0.092***	***-0.160***

The results for 2001/02 changes considerably. All countries show still negative concentration indices, with England recording a very slight improvement. Wales and Scotland both experience an increase in income-related inequity in outpatient visits (see Table 3-19).

Table 3-19: Percentages of Outpatient visits by individuals reporting 'not good' health by and income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	25.90	25.71	38.57	37.48	27.13	29.02
	2	36.39	34.98	34.29	31.63	31.78	29.70
	3	15.02	15.01	17.14	18.08	19.38	21.63
	4	14.43	13.10	6.43	10.32	9.30	9.81
Richest	**5**	8.27	11.19	3.57	2.48	12.40	9.84
Concentration Index		***-0.229***	***-0.204***	***-0.391***	***-0.365***	***-0.208***	***-0.233***

Similarly to the results obtained for the concentration indices for GP consultations and inpatient stays, results across countries and years of data are consistent suggesting that they are robust. However, as before t-statistics for the concentration indices for outpatient visits are all very small, and therefore need to be interpreted with caution (as reported in Table 3-B.3 in Appendix 3-B).

Further, it is not possible to compare more meaningfully the results obtained for outpatient visits across countries as the concentration curves for outpatient visits of each country cross at least once (see Appendix 3-B).

3.8.4 Conclusions

The utilisation of healthcare services – GP consultations, inpatient stays and outpatient visits – is inequitably distributed in all three countries and favouring the lowest income groups. Further, the degree of these inequities varies with type of NHS care, with GP consultations having the largest negative concentration index in each country. My results are in line with evidence suggesting that lower income groups make proportionally greater use of primary care, even though they are less likely to engage in health promotion/preventive activities and enjoy lower access to secondary care (Dixon *et al.*, 2006).

England, Wales and Scotland follow very different pattern of healthcare utilisation, both in 1995/96 and 2001/02. This is an indication that NHS services were already allocated to individuals in each country following different priority criteria. One of the advantages that may accrue The economic theory on decentralisation suggests that income-related inequity in healthcare utilisation should be positively affected by a policy of decentralisation of the healthcare sector; however, our findings do not allow to draw any definite conclusions supporting the above expectation. On the other hand, it may be also plausible for differences observed to be much more accentuated had the devolution process not taken place. It is simply not possible at this early stage of the analysis to draw definitive conclusions.

3.9 Conclusions

The aim of this part was to explore the issue relating income-related inequality in health and inequity in healthcare utilisation in England, Wales and Scotland and how these have changed after the introduction of the devolved health system in Great Britain.

The advantages of decentralised health system lie in the fact that resources can be allocated more efficiently to meet local preferences and used with greater cost consciousness at the local level (Oates, 1972; 1999). Further, it is believed that improvements in equity can be attained as local governments may be able to respond to specific local needs in more appropriate ways than a central government or agency can

(Pauly, 1973). The main disadvantage derives from the fact that individuals who are "equal" in every respect but the jurisdiction in which they happen to live may end up being treated differently and that this may give rise to "unacceptable" variations across the country as a whole.

We used a well-known and widely used measure of inequality in health and inequity in healthcare utilisation: the concentration index. The concentration index is analogous to the Gini coefficient, which is commonly used as a measure of income inequality. Further, we analysed the distribution of NHS care within morbidity groups by looking at the percentages of total utilisation made by each income group.

We find that income-related inequality in (ill-) health in all three countries exists and that it is favouring the highest income groups. A summary of the direction of change is shown in Table 19.

Table 3-20: Summary of income-related inequality in health

Health measure \ Country	England	Wales	Scotland
Acute sickness (*hstate*)	Pro-rich, increase in inequality	Pro-rich, reduction in inequality	Pro-rich, increase in inequality
Long-standing illness (*hstatus*)	Pro-rich, no change in inequality	Pro-rich, reduction in inequality	Pro-rich, increase in inequality
Not good health (*sah*)	Pro-rich, increase in inequality	Pro-rich, reduction in inequality	Pro-rich, increase in inequality

Further, we find that income-related inequity in healthcare utilisation exists and that it is favouring the lowest income groups. Table 20 shows a summary of our findings.

Table 3-21: Summary of income-related inequity in healthcare utilisation

Healthcare service \ Country	England	Wales	Scotland
GP consultations	Pro-poor, increase in inequity	Pro-poor, increase in inequity	Pro-poor, reduction in inequity
Inpatient stays	Pro-poor, no change in inequity	Pro-poor, reduction in inequity	Pro-poor, no change in inequity
Outpatients visits	Pro-poor, reduction in inequity	Pro-poor, increase in inequity	Pro-poor, increase in inequity

We realise that the results for Wales should be taken *cum grano salis* as they might be contaminated by measurement error given the small sample size.

It is not possible to attribute any changes directly to the implementation of devolution, as other policy reforms may have been introduced in any country at the same time. However, it is a first attempt to investigate whether pre-existing inequalities in health and inequities in healthcare utilisation have evolved differently in the three countries.

[56] In this paper we use the term "jurisdiction" as a synonym for either of the following: local government, sub-national level of government, region, state, country. That is for the sub-national level of government to which the governmental function "health" has been decentralised. In the case of the United Kingdom, "jurisdiction" hence refer to either England, Wales, Scotland and Northern Ireland.

[57] The decentralisation reform in the United Kingdom is usually referred to as devolution. We will adopt throughout this chapter the above convenience, whenever and wherever we refer to the British reform. This despite the fact that the term has been erroneously adopted in this country as will appear clearly from the section on Decentralisation.

[58] With the exclusion of Northern Ireland, which has been administered centrally by Westminster because of the political instabilities that have since interested this area.

[59] An excellent review of the literature can be found in 'An Essay on Fiscal Federalism", by Oates (1999).

[60] The hypothesis of income redistribution as a local or spatial public good was tested by Brown and Oates for the American Provinces.

[61] Also referred to as "Westminster Parliament" or simply "Westminster".

[62] Further details on the specific arrangements made for Scotland and Wales can be found in the Devolution Guidance Note 11, *Ministerial Accountability after Devolution*, available at http://dca.gov.uk/constitution/devolution/guidance.htm.

[63] Further details are available in the Devolution Guidance Note 5.

[64] The Northern Irish consultation paper did not terminate in an equivalent white paper or legislation. The process was stopped because of the turmoil of the Northern Irish political scene.

[65] In case one is studying the distribution of a specific health care utilisation measure in a given population, then a value of the CI equal to 1 corresponds to a situation where the use of that particular healthcare service is concentrated in the hands of the most advantaged individuals (or groups). The opposite is true when CI is equal to -1.

[66] This formula is taken from the World Bank (2004) "Quantitative Technique for Health Equity Analysis – Technical Paper # 7"

[67] With the exception of 1997/98.

[68] For the purpose of this study, an adult is an individual who is 16 years of age or older.

[69] Caution should, however, be used in employing the measure of health that we call in this paper "self-assessed (sah)" in cross-country comparisons. Several studies (Mathers and Douglas, 1998; Murray, 1996; Wagstaff 2002; Lindeboom and van Doorslaer, 2004; van Doorslaer and Gerdtham, 2003; Milcent and Etile, 2006; Salomon *et al.*, 2004; Tandon *et al.*, 2006; Bago d'Uva *et al.* 2007) show that these are highly affected by factors such as culture and tradition, as well as the individuals' socio-economic status.

[70] The actual and age-sex standardised percentages of inpatient stays by income group are computed from statistics reported in the following Table.

Income group	Actual nr. of Inpatient stays	Age-sex stand. nr. of Inpatient stays
1	17	18.78
2	57	61.39
3	10	9.52
4	4	2.74
5	8	6.03
Total	**96**	**98**

Conclusions

This thesis has investigated the issues relating to the measurement of health system performance. Two different dimensions of health system performance were addressed: efficiency and equity. Part I and II consider the first dimension, respectively for the health system as a whole and for a specific programme of care. The third part of the thesis considers the second dimension, assessing the impact of the devolution reform on equity in health and healthcare utilisation in Great Britain.

In Part I we addressed the issues relating to the measurement of government output for the healthcare sector. Three key challenges usually arise when measuring output growth. First, it is necessary to identify and quantify **healthcare output** correctly. We distinguish between *activity*, *output* and *outcome*. We define output as courses of treatment that may require a bundle of *activities* (tests, surgery, drugs, etc.) and *outcome* as the quality characteristics of healthcare output that individuals value (health improvement, waiting time, being treated with dignity, etc.). We identified as the unit of output the patient treated. The IT system in the NHS does not currently allow tracking patients across all of the settings in which they receive care (primary and secondary sectors, for example). However, and limited to hospital activity, the HES database includes information that enables us to at least track patients across consultants within providers and also across providers. All remaining NHS services are included in the output growth in the units of activity that they are collected and reported in the various sources. These vary from number of tests performed to bed days, to attendances, etc. Second, even if it is possible to count these outputs, it is difficult to measure their quality. **Quality** of healthcare goods and services is likely to be an important source of output growth. Two challenges are involved: 1) identifying and defining what constitutes the quality of healthcare and 2) develop a way of incorporating these quality characteristics into an output growth index. We have identified the following quality adjustors: survival rates, pre- and post-treatment health status for a limited number of hospital outputs, life expectancy and waiting times. These data are currently available only for patients admitted to hospitals as inpatients. Third, some means of weighting different goods and services is required in order to aggregate them into a single index. In principle, marginal social values of different NHS outputs should be used. The

standard assumption in the national accounting literature is that marginal social values are measured by the unit costs of production. Although an imperfect measure, and in the absence of marginal social values, we decided to follow the National Accounts and use unit costs derived from the National Schedule of Reference Costs. We have demonstrated how quality change can be accounted for in an output growth index, given current data availability. Quality-adjusting output adds on average about 0.2 per cent per annum to the simple cost weight output growth measure. In 2001/02 – 2002/03 and 2002/03 – 2003/04 alone, it adds between 0.50 and 0.73 percentage points.

Part II has considered the feasibility and usefulness of developing measures of growth in outputs, costs and productivity of a single programme of care within the NHS: hospital treatment of circulatory diseases. Determining output indices that consider the complete treatment of individual illnesses has been recognised as early as the 1960s. The US literature has studied widely and developed disease-specific and patient-based healthcare output and price indices that focus on the direct measurement of medical costs of treating an episode of illness. We have demonstrated that it is feasible, using hospital spells as the unit of output, to develop quite refined models of the output of a programme of care. The development of HRGs has assisted greatly in this endeavour, yielding meaningful counts of output. Output growth for hospital treatment of all circulatory diseases has increased over the time period we considered. In actual cost-weighted volume terms, the increase is of the order of 3.9 per cent per annum, but incorporation of quality data in the form of survival rates implies an increased rate of 4.5 per cent per annum. This is clearly crude, but the recent improvement in survival rates in many procedures for circulatory disease yields quite a large improvement in estimates of annual rates of output growth. This is in line with ONS estimates, which estimates annual increase in outputs over the same period for the whole of the NHS (including primary care and prescribing) at about 5 per cent. The lack of health outcome measurement in the NHS (other than survival data) means that we are unable to say much about the quality of life after treatment. However, we have demonstrated how this might be incorporated into an output index using health status measures of before and after treatment from a private health insurer. Health outcome data were available for CABG and PTCA elective procedures. For all other procedures/diagnoses of circulatory disease we attributed an average value to the ratio of before and after health outcome measures ($k_j = h_j^0/h_j^*$) for electives and non-electives activity (See Castelli *et al.*,

2007a). Sensitivity analyses were carried out to determine the effect of different values on the cost weighted output growth indices. In the first instance, we calculated output growth measures for CABG and PTCA procedures only, finding that consideration of the quality of health outcomes added about 0.2 per cent per annum to the estimates of output growth. Incorporating health outcomes measures for all circulatory diseases activity yields a higher increase in average output growth of about 5.19 per cent per annum, adding about 1.3 per cent per annum to the unadjusted CWOI and 0.71 per cent annum to the survival adjusted CWOI.

Common conclusions can be drawn for part I and II. The measurement of output growth and productivity for any public sector relies on the existence of routinely collected administrative data. The benefits of this type of data are well known and are for example 100 coverage of target population, minimised attrition problems, and accuracy (Jones and Elias, 2006). Nonetheless, some drawbacks may arise with the introduction of new collection exercises which are very often phased into a system. One of the problems that this may cause is that of introducing volatility in the output growth measure. This problem is usually avoided and/or minimised in the National Accounts by using the so-called 'mapping technique' by which activity in any two consecutive years is matched, where possible, and all the activity that cannot be compared and/or mapped is discarded from the estimates. Further and although, we recognise that the *mapping approach* used for the inclusion of new activity categories reported in the Reference Costs constitutes a step forward compared to the *traditional approach*, which required output categories to be consistent through time, it has the limitation that it relies heavily on judgements about the nature of the relationship between existing categories and new categories, and that it is not always possible to map all activity, especially activity that was previously not recorded. In the presence of technological progress, which constantly introduces both new treatments/procedures and drugs, as well as new ways of recording and tracking patients' care, it becomes more and more important to be able to account for this new activity categories as soon as they are reported. We believe that the issue of changing output categories needs to be addressed. Elsewhere, (Castelli *et al.* (2008)), we have developed a new method, and our research should be updated in order to incorporate this improved approach.

We strongly recommend that the NHS makes it their priority to start the routine collection of health outcomes data. These are important not only to be used in improved measure of healthcare output growth, but could also successfully be used in surveillance of clinical performance, resource allocation, and informing patient choice and improved patient care.

Health outcomes constitute undoubtedly the most important element of quality to incorporate into the model of NHS output growth. However, there is also a case for exploring the feasibility and usefulness of incorporating non-health aspects of NHS quality into the model, such as measures of patient experience. Other aspects of output that may be important in some programmes of care include the benefits of treatment to the patient's carers, and the implications of NHS activities for labour productivity and social care expenditure. Further, we recommend to extend the quality adjustments to other areas of healthcare; in particular, the primary care sector.

A crucial methodological consideration concerns the weights to be applied to the separate NHS output activities. The diverse hospital spells that make up this programme of care do not necessarily confer equal patient benefits. We have followed the conventional practice in weighting treatments according to their estimated costs, acknowledging that these are imperfect measures of marginal social value. We recognise that is desirable to do further research on determining 'value weights'.

The analysis carried out in Part I and II focus on the English NHS only, this does not preclude, however, for the same methods to be applied to any of the devolved administrations. An analysis of NHS output growth and productivity for Wales, Northern Ireland and Scotland is not only to be encouraged but necessary, especially for the purposes of the National Accounts. We consider extending this analysis to the remaining three countries of the UK a priority to be addressed in the near future. It is to our knowledge that ONS has already started calculating output and productivity growth for the Northern Ireland NHS (ONS, 2008).

Limitedly to part II, we believe that it is important to extend the analysis to programmes of care performed outside the hospital sector, such as community and primary care settings.

In part III "Equity in the delivery of healthcare in Great Britain: the impact of decentralisation", we investigated the impact of devolution on equity in the delivery of healthcare in the constituent countries of Great Britain: England, Wales and Scotland. Decentralisation of the health care sector has received substantial attention as a policy reform in the last decade or so in many countries. In 1998 the Labour Government passed an important reform which transferred political power and responsibilities from Westminster to Scotland, Wales and Northern Ireland, with Health being the most important responsibility that has been devolved. Prior to devolution, health services in the constituent countries of the United Kingdom were administered as part of the National Health Service, which was designed to achieve common standards across the whole of the UK. However, since devolution, each constituent country has been granted freedom to organise aspects of their NHS differently, subject to overarching criteria and constraints. We investigated whether any significant changes had occurred in the distribution of health and healthcare utilisation across different income groups, by means of the concentration index. We found that income-related inequality in (ill-) health exists in all three countries, and that it is favouring the highest income groups. In the case of healthcare utilisation, income-related inequity also exists and it is favouring the lowest income groups. Although important changes occur in the way health and healthcare utilisation are distributed across income groups from 1995/96 to 2001/02, no clear pattern of change emerges. Although we realise that it is not possible to attribute these changes directly to the introduction of the devolution reform as other policy reforms may have been implemented in any country at the same time; we consider, however, this study as a very first attempt to investigate these issues. We recommend investigating this issue further by adding more years to the time period considered both before and after the policy reform was introduced. Further, we recommend to harmonise data specification across the 3 countries under investigation to enable more accurate comparisons of income-related inequality in health and inequity in healthcare utilisation.

This PhD thesis has investigated important aspects of the measurement of health system performance and the uses to which such measures might be put. Performance is a multi-dimensional concept which can be addressed from a variety of points of views and with a variety of instruments. We presented in this thesis one way of assessing NHS

performance as a whole and for one programme of care by means of a quality-adjusted output index, respectively in part I and II.

The way in which healthcare output is measured constitutes a novelty on its own. The output index formulation developed allows for the comprehensive measurement of all output produced by the NHS, and for quality aspects to be taken into account.. Further, and following suggestions set out both in the Eurostat Handbook (2001) and in the Atkinson Review (2005), building on Lakhani *et al.* (2005) we develop a measure of healthcare output which considers the treatment pathway that a patient follows whilst under the care of the NHS. Limitations in current IT technology, allow us only to track patients in acute care and we develop a new unit of output measure: Continuous Inpatient Spell of NHS hospital care. Output growth measurements in the National Accounts use still an elementary measure of healthcare (hospital) activity, based of finished consultant episodes.

The increased interest in the measurement of output and productivity growth in the NHS, extends also to gaining a better understanding of the output growth and productivity of individual programmes of care, so as to ensure that resources are allocated efficiently within the NHS. Hitherto, such information has not been available. In the second part of the thesis using the method developed in the first chapter, we undertake and exploratory study of the feasibility and usefulness of developing measures of growth in outputs and productivity of a single programme of care within the NHS hospital setting.

Further, the fundamental objective of any public health system is still that to improve patients' health and to that end to provide healthcare services to people according to their needs and not their ability to pay. It is, therefore, important to be able to investigate whether this objective is met in the presence of any policy reform that could potentially jeopardise it. We have focused on this issue in the third part of this PhD thesis.

In the last chapter an attempt is made to evaluate the devolution of the NHS in the UK by looking at the effects it has on income-related equity in health and healthcare utilisation. No previous attempt has been made to evaluate this reform and within the

specific methodological framework used in this chapter. We are aware of only one paper (Alvarez-Rosete *et al.*, 2005) that attempts to evaluate the effects of the diverging policies introduced since the devolution of the NHS. In this paper, however, only routine data on performance of the NHS are used to compare the four constituent countries of the UK on a number of aspects such as health indicators, expenditure, waiting times before and after the devolution took place. Our paper constitutes an improvement compared to this paper, in that we apply a more sophisticated framework in order to establish whether the devolution of the NHS has allowed each constituent country to improve the realisation of the fundamental aim of the NHS which is that of delivering healthcare to people who are in need of them, based on need and need alone.

The research undertaken for this PhD has been affected by severe data difficulties; however, we have shown power of data sources. There is a clear case for improving data specification and collection, which will allow for the improved measurement of health system performance for both policy making purposes and accountability to the public.

Appendix 1-A

Atkinson's principles for the direct measurement of government output, inputs and productivity (Atkinson, 2005)

Principle A: The measurement of government non-market output should, as far as possible, follow a procedure parallel to that adopted in the National Accounts for market output.

Principle B: The output of the government sector should in principle be measured in a way that is adjusted for quality, taking account of the attributable incremental contribution of the service to the outcome.

Principle C: Account should be taken of the complementarity between public and private output, allowing for the increased real value of public services in an economy with rising real GDP.

Principle D: Formal criteria should be set in place for the extension of direct output measurement to new functions of government, Specifically, the conditions for introducing a new directly measured output indicator should be that (i) it covers adequately the full range of services for that functional area, (ii) it makes appropriate allowance for quality change, (iii) the effects of its introduction have been tested service by service, (iv) the context in which it will be published has been fully assessed, in particular the implied productivity estimate, and (v) there should be provision for regular statistical review.

Principle E: Measures should cover the whole of the United Kingdom; where systems for public service delivery and/or data collection differ across the different countries of the United Kingdom, it is necessary to reflect this variation in the choice of indicators.

Principle F: The measurement of inputs should be as comprehensive as possible, and in particular should include capital services; labour inputs should be compiled using both direct and indirect methods, compared and reconciled.

Principle G: Criteria should be established for the quality of pay and price deflators to be applied to the input spending series; they should be sufficiently disaggregated to take account of changes in the mix of inputs and should reflect full and actual costs.

Principle H: Independent corroborative evidence should be sought on government productivity, as part of a process of 'triangulation', recognising the limitations in reducing productivity to a single number.

Principle I: Explicit reference should be made to the margins of error surrounding national accounts estimates

* * *

Health – recommendation 8.5 (Atkinson, 2005)

We regard the measurement of quality change in health care as a difficult area, but have a number of suggestions for work which should be taken forward. The results of research commissioned by the DH from the University of York and National Institute for Economic and Social Research will be important. We recommend that:

a) a number of dimensions of quality should be measured, with results weighted together by marginal social valuation: more work would be required to underpin these weights;

b) a range of expertise should be used to develop quality measures, including public health medicine, epidemiology, health service management, health informatics and health economics;

c) ONS and the health departments should assess options for collecting new information on health outcomes resulting from NHS treatment, with particular consideration to the needs ONS has for measurement of change over time, rather than cross-sectional data sets which are useful to health departments for other purposes;

d) ONS and the health departments should consider studies of changing treatment patterns for particular major disease groups to assess whether these could provide useful estimates of improved health outcomes resulting from changes in clinical practice;

e) ONS and the health departments should explore the data set on quality standards in general practice, resulting from the new GP contract, to see whether this could be the basis for a measure of quality change;

f) ONS and the health departments should consider whether, with advice from the National Institute for Clinical Excellence, it might be possible to identify treatments where marginal valuation and cost weights are very different, and explore the difference in output growth resulting from use of estimated marginal valuation instead of cost weights;

g) ONS and the health departments should develop a measure of quality change based on speed of access to elective treatment, using the Hospital Episode Statistics data set and taking account of non-linearity, with further developments if new measures of total waiting time are introduced;

h) ONS and the health departments should explore whether measures of quality change could be developed from information sources for time taken for admission to hospital from accident and emergency departments, time before seeing a general practitioner and ambulance emergency response times;

i) ONS and the health departments should explore whether measures of quality change over time could be based on the national patient survey programme which measures aspects of patient experience.

Appendix 1-B

Literature search strategy

HMIC

Initial strategy
#1 quantity index
#2 growth accounting
#3 tornqvist index
#4 fisher index
#5 labour productivity
#6 residual productivity
#7 solow residual
#8 index number theory
#9 translog production
#10 hedonic
#11 medical productivity
#12 health productivity
#13 health care productivity
#14 healthcare productivity
#15 frontier analysis
#16 frontier analyses
#17 data envelopment analysis
#18 data envelopment analyses
#19 total factor productivity
#20 multifactor productivity
#21 multi factor productivity
#22 multi-factor productivity
#23 (multi-factor productivity) or (multi factor productivity) or (hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or (quantity index) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis) or (healthcare productivity) or (health care productivity) or (health productivity) or (medical productivity)
#24 (medical service*) in ti,de
#25 (medical system*) in ti,de
#26 (public service*) in ti,de
#27 (public sector*) in ti,de
#28 ((health adj care) or healthcare) in ti,de
#29 (health service*) in ti,de
#30 (health system*) in ti,de
#31 (health insurance system*) in ti,de
#32 (primary care) in ti,de
#33 (family health service*) in ti,de
#34 (family practice*) in ti,de
#35 (general practice*) in ti,de

#36 nhs in ti,de
#37 (national health service*) in ti,de
#38 hospitals in ti,de
#39 ((medical service*) in ti,de) or (hospitals in ti,de) or ((national health service*) in ti,de) or (nhs in ti,de) or ((general practice*) in ti,de) or ((family practice*) in ti,de) or ((family health service*) in ti,de) or ((primary care) in ti,de) or ((health insurance system*) in ti,de) or ((health system*) in ti,de) or ((health service*) in ti,de) or (((health adj care) or healthcare) in ti,de) or ((public sector*) in ti,de) or ((public service*) in ti,de) or ((medical system*) in ti,de)
#40 (productivity or output or outputs of efficient or efficiency) in ti,de
#41 ((productivity or output or outputs of efficient or efficiency) in ti,de) and (((medical service*) in ti,de) or (hospitals in ti,de) or ((national health service*) in ti,de) or (nhs in ti,de) or ((general practice*) in ti,de) or ((family practice*) in ti,de) or ((family health service*) in ti,de) or ((primary care) in ti,de) or ((health insurance system*) in ti,de) or ((health system*) in ti,de) or ((health service*) in ti,de) or (((health adj care) or healthcare) in ti,de) or ((public sector*) in ti,de) or ((public service*) in ti,de) or ((medical system*) in ti,de))
#42 ((medical service*) in ti,de,ab) or (hospitals in ti,de,ab) or ((national health service*) in ti,de,ab) or (nhs in ti,de,ab) or ((general practice*) in ti,de,ab) or ((family practice*) in ti,de,ab) or ((family health service*) in ti,de,ab) or ((primary care) in ti,de,ab) or ((health insurance system*) in ti,de,ab) or ((health
system*) in ti,de,ab) or ((health service*) in ti,de,ab) or (((health adj care) or healthcare) in ti,de,ab) or ((public sector*) in ti,de,ab) or ((public service*) in ti,de,ab) or ((medical system*) in ti,de,ab)
#43 (productivity or output or outputs of efficient or efficiency) in ti,de,ab
#44 (measur* or estimat* or index or indexes or indices or indicator* or instrument* or calculat* or monitor* or gain* or chang* or increas* or improv* or grow*)in ti,de,ab
#45 ((productivity or output or outputs of efficient or efficiency) in ti,de,ab) and (((medical service*) in ti,de,ab) or (hospitals in ti,de,ab) or ((national health service*) in ti,de,ab) or (nhs in ti,de,ab) or ((general practice*) in ti,de,ab) or ((family practice*) in ti,de,ab) or ((family health service*) in ti,de,ab) or ((primary care) in ti,de,ab) or ((health insurance system*) in ti,de,ab) or ((health system*) in ti,de,ab) or ((health service*) in ti,de,ab) or (((health adj care) or healthcare) in ti,de,ab) or ((public sector*) in ti,de,ab) or ((public service*) in ti,de,ab) or ((medical system*) in ti,de,ab)) and ((measur* or estimat* or index or indexes or indices or indicator* or instrument* or calculat* or monitor* or gain* or chang* or increas* or improv* or grow*)in ti,de,ab)
#46 outcome* in ti
#47 ((medical service*) in ti) or (hospitals in ti) or ((national health service*) in ti) or (nhs in ti) or ((general practice*) in ti) or ((family practice*) in ti) or ((family health service*) in ti) or ((primary care) in ti) or ((health insurance system*) in ti) or ((health system*) in ti) or ((health service*) in ti) or (((health
adj care) or healthcare) in ti) or ((public sector*) in ti) or ((public service*) in ti) or ((medical system*) in ti)
#48 (((medical service*) in ti) or (hospitals in ti) or ((national health service*) in ti) or (nhs in ti) or ((general practice*) in ti) or ((family practice*) in ti) or ((family health service*) in ti) or ((primary care) in ti) or ((health insurance system*) in ti) or ((health system*) in ti) or ((health service*) in ti) or (((health
adj care) or healthcare) in ti) or ((public sector*) in ti) or ((public service*) in ti) or ((medical system*) in ti)) and (outcome* in ti)
#49 (technical change*) or (technological change*)

#50 (technical innovation*) or (technological innovation*)
#51 technology adj2 (chang*)
#52 technology adj (change or changes or changing or changed)
#53 ((technical innovation*) or (technological innovation*)) or (technology adj (change or changes or changing or changed)) or ((technical change*) or (technological change*)) or (technology adj2
(chang*))
#54 health sector account*
#55 (health or medical) near (price index)
#56 (health or medical) near (price indexes)
#57 (health or medical) near (price indices)
#58 ((measur* or estimate* or index or indexes or indices or indicator* or instrument* or calculat* or monitor* or gain* or chang* or increas* or improv* or grow*) in ti,de) near2 quality
#59 ((productivity or efficient or efficiency or output or outputs) in ti,de) near2 quality
#60 (((productivity or efficient or efficiency or output or outputs) in ti,de) near2 quality) or (((measur* or estimate* or index or indexes or indices or indicator* or instrument* or calculat* or monitor* or gain* or chang* or increas* or improv* or grow*) in ti,de) near2 quality)
#61 (inspection in ti) and ((services or council or borough or city) in ti)
#62 #60 not #61
#63 burden near2 disease
#64 cost* near2 disease*
#65 economic burden*
#66 (economic burden*) or (cost* near2 disease*) or (burden near2 disease)
#67 (survival rate*) near2 (measur* or estimate* or index or indexes or indices or indicator* or instrument* or calculat* on monitor* or gain* or chang* or increas* or improv* or grow*)
#68 physical capital
#69 capital near2 (hospital* or building* or equipment or infrastructure)
#70 (general practice* or family practice or family health service* or primary care) in ti,ab,de
#71 (input or inputs) and #70
#72 #23 or #41 or #45 or #48 or #53 or #54 or #55 or #56 or #62 or
#57 or #66 or #67 or #68 or #69 or #71
#73 (#23 or #41 or #45 or #48 or #53 or #54 or #55 or #56 or #62 or
#57 or #66 or #67 or #68 or #69 or #71) and ((PY:HMIC >= 1989) or
(PY:HQ >= 1989)

Refined strategy
#1 quantity index
#2 growth accounting
#3 tornqvist index
#4 fisher index
#5 labour productivity
#6 residual productivity
#7 solow residual
#8 index number theory
#9 translog production
#10 hedonic

#11 medical productivity
#12 health productivity
#13 health care productivity
#14 healthcare productivity
#15 frontier analysis
#16 frontier analyses
#17 data envelopment analysis
#18 data envelopment analyses
#19 total factor productivity
#20 multifactor productivity
#21 multi factor productivity
#22 multi-factor productivity
#23 (multi-factor productivity) or (multi factor productivity) or (hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or (quantity index) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis) or (healthcare productivity) or (health care productivity) or (health productivity) or (medical productivity)
#24((productivity OR output*) in ti,de) AND ((medical service*) in ti,de) or (hospitals in ti,de) or ((national health service*) in ti,de) or (nhs in ti,de) or ((general practice*) in ti,de) or ((family practice*) in ti,de) or ((family health service*) in ti,de) or ((primary care) in ti,de) or ((health insurance system*) in ti,de) or ((health system*) in ti,de) or ((health service*) in ti,de) or (((health adj care) or healthcare) in ti,de) or ((public sector*) in ti,de) or ((public service*) in ti,de) or ((medical system*) in ti,de)
#25 health sector account*
#26 (health or medical) near (price index)
#27 (health or medical) near (price indexes)
#28 (health or medical) near (price indices)
#29 #23 or #24 or #25 or #26 or #27 or #28 and ((PY:HMIC >= 1989) or (PY:HQ >= 1989)

EconLit

Initial strategy
#1 quantity index
#2 growth accounting
#3 tornqvist index
#4 fisher index
#5 labour productivity
#6 residual productivity
#7 solow residual
#8 index number theory
#9 translog production
#10 hedonic
#11 frontier analysis
#12 frontier analyses
#13 data envelopment analysis
#14 data envelopment analyses

#15 total factor productivity
#16 multifactor productivity
#17 multi-factor productivity
#18 multi factor productivity
#19 (hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or
(quantity index) or (multi factor productivity) or (multi-factor productivity) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis)
#20 medical service*
#21 medical system*
#22 public service*
#23 public sector*
#24 (health adj care) or healthcare
#25 health service*
#26 health system*
#27 health insurance system*
#28 primary care
#29 family health service*
#30 family practice*
#31 general practice*
#32 nhs
#33 national health service*
#34 hospitals
#35 ((health adj care) or healthcare) or (public sector*) or (public service*) or (medical system*) or (hospitals) or (national health service*) or (nhs) or (general practice*) or (medical service*) or (family practice*) or (family health service*) or (primary care) or (health insurance system*) or (health system*) or ((health service*) in ti,ab,de)
#36 (((health adj care) or healthcare) or (public sector*) or (public service*) or (medical system*) or (hospitals) or (national health service*) or (nhs) or (general practice*) or (medical service*) or (family practice*) or (family health service*) or (primary care) or (health insurance system*) or (health system*) or ((health service*) in ti,ab,de)) and ((hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or
(growth accounting) or (quantity index) or (multi factor productivity) or (multi-factor productivity) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis))
#37 ((health or medical) in ti) and #19
#38 (((health or medical) in ti) and #19) or ((((health adj care) or healthcare) or (public sector*) or (public service*) or (medical system*) or (hospitals) or (national health service*) or (nhs) or (general practice*) or (medical service*) or (family practice*) or (family health service*) or (primary care) or (health insurance system*) or (health system*) or ((health service*) in ti,ab,de)) and ((hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or (quantity index) or (multi factor productivity) or (multi-factor productivity) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis)))

#39 (productivity or output or outputs or efficient or efficiency) near2 #35
#40 (productivity or output or outputs or efficient or efficiency) near2 (health or medical)
#41 ((productivity or output or outputs or efficient or efficiency) near2 #35) or ((productivity or output or outputs or efficient or efficiency) near2 (health or medical))
#42 outcome* and #35
#43 (technical innovation*) or (technological innovation*) or ((technology near2 (change or changes or changing or changed))in ti,ab,de)
#44 #43 and (health or medical)
#45 #43 and #35
#46 (#43 and #35) or (#43 and (health or medical))
#47 health sector account*
#48 (health or medical) near (price index or price indexes or price indices)
#49 (measur* or estimat* or index or indices or indexes or indicator* or instrument* or calculat* or monitor* or gain* or chang* or increas* or improv* or grow*) near2 quality
#50 #49 and (health or medical or #35)
#51 burden near2 disease
#52 cost near2 disease*
#53 illness near2 burden
#54 (illness near2 burden) or (cost near2 disease*) or (burden near2 disease)
#55 survival rate*
#56 capital near2 hospital*
#57 (input or inputs) in ti,ab,de
#58 #57 near2 (health or medical or #35)
#59 (#38 or #41 or #42 or #46 or #47 or #48 or #50 or #54 or #55 or #56 or #58) and (PY:ECON >= 1989)

Refined strategy
#1 ((health or medical) in ti) and ((hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or (quantity index) or (multi factor productivity) or (multi-factor productivity) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis))
#2 (((health adj care) or healthcare) or (public sector*) or (public service*) or (medical system*) or (hospitals) or (national health service*) or (nhs) or (general practice*) or (medical service*) or (family practice*) or (family health service*) or (primary care) or (health insurance system*) or (health system*) or ((health service*) in ti,ab,de)) and ((hedonic) or (translog production) or (index number theory) or (solow residual) or (residual productivity) or (labour productivity) or (fisher index) or (tornqvist index) or (growth accounting) or (quantity index) or (multi factor productivity) or (multi-factor productivity) or (multifactor productivity) or (total factor productivity) or (data envelopment analyses) or (data envelopment analysis) or (frontier analyses) or (frontier analysis))
#3 (productivity or output or outputs or efficient or efficiency) near2 (health or medical)
#4 (productivity or output or outputs or efficient or efficiency) near2 ((health adj care) or healthcare) or (public sector*) or (public service*) or (medical system*) or (hospitals) or (national health service*) or (nhs) or (general practice*) or (medical service*) or (family practice*) or (family health service*) or

(primary care) or (health insurance system*) or (health system*) or((health service*) in ti,ab,de)
#5 (productivity or output or outputs or efficient or efficiency) near2 (health or medical)
#6 (#1 or #2 or #3 or #4 or 5) and (PY:ECON >= 1989)

These search strategies were carried out by members of staff at CRD - University of York.

Appendix 1-C

Table 1-C.1: Pre- and post-treatment health status

			Health outcome	
HRG description	**HRG**	**Source**	h^0_j	h^*j
Intermediate pain procedures	A07	PHI	0.41	0.57
Phakoemulsification cataract extraction with lens implant	B02	PHI	0.73	0.76
Other cataract extraction with lens implant	B03	PHI	0.7	0.72
Mouth or throat procedures - category 2	C14	PHI	0.87	0.95
Nose procedures - category 3	C22	PHI	0.83	0.91
Mouth or throat procedures - category 3	C24	PHI	0.77	0.93
Coronary bypass	E04	PHI	0.5	0.73
Acute myocardial infarction w/o cc	E12	CT	0.68	0.72
Percutaneous transluminal coronary angioplasty (PTCA)	E15	PHI	0.54	0.79
Chest pain >69 or w cc	E35	CT	0.63	0.69
Inguinal umbilical or femoral hernia repairs >69 or w cc	F73	PHI	0.64	0.69
Inguinal umbilical or femoral hernia repairs <70 w/o cc	F74	PHI	0.74	0.81
Liver transplant	G01	CT	0.53	0.59
Biliary tract - major procedures >69 or w cc	G13	PHI	0.63	0.66
Biliary tract - major procedures <70 w/o cc	G14	PHI	0.68	0.81
Primary hip replacement	H02	PHI	0.37	0.62
Primary knee replacement	H04	HT	0.35	0.54
Soft tissue disorders >69 or w cc	H23	PHI	0.77	0.84
Soft tissue disorders <70 w/o cc	H24	PHI	0.72	0.74
w/o cc	H26	CT	0.41	0.53
Complex breast reconstruction using flaps	J01	PHI	0.93	0.96
Non-malignant prostate disorders	L32	CT	0.81	0.85
Upper genital tract major procedures	M07	PHI	0.7	0.8
Threatened or spontaneous abortion	M09	PHI	0.72	0.83
Psychiatric disorders	P18	CT	0.36	0.41
Varicose vein procedures	Q11	CT	0.77	1
Surgery for degenerative spinal disorders	R02	PHI	0.37	0.67
Spinal fusion or decompression excluding trauma	R03	PHI	0.36	0.62
Revisional spinal procedures	R09	PHI	0.32	0.6

where PHI: Private Health Insurer; CT: Clinical Trials; HT: Hospital Trust

Appendix 1-D

Table 1-D.1 - Calculation of Quality-adjusted Life Expectancy base on the 2000-2002 Life Tables

Age	MALES			FEMALES		
	Life Expectancy i	Quality Adjustment ii	QA Life Expectancy iii	Life Expectancy i	Quality Adjustment ii	QA Life Expectancy iii
0	75.70	11.66	64.04	80.40	11.95	68.45
1	74.84	11.38	63.47	79.57	11.99	67.57
2	73.96	11.11	62.85	78.70	12.03	66.67
3	73.06	10.86	62.21	77.79	12.05	65.75
4	72.14	10.61	61.53	76.86	12.05	64.81
5	71.20	10.39	60.81	75.90	12.05	63.85
6	70.24	10.17	60.07	74.92	12.03	62.89
7	69.27	9.97	59.30	73.93	12.01	61.92
8	68.29	9.78	58.51	72.92	11.97	60.95
9	67.30	9.61	57.69	71.91	11.93	59.98
10	66.30	9.44	56.86	70.90	11.87	59.03
11	65.30	9.28	56.01	69.89	11.81	58.08
12	64.29	9.13	55.16	68.89	11.74	57.14
13	63.29	8.99	54.29	67.89	11.67	56.22
14	62.29	8.86	53.43	66.89	11.59	55.30
15	61.30	8.74	52.56	65.90	11.50	54.40
16	60.33	8.62	51.70	64.91	11.41	53.50
17	59.36	8.51	50.85	63.93	11.32	52.62
18	58.41	8.41	50.00	62.95	11.22	51.73
19	57.45	8.31	49.14	61.98	11.12	50.86
20	56.50	8.22	48.28	61.00	11.02	49.98
21	55.55	8.13	47.42	60.02	10.91	49.11
22	54.59	8.04	46.55	59.04	10.81	48.23
23	53.63	7.96	45.67	58.06	10.71	47.36
24	52.66	7.88	44.79	57.08	10.60	46.48
25	51.70	7.80	43.90	56.10	10.50	45.60
26	50.73	7.72	43.02	55.12	10.40	44.72
27	49.77	7.64	42.13	54.14	10.30	43.84
28	48.81	7.56	41.24	53.16	10.20	42.96
29	47.85	7.48	40.37	52.18	10.11	42.07
30	46.90	7.41	39.49	51.20	10.02	41.18
31	45.96	7.33	38.63	50.22	9.93	40.29
32	45.02	7.25	37.77	49.23	9.83	39.40
33	44.09	7.17	36.91	48.25	9.73	38.52
34	43.15	7.09	36.06	47.27	9.63	37.64
35	42.20	7.01	35.19	46.30	9.53	36.77
36	41.24	6.93	34.32	45.34	9.42	35.92
37	40.28	6.84	33.44	44.38	9.31	35.07
38	39.31	6.75	32.56	43.42	9.20	34.22
39	38.35	6.66	31.70	42.46	9.08	33.38
40	37.40	6.56	30.84	41.50	8.96	32.54
41	36.46	6.47	30.00	40.53	8.84	31.69
42	35.53	6.37	29.16	39.57	8.72	30.85
43	34.62	6.27	28.34	38.60	8.60	30.01
44	33.71	6.18	27.53	37.65	8.47	29.18
45	32.80	6.08	26.72	36.70	8.34	28.36

Table 1-D.1 - continued

Age	MALES			FEMALES		
	Life Expectancy	Quality Adjustment	QA Life Expectancy	Life Expectancy	Quality Adjustment	QA Life Expectancy
	i	ii	iii	i	ii	iii
46	31.90	5.97	25.92	35.77	8.21	27.56
47	31.00	5.86	25.14	34.85	8.08	26.77
48	30.10	5.74	24.36	33.93	7.94	25.99
49	29.20	5.61	23.59	33.02	7.81	25.21
50	28.30	5.48	22.82	32.10	7.67	24.43
51	27.40	5.34	22.06	31.17	7.53	23.65
52	26.51	5.21	21.30	30.25	7.39	22.86
53	25.63	5.08	20.55	29.32	7.25	22.07
54	24.76	4.95	19.81	28.40	7.11	21.29
55	23.90	4.82	19.08	27.50	6.97	20.53
56	23.06	4.69	18.36	26.62	6.81	19.80
57	22.23	4.56	17.67	25.75	6.65	19.10
58	21.41	4.42	16.99	24.89	6.48	18.42
59	20.61	4.28	16.33	24.05	6.29	17.75
60	19.80	4.13	15.67	23.20	6.10	17.10
61	19.00	3.98	15.02	22.35	5.91	16.44
62	18.20	3.82	14.38	21.51	5.72	15.79
63	17.42	3.66	13.75	20.66	5.53	15.13
64	16.65	3.50	13.14	19.83	5.35	14.48
65	15.90	3.35	12.55	19.00	5.18	13.82
66	15.18	3.20	11.98	18.19	5.00	13.18
67	14.48	3.05	11.43	17.39	4.84	12.55
68	13.81	2.91	10.89	16.60	4.68	11.92
69	13.15	2.78	10.36	15.84	4.53	11.31
70	12.50	2.66	9.84	15.10	4.37	10.73
71	11.86	2.54	9.32	14.38	4.22	10.16
72	11.24	2.43	8.81	13.68	4.06	9.62
73	10.64	2.32	8.32	13.01	3.90	9.11
74	10.06	2.21	7.84	12.35	3.73	8.62
75	9.50	2.11	7.39	11.70	3.56	8.14
76	8.97	2.01	6.97	11.07	3.39	7.68
77	8.48	1.90	6.58	10.45	3.22	7.23
78	8.00	1.79	6.21	9.85	3.06	6.79
79	7.54	1.69	5.86	9.26	2.90	6.37
80	7.10	1.58	5.52	8.70	2.74	5.96
81	6.67	1.48	5.19	8.16	2.59	5.56
82	6.25	1.38	4.87	7.63	2.45	5.18
83	5.85	1.29	4.56	7.13	2.31	4.82
84	5.46	1.20	4.27	6.65	2.18	4.48
85	5.10	1.11	3.99	6.20	2.05	4.15
86	4.76	1.03	3.73	5.77	1.93	3.84
87	4.45	0.96	3.49	5.36	1.81	3.55
88	4.17	0.89	3.28	4.98	1.70	3.28
89	3.92	0.82	3.09	4.63	1.59	3.04
90	3.70	0.76	2.94	4.30	1.49	2.81
91	3.52	0.71	2.82	4.00	1.39	2.60
92	3.39	0.65	2.73	3.73	1.30	2.42
93	3.29	0.61	2.69	3.48	1.22	2.26
94	3.24	0.56	2.68	3.27	1.14	2.13
95	3.24	0.52	2.73	3.08	1.07	2.01

Appendix 2-A

Table 2-A.1: List of HRGs attributable to Circulatory Diseases, activity and unit costs for 2003/04

HRG code	HRG Description	Activity 2003/04		Unit Costs 2003/04	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
A01	Intracranial Procedures Except Trauma - Category 1	1,386	542	2,983	2,592
A02	Intracranial Procedures Except Trauma - Category 2	3,117	2,327	3,215	4,659
A03	Intracranial Procedures Except Trauma - Category 3	2,256	2,533	4,929	6,331
A04	Intracranial Procedures Except Trauma - Category 4	2,584	2,064	7,286	8,494
A05	Intracranial Procedures for Trauma w cc	24	645	3,695	6,237
A06	Intracranial Procedures for Trauma w/o cc	244	2,130	1,805	4,154
A16	Cerebral Degenerations >69 or w cc	3,602	9,664	2,075	4,166
A17	Cerebral Degenerations <70 w/o cc	5,105	4,526	1,164	1,687
A19	Haemorrhagic Cerebrovascular Disorders	672	16,702	3,470	2,727
A20	Transient Ischaemic Attack >69 or w cc	213	13,085	1,896	1,262
A21	Transient Ischaemic Attack <70 w/o cc	95	5,442	807	725
A22	Non-Transient Stroke or Cerebrovascular Accident >69 or w cc	1,351	48,565	4,354	3,504
A23	Non-Transient Stroke or Cerebrovascular Accident <70 w/o cc	872	13,965	2,059	2,286
D10	Pulmonary Embolus >69 or w cc	357	6,657	1,112	2,008
D11	Pulmonary Embolus <70 w/o cc	636	6,502	670	1,430
E01	Heart and Lung Transplant	4	8	25,472	27,132
E02	Heart Transplant	79	52	12,803	31,198
E03	Cardiac Valve Procedures	6,612	962	8,530	10,213
E04	Coronary Bypass	14,991	2,437	6,359	7,260
E05	Other Cardiothoracic Procedures with Cardiopulmonary Support	4,856	914	3,857	4,991
E06	Other Cardiothoracic Procedures without Cardiopulmonary Supp	812	765	4,276	4,970
E07	Pacemaker Implant for AMI, Heart Failure or Shock	214	733	4,141	3,810
E08	Pacemaker Implant except for AMI, Heart Failure or Shock	9,566	7,037	3,594	4,267
E09	Cardiac Pacemaker Replacement/Revision	5,566	795	2,702	3,200
E10	Other Circulatory Procedures	5,883	3,001	925	2,705
E11	Acute Myocardial Infarction w cc	187	15,835	2,829	2,130
E12	Acute Myocardial Infarction w/o cc	367	61,582	1,985	1,480
E13	Cardiac Catheterisation with Complications	1,419	656	786	3,226
E14	Cardiac Catheterisation without Complications	96,093	15,891	843	2,886

Table 2-A.1: List of HRGs attributable to Circulatory Diseases, activity and unit costs for 2003/04 – continued

HRG code	HRG Description	Activity 2003/04		Unit Costs 2003/04	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
E15	Percutaneous Transluminal Coronary Angioplasty (PTCA)	21,577	13,358	2,826	3,589
E16	Other Percutaneous Cardiac Procedures	7,632	2,357	2,164	2,316
E17	Endocarditis	70	941	2,930	4,648
E18	Heart Failure or Shock >69 or w cc	1,933	44,111	1,843	2,195
E19	Heart Failure or Shock <70 w/o cc	826	9,995	1,324	1,629
E20	Deep Vein Thrombosis >69 or w cc	2,510	11,459	524	1,377
E21	Deep Vein Thrombosis <70 w/o cc	3,900	12,168	397	835
E22	Coronary Atherosclerosis >69 or w cc	895	4,470	2,425	2,362
E23	Coronary Atherosclerosis <70 w/o cc	900	3,351	1,915	1,815
E24	Hypertension >69 or w cc	352	2,745	919	1,389
E25	Hypertension <70 w/o cc	519	3,178	647	838
E26	Congenital or Valvular Disorders >69 or w cc	1,187	4,040	3,166	3,222
E27	Congenital or Valvular Disorders <70 w/o cc	2,116	3,519	2,816	2,353
E28	Cardiac Arrest	50	2,224	1,853	1,351
E29	Arrhythmia or Conduction Disorders >69 or w cc	7,101	49,767	674	1,422
E30	Arrhythmia or Conduction Disorders <70 w/o cc	9,052	36,168	522	686
E31	Syncope or Collapse >69 or w cc	900	47,113	967	1,331
E32	Syncope or Collapse <70 w/o cc	1,082	22,996	553	600
E33	Angina >69 or w cc	817	60,108	2,178	1,219
E34	Angina <70 w/o cc	768	51,828	1,986	925
E35	Chest Pain >69 or w cc	550	51,389	1,055	830
E36	Chest Pain <70 w/o cc	1,228	113,429	741	484
E37	Other Cardiac Diagnoses	2,710	13,812	1,209	1,527
E99	Complex Elderly with a Cardiac Primary Diagnosis	1,063	33,339	2,536	2,711
P25	Cardiac Conditions	434	1,423	1,356	1,378
Q01	Emergency Aortic Surgery	114	1,391	3,620	4,545
Q17	Peripheral Vascular Disease >69 or w cc	3,608	11,056	1,828	2,671
Q18	Peripheral Vascular Disease <70 w/o cc	3,507	4,983	966	1,698

Table 2-A.2: List of HRGs attributed to Circulatory diseases, Survival rate

HRG code	HRG Description	Survival rate 2003/04			
		In-hospital		In-hospital and 30 days post discharge	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
A01	Intracranial Procedures Except Trauma - Category 1	0.9978	0.9576	0.9964	0.952
A02	Intracranial Procedures Except Trauma - Category 2	0.9955	0.9665	0.9901	0.9506
A03	Intracranial Procedures Except Trauma - Category 3	0.9889	0.8549	0.9831	0.8426
A04	Intracranial Procedures Except Trauma - Category 4	0.9861	0.9236	0.9826	0.9129
A05	Intracranial Procedures for Trauma w cc	0.9583	0.8211	0.9583	0.8103
A06	Intracranial Procedures for Trauma w/o cc	0.9877	0.8987	0.9836	0.895
A16	Cerebral Degenerations >69 or w cc	0.9641	0.8984	0.9499	0.8732
A17	Cerebral Degenerations <70 w/o cc	0.9945	0.9565	0.9918	0.9483
A19	Haemorrhagic Cerebrovascular Disorders	0.9268	0.6804	0.9208	0.6665
A20	Transient Ischaemic Attack >69 or w cc	0.9765	0.9886	0.9765	0.9783
A21	Transient Ischaemic Attack <70 w/o cc	1	0.9993	1	0.998
A22	Non-Transient Stroke or Cerebrovascular Accident >69 or w cc	0.8894	0.7913	0.8701	0.7757
A23	Non-Transient Stroke or Cerebrovascular Accident <70 w/o cc	0.9862	0.9315	0.9828	0.928
D10	Pulmonary Embolus >69 or w cc	0.9972	0.9775	0.9916	0.965
D11	Pulmonary Embolus <70 w/o cc	0.9984	0.9952	0.9984	0.9915
E01	Heart and Lung Transplant	0.75	0.875	0.75	0.875
E02	Heart Transplant	0.8734	0.8654	0.8734	0.8462
E03	Cardiac Valve Procedures	0.9599	0.8832	0.9562	0.8822
E04	Coronary Bypass	0.9886	0.9662	0.9866	0.965
E05	Other Cardiothoracic Procedures with Cardiopulmonary Support	0.9924	0.9073	0.9907	0.9018
E06	Other Cardiothoracic Procedures without Cardiopulmonary Support	0.9778	0.8692	0.9753	0.8522
E07	Pacemaker Implant for AMI, Heart Failure or Shock	0.9813	0.665	0.972	0.65
E08	Pacemaker Implant except for AMI, Heart Failure or Shock	0.9983	0.9635	0.9955	0.956
E09	Cardiac Pacemaker Replacement/Revision	0.9986	0.9823	0.995	0.9748
E10	Other Circulatory Procedures	0.9971	0.9442	0.9952	0.9352
E11	Acute Myocardial Infarction w cc	0.7807	0.8042	0.7701	0.7869
E12	Acute Myocardial Infarction w/o cc	0.8823	0.8964	0.8742	0.8876
E13	Cardiac Catheterisation with Complications	0.9979	0.9539	0.9951	0.9494
E14	Cardiac Catheterisation without Complications	0.9993	0.9859	0.9978	0.982

Table 2-A.2: List of HRGs attributed to Circulatory diseases, Survival rate - continued

HRG code	HRG Description	Survival rate 2003/04			
		In-hospital		In-hospital and 30 days post discharge	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
E15	Percutaneous Transluminal Coronary Angioplasty (PTCA)	0.9984	0.9847	0.9965	0.9809
E16	Other Percutaneous Cardiac Procedures	0.999	0.9592	0.998	0.9486
E17	Endocarditis	0.9709	0.8851	0.9709	0.8745
E18	Heart Failure or Shock >69 or w cc	0.9094	0.8484	0.8945	0.8281
E19	Heart Failure or Shock <70 w/o cc	0.9782	0.9261	0.9709	0.9147
E20	Deep Vein Thrombosis >69 or w cc	0.9984	0.9816	0.9956	0.9658
E21	Deep Vein Thrombosis <70 w/o cc	0.9997	0.9983	0.9995	0.9953
E22	Coronary Atherosclerosis >69 or w cc	0.9754	0.7976	0.9709	0.7866
E23	Coronary Atherosclerosis <70 w/o cc	0.9956	0.9707	0.9933	0.9689
E24	Hypertension >69 or w cc	0.9915	0.9428	0.9886	0.9307
E25	Hypertension <70 w/o cc	1	0.9934	0.9981	0.9918
E26	Congenital or Valvular Disorders >69 or w cc	0.9815	0.911	0.9739	0.8962
E27	Congenital or Valvular Disorders <70 w/o cc	0.9934	0.9701	0.9924	0.9616
E28	Cardiac Arrest	0.38	0.3068	0.34	0.2897
E29	Arrhythmia or Conduction Disorders >69 or w cc	0.997	0.971	0.9934	0.9611
E30	Arrhythmia or Conduction Disorders <70 w/o cc	1	0.9968	0.9993	0.9951
E31	Syncope or Collapse >69 or w cc	0.9866	0.9642	0.9733	0.952
E32	Syncope or Collapse <70 w/o cc	1	0.9953	0.9972	0.9927
E33	Angina >69 or w cc	0.9755	0.9837	0.9706	0.9766
E34	Angina <70 w/o cc	0.9974	0.9979	0.9961	0.9964
E35	Chest Pain >69 or w cc	0.9927	0.9887	0.9891	0.9814
E36	Chest Pain <70 w/o cc	1	0.9991	0.9976	0.9979
E37	Other Cardiac Diagnoses	0.9834	0.9337	0.979	0.9222
E99	Complex Elderly with a Cardiac Primary Diagnosis	0.8775	0.7341	0.8578	0.7084
P25	Cardiac Conditions	0.9977	0.9824	0.9977	0.9789
Q01	Emergency Aortic Surgery	0.8509	0.6125	0.8421	0.6089
Q17	Peripheral Vascular Disease >69 or w cc	0.9745	0.7951	0.9692	0.7616
Q18	Peripheral Vascular Disease <70 w/o cc	0.998	0.9712	0.9963	0.9652

Appendix 2-B

2-B.1 Sensitivity analysis for CABG and PTCA only.

We present the four different cases considered in our sensitivity analysis, including the one shown in Section 6.2. The differences across the various estimates rest in different values attributed to both the before and after treatment health outcomes of non-elective patients, as shown in the Table below.

Case 1 (seen in Section 6.2) assumes that the value of before treatment health outcome measures for no-elective patients is equal to half the value of the corresponding elective counterparts. The post-operative health outcomes for non-electives are set equal to the respective electives ones.

In Case 2, we make the same assumption as in Case 1 for non-elective pre-treatment health outcomes, but assume that the post-operative health outcomes for CABG and PTCA are the same and are equal to half the average value of their elective counterparts.

Case 3 assumes that both the before and after treatment health outcomes for non-elective procedures are equal to half their elective counterparts as follows.

In Case 4, we assume that the before treatment health outcomes for non-elective CABG and PTCA procedures are equal to half the average value of the elective before treatment health outcomes; whilst the post-operative health outcomes are equal to half the value of their elective counterparts.

Table 2-B.1: Sensitivity analysis for pre- and post-treatment health status for CABG and PTCA

	Health Status	
	Pre-treatment	**Post-treatment**
Case 1	$h^0_{CABG,non-elective} = 1/2 * h^0_{CABG,elective}$ $h^0_{PTCA,non-elective} = 1/2 * h^0_{PTCA,elective}$	$h^*_{CABG,non-elective} = h^*_{CABG,elective}$ $h^*_{PTCA,non-elective} = h^*_{PTCA,elective}$
Case 2	As Case 1	$h^*_{CABG,non-elective} = h^*_{PTCA,non-elective} =$ $1/2 * Mean(h^*_{CABG,elective}; h^*_{PTCA,elective})$
Case 3	As Case 1	$h^*_{CABG,non-elective} = 1/2 * h^*_{CABG,elective}$ $h^*_{PTCA,non-elective} = 1/2 * h^*_{PTCA,elective}$
Case 4	$h^0_{CABG,non-elective} = h^0_{PTCA,non-elective} =$ $1/2 * Mean(h^0_{CABG,elective}; h^0_{PTCA,elective})$	As Case 3

Results of the CWOIs are shown in the Table below.

Table 2-B.2: Results for CWOIs using different values for before and after treatment health outcome

Year	CWOI with survival and health effect - Case 1	CWOI with survival and health effect - Case 2	CWOI with survival and health effect - Case 3	CWOI with survival and health effect - Case 4
1998/99 - 1999/00	-0.47%	-0.62%	-0.63%	-0.65%
1999/00 - 2000/01	5.86%	6.39%	6.38%	6.40%
2000/01 - 2001/02	7.14%	7.17%	7.14%	7.10%
2001/02 - 2002/03	15.81%	16.29%	16.33%	16.38%
2002/03 - 2003/04	5.58%	5.84%	5.85%	5.87%
Average growth	6.79%	7.01%	7.01%	7.02%

2-B.2 Sensitivity analysis for all HRGs of circulatory diseases.

The first set of sensitivity analyses assumed a common value of k for both electives and non-electives HRGs of circulatory diseases. The value for CABG and PTCA procedures for elective activity is equal to the values of the before and after health outcome, whereas those for non-elective activity for these two procedures are the same as set out in Case 1 in Appendix 2-B.1. The results (see Table 2-B.2) show that on average, cost weighted output growth for hospital treatment of all circulatory diseases has increased by 4.49 per cent per annum when $k_{elective} = k_{non\text{-}elective} = 0.9$ (Case C), by 4.94 per cent per annum when $k_{elective} = k_{non\text{-}elective}$ k = 0.8 (Case A), and 5.24 per cent per annum when $k_{elective} = k_{non\text{-}elective} = 0.7$ (Case B). The results show some sensitivity of the output growth measures to the value of k.

Table 2-B.3: Results for CWOIs using different values for before and after treatment health outcome

Year	CWOI with 30 day post discharge and health effect - Case A	CWOI with 30 day post discharge and health effect - Case B	CWOI with 30 day post discharge and health effect - Case C
1998/99 - 1999/00	0.83%	0.84%	1.38%
1999/00 - 2000/01	3.56%	3.71%	3.33%
2000/01 - 2001/02	3.65%	3.79%	3.42%
2001/02 - 2002/03	9.63%	10.32%	8.38%
2002/03 - 2003/04	7.06%	7.53%	5.93%
Average growth	**4.94%**	**5.24%**	**4.49%**

Estimates of the cost weighted output growth indices using different values for the before and after health outcomes measures are shown in Table 2-B.3. The first column (Case A) presents results for the combination $k_{elective} = 0.8$ and $k_{non\text{-}elective} = 0.4$. In Case B and Case C 3, we have changed the value of $k_{non\text{-}elective}$ only, setting it equal to 0.35 and 0.45 respectively. Results show that output growth indices are slightly sensitive to the choice of the value of the health outcome for non-elective HRGs.

Table 2-B.4: Results for CWOIs using different values for before and after treatment health outcome

Year	CWOI with 30 day post discharge and health effect - Case A 1	CWOI with 30 day post discharge and health effect - Case A 2	CWOI with 30 day post discharge and health effect - Case A 3
1998/99 - 1999/00	0.25%	0.58%	-0.12%
1999/00 - 2000/01	3.86%	3.74%	3.99%
2000/01 - 2001/02	3.72%	3.85%	3.89%
2001/02 - 2002/03	11.16%	10.50%	12.23%
2002/03 - 2003/04	6.96%	6.77%	7.19%
Average growth	**5.19%**	**5.09%**	**5.44%**

The sensitivity analysis carried out show that cost weighted output growth measures are sensitive to different values of the health outcomes. The routinely collection of data on patient reported outcomes has just started to take off in some NHS hospital Trusts. Until these data become publicly available, we will continue using average measures of health effect (k) derived from Castelli *et al.* (2007a).

Appendix 3-A

3-A.1 Inequalities in health: distribution of morbidity by income groups and country

Table 3-A.1: Actual number of individuals reporting ill-health by income group – 1995/96 and 2001/02

Great Britain - 1995/96

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	497	1,186	578
	2	594	1,424	643
	3	397	983	334
	4	382	838	223
Richest	**5**	398	822	182
Total		**2,268**	**5,253**	**1,960**

Great Britain - 2001/02

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	531	1,203	582
	2	537	1,345	604
	3	351	976	324
	4	359	836	242
Richest	**5**	330	732	155
Total		**2,108**	**5,092**	**1,907**

Acute sickness (hstate)

Table 3-A.2: Actual and age-sex standardised percentages of all adults reporting acute sickness (*hstate*) and relative CIs by country – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	21.9	22.3	22.7	24.9	21.9	21.5
	2	26.0	24.2	28.9	22.9	27.4	26.8
	3	17.0	16.9	21.9	23.7	17.7	17.6
	4	17.1	17.5	10.9	12.6	16.7	17.6
Richest	**5**	18.0	19.2	15.6	15.8	16.3	16.5
Concentration Index		***-0.089***	***-0.073***	***-0.149***	***-0.135***	***-0.109***	***-0.099***

Table 3-A.3: Actual and age-sex standardised percentages of all adults reporting acute sickness (*hstate*) and relative CIs by country – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	25.4	27.0	20.9	20.2	27.5	29.7
	2	25.3	22.3	27.6	23.4	23.8	21.9
	3	15.9	16.2	23.1	23.3	18.7	19.3
	4	17.3	18.3	14.2	16.8	17.6	17.8
Richest	**5**	16.1	16.2	14.2	16.3	12.4	11.2
Concentration Index		***-0.108***	***-0.105***	***-0.110***	***-0.059***	***-0.147***	***-0.166***

Table 3-A.4: Actual and age-sex standardised percentages of all adults reporting long-standing illness (*hstatus*) and relative CIs by country – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	22.5	22.2	23.8	24.5	22.9	22.7
	2	27.1	24.1	28.7	23.4	27.6	25.4
	3	18.4	18.5	18.5	19.0	18.6	18.5
	4	15.9	17.2	15.8	18.8	16.0	17.6
Richest	**5**	16.0	17.9	13.2	14.2	14.9	15.9
Concentration Index		***-0.118***	***-0.084***	***-0.157***	***-0.123***	***-0.132***	***-0.108***

Table 3-A.5: Actual and age-sex standardised percentages of all adults reporting long-standing illness (*hstatus*) and relative CIs by country – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	23.7	24.2	21.4	20.8	26.3	27.9
	2	26.2	22.5	26.7	22.2	26.8	24.1
	3	19.0	19.5	22.8	22.9	18.5	19.2
	4	16.4	17.9	15.7	17.7	17.1	18.4
Richest	**5**	14.8	15.9	13.5	16.4	11.4	10.4
Concentration Index		***-0.112***	***-0.087***	***-0.109***	***-0.056***	***-0.160***	***-0.165***

'Not good health' (sah)

Table 3-A.6: Actual and age-sex standardised percentages of all adults reporting 'not good' health (*sah*) and relative CIs by country – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	29.6	30.3	28.6	31.0	29.6	29.4
	2	32.7	28.9	35.3	30.4	31.2	30.0
	3	16.5	16.2	19.3	20.5	19.6	18.8
	4	11.8	12.9	8.4	10.4	10.1	11.5
Richest	**5**	9.4	11.7	8.4	7.7	9.5	10.4
Concentration Index		***-0.265***	***-0.233***	***-0.289***	***-0.286***	***-0.266***	***-0.247***

Table 3-A.7: Actual and age-sex standardised percentages of all adults reporting 'not good' health (*sah*) and relative CIs by country – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand %*	*Actual %*	*Age-sex stand %*	*Actual %*	*Age-sex stand %*
Poorest	**1**	30.6	32.9	28.3	28.4	30.2	31.6
	2	31.3	26.6	33.0	27.9	33.1	30.9
	3	17.5	18.1	19.8	19.8	17.2	17.5
	4	12.4	13.6	8.5	12.3	12.4	13.0
Richest	**5**	8.3	8.7	10.4	11.6	7.1	7.0
Concentration Index		***-0.256***	***-0.247***	***-0.244***	***-0.198***	***-0.270***	***-0.271***

Table 3-A.8: Actual number of individuals reporting ill-health by income group and country – 1995/96

England

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	422	1,014	489
	2	501	1,221	540
	3	327	827	272
	4	329	716	195
Richest	**5**	346	721	156
Total		**1,925**	**4,499**	**1,652**

Wales

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	29	63	34
	2	37	76	42
	3	28	49	23
	4	14	42	10
Richest	**5**	20	35	10
Total		**128**	**265**	**119**

Scotland

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	47	112	56
	2	59	135	59
	3	38	91	37
	4	36	78	19
Richest	**5**	35	73	18
Total		**215**	**489**	**189**

Table 3-A.9: Actual number of individuals reporting ill-health by income group and country – 2001/02

England

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	452	1,038	499
	2	450	1,149	511
	3	283	833	285
	4	309	720	202
Richest	**5**	287	649	135
Total		**1,781**	**4,389**	**1,632**

Wales

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	28	60	30
	2	37	75	35
	3	31	64	21
	4	19	44	9
Richest	**5**	19	38	11
Total		**134**	**281**	**106**

Scotland

Income group		Number of individuals		
		Acute sickness	Long-standing illness (*hstatus*)	'Not good' health
Poorest	**1**	53	111	51
	2	46	113	56
	3	36	78	29
	4	34	72	21
Richest	**5**	24	48	12
Total		**193**	**422**	**169**

Appendix 3-B

3-B.1 Concentration Indices and respective t-statistics for healthcare utilisation by individuals reporting 'not good' health

Table 3-B.1: GP consultations: CI and t-statistics – by country and year

	Concentration Index - 1995/96			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.232	-0.31	-0.241	-0.34
Wales	-0.247	-0.34	-0.287	-0.49
Scotland	-0.300	-0.45	-0.313	-0.50
Great Britain	-0.237	-0.32	-0.249	-0.36

	Concentration Index - 2001/02			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.256	-0.41	-0.252	-0.38
Wales	-0.308	-0.37	-0.288	-0.31
Scotland	-0.245	-0.33	-0.259	-0.38
Great Britain	-0.259	-0.33	-0.256	-0.33

Table 3-B.2: Inpatient stays: CI and t-statistics – by country and year

	Concentration Index - 1995/96			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.196	-0.24	-0.193	-0.23
Wales	-0.296	-0.47	-0.342	-0.63
Scotland	-0.194	-0.22	-0.175	-0.17
Great Britain	-0.193	-0.23	-0.195	-0.23

	Concentration Index - 2001/02			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.201	-0.28	-0.192	-0.22
Wales	-0.244	-0.37	-0.247	-0.43
Scotland	-0.216	-0.37	-0.177	-0.28
Great Britain	-0.212	-0.26	-0.197	-0.24

Table 3-B.3: Outpatient visits: CI and t-statistics – by country and year

	Concentration Index - 1995/96			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.213	-0.26	-0.227	-0.29
Wales	-0.257	-0.48	-0.271	-0.55
Scotland	-0.092	-0.10	-0.160	-0.20
Great Britain	-0.198	-0.25	-0.215	-0.29

	Concentration Index - 2001/02			
	Actual	*t-statistics*	*Age-sex stand.*	t-statistics
England	-0.229	-0.31	-0.204	-0.23
Wales	-0.391	-0.83	-0.365	-0.73
Scotland	-0.208	-0.23	-0.233	-0.30
Great Britain	-0.228	-0.29	-0.206	-0.23

3-B.2 Concentration Curves for healthcare utilisation by individuals reporting 'not good' health

GP consultations

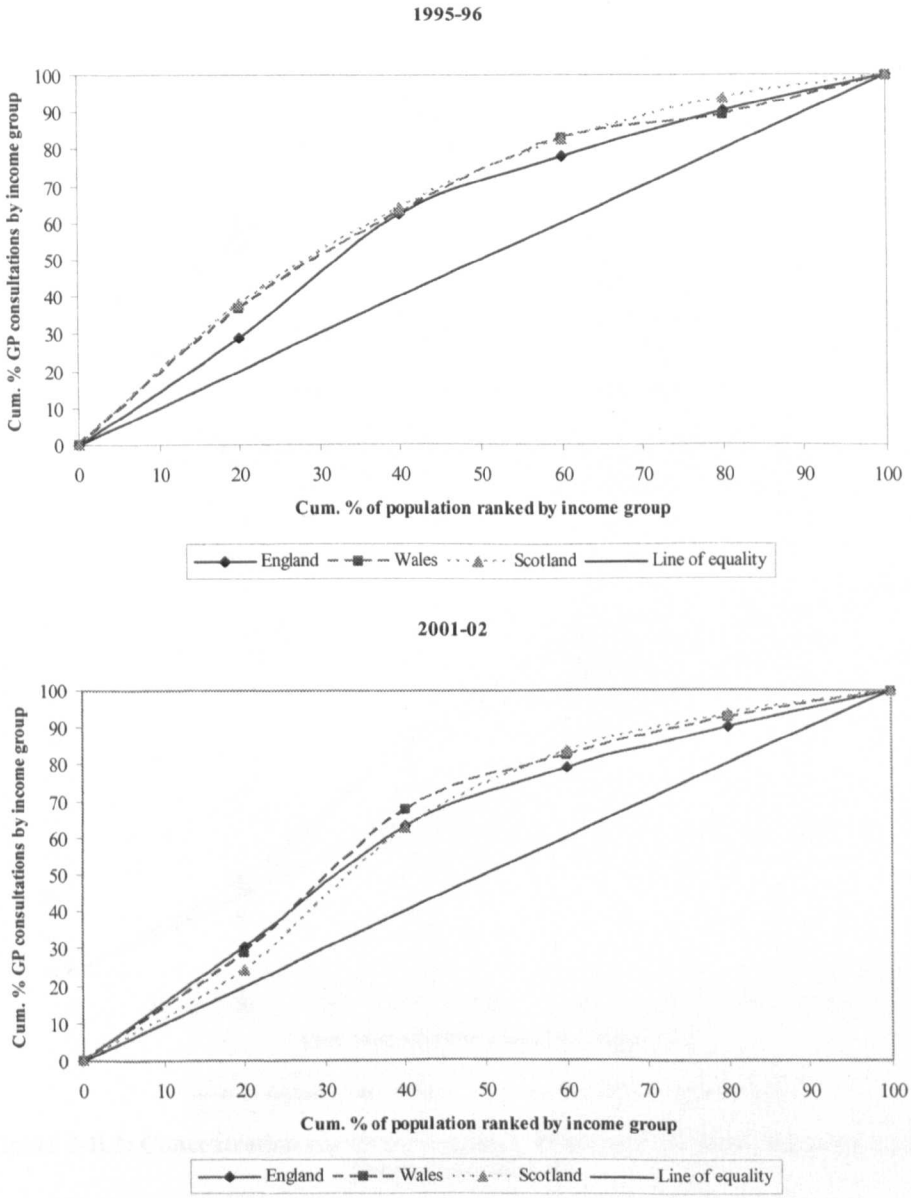


Figure 3-B.1: Concentration curves for England, Wales and Scotland, GP consultations, 1995/96 and 2001/02

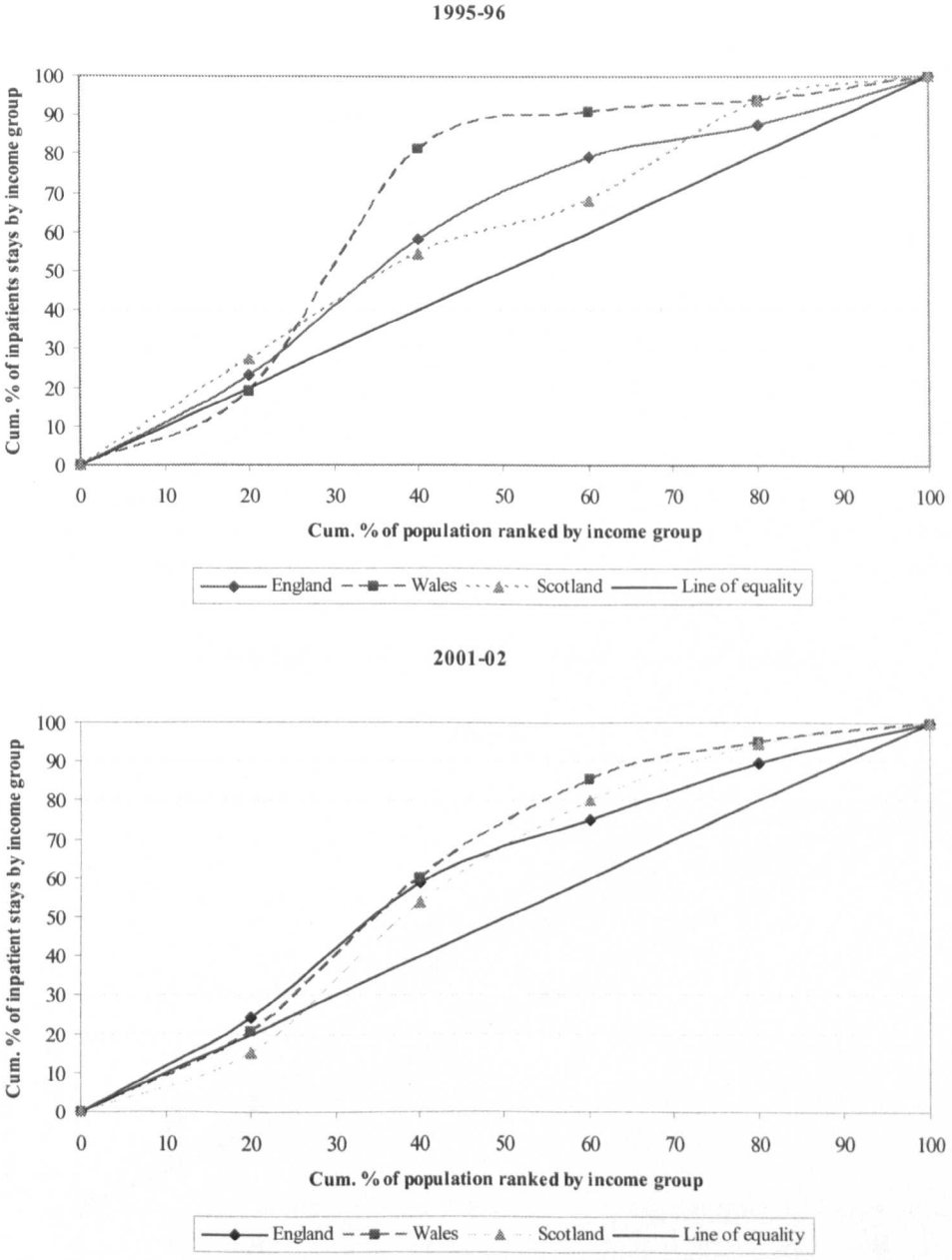


Figure 3-B.2: Concentration curves for England, Wales and Scotland, Inpatient stays, 1995/96 and 2001/02

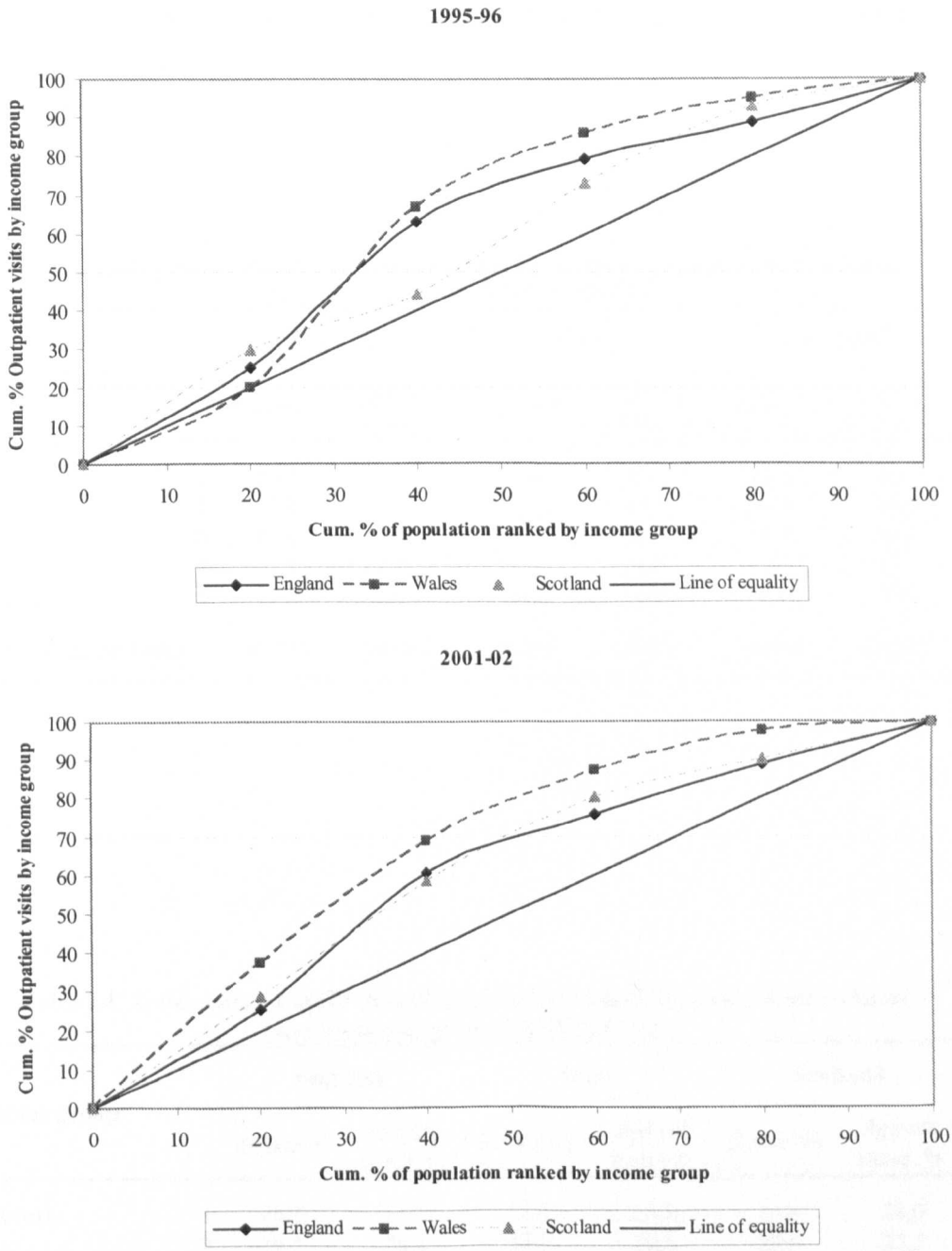


Figure 3-B.3: Concentration curves for England, Wales and Scotland, Outpatient visits, 1995/96 and 2001/02

Appendix 3-C

3-C.1 Distribution of healthcare utilisation by income groups made by individuals reporting acute sickness

GP consultations

Table 3-C.1: Percentages of GP consultations by individuals reporting acute sickness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	20.2	19.7	23.4	25.5	33.6	32.3
	2	25.8	25.4	31.2	24.2	26.0	24.5
	3	19.0	18.8	18.2	19.7	18.5	18.5
	4	17.7	17.7	7.8	9.8	14.4	17.1
Richest	**5**	17.3	18.3	19.5	20.8	7.5	7.6
Concentration Index		***-0.055***	***-0.041***	***-0.125***	***-0.095***	***-0.255***	***-0.227***

Table 3-C.2: Percentages of GP consultations by individuals reporting acute sickness and by income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	26.2	27.2	28.3	28.2	26.8	28.0
	2	29.5	26.8	28.3	29.5	29.5	23.5
	3	16.2	16.4	24.5	24.4	17.0	18.0
	4	15.7	16.9	11.3	10.1	17.9	18.3
Richest	**5**	12.4	12.7	7.5	7.8	8.9	12.3
Concentration Index		***-0.168***	***-0.157***	***-0.236***	***-0.244***	***-0.191***	***-0.149***

Table 3.C.3: Percentages of Inpatient stays by individuals reporting acute sickness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	23.4	21.2	26.8	34.4	27.7	23.6
	2	32.9	31.6	44.6	38.7	31.7	21.2
	3	18.9	17.3	10.7	11.9	12.9	11.2
	4	12.5	14.1	1.8	1.2	23.8	38.8
Richest	**5**	12.3	15.8	16.1	13.7	4.0	5.2
Concentration Index		***-0.171***	***-0.112***	***-0.257***	***-0.315***	***-0.222***	***-0.076***

Table 3.C.4: Percentages of Inpatient stays by individuals reporting acute sickness and by income group – GHS 12001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	24.1	26.3	18.5	17.9	13.8	15.1
	2	38.5	31.0	37.0	33.7	45.0	34.3
	3	12.8	14.1	20.4	20.8	21.3	26.0
	4	13.9	17.2	13.0	15.7	13.8	18.7
Richest	**5**	10.7	11.4	11.1	12.0	6.3	5.9
Concentration Index		***-0.205***	***-0.175***	***-0.156***	***-0.119***	***-0.185***	***-0.136***

Table 3.C.5: Percentages of Outpatient visits by individuals reporting acute sickness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	19.5	17.7	28.2	35.7	26.1	27.2
	2	34.1	37.4	41.1	32.7	9.2	8.7
	3	15.8	14.1	14.7	16.8	32.4	29.0
	4	14.4	13.1	8.0	8.0	27.1	28.5
Richest	**5**	16.2	17.7	8.0	6.8	5.3	6.5
Concentration Index		***-0.106***	***-0.096***	***-0.294***	***-0.329***	***-0.095***	***-0.087***

Table 3.C.6: Percentages of Outpatient visits by individuals reporting acute sickness and by income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	21.7	25.7	19.9	17.9	21.0	26.0
	2	42.1	30.9	47.7	47.1	37.3	29.3
	3	12.6	14.3	25.2	24.1	16.5	20.6
	4	12.5	15.0	6.0	9.1	6.5	7.2
Richest	**5**	11.1	14.2	1.3	1.8	18.7	16.9
Concentration Index		***-0.203***	***-0.155***	***-0.315***	***-0.286***	***-0.142***	***-0.161***

3-C.2 Distribution of healthcare utilisation by income groups made by individuals reporting longstanding illness

GP consultations

Table 3-C.7: Percentages of GP consultations by individuals reporting along-standing illness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	24.8	24.9	27.7	29.9	30.2	29.7
	2	28.2	26.4	25.7	22.0	29.6	29.6
	3	18.0	18.3	16.8	17.3	17.3	16.7
	4	15.3	16.3	13.9	16.0	15.6	18.3
Richest	**5**	13.7	14.1	15.8	14.8	7.3	5.7
Concentration Index		***-0.140***	***-0.127***	***-0.142***	***-0.144***	***-0.239***	***-0.237***

Table 3-C.8: Percentages of GP consultations by individuals reporting long-standing illnesss and by income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	28.3	28.2	23.8	22.5	30.3	28.2
	2	27.5	27.0	25.0	26.1	32.4	35.8
	3	18.1	17.6	26.3	25.1	16.9	16.9
	4	13.6	14.0	12.5	12.5	12.0	11.2
Richest	**5**	12.4	13.1	12.5	13.8	8.5	7.8
Concentration Index		***-0.184***	***-0.175***	***-0.142***	***-0.126***	***-0.258***	***-0.264***

Table 3-C.9: Percentages of Inpatient stays by individuals reporting along-standing illness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	24.6	23.5	27.8	36.1	26.5	24.8
	2	32.0	31.2	43.0	38.8	33.8	28.1
	3	20.7	20.3	11.4	11.5	11.8	10.5
	4	12.2	12.6	7.6	6.3	21.3	30.5
Richest	**5**	10.5	12.5	10.1	7.3	6.6	6.1
Concentration Index		***-0.192***	***-0.163***	***-0.283***	***-0.360***	***-0.209***	***-0.140***

Table 3-C.10: Percentages of Inpatient stays by individuals reporting long-standing illnesss and by income group – GHS 2001/02

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	25.3	24.3	17.5	17.7	15.5	14.2
	2	32.7	32.9	38.6	39.3	37.9	35.8
	3	15.7	15.6	22.8	23.0	23.3	23.8
	4	14.5	16.0	14.0	12.4	14.7	16.0
Richest	**5**	11.8	11.3	7.0	7.5	8.6	10.2
Concentration Index		***-0.180***	***-0.172***	***-0.182***	***-0.189***	***-0.148***	***-0.111***

Table 3-C.11: Percentages of Outpatient visits by individuals reporting along-standing illness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	23.0	21.8	17.8	19.8	21.4	25.5
	2	34.5	36.5	36.4	30.6	16.5	18.0
	3	16.7	15.7	18.2	19.2	27.2	24.6
	4	13.1	12.2	20.5	25.0	22.9	21.3
Richest	**5**	12.7	13.8	7.1	5.5	11.9	10.6
Concentration Index		***-0.168***	***-0.162***	***-0.149***	***-0.136***	***-0.051***	***-0.106***

Table 3-C.12: Percentages of Outpatient visits by individuals reporting along-standing illness and by income group – GHS 1995/96

Income group		England		Wales		Scotland	
		Actual %	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*	*Actual %*	*Age-sex stand. %*
Poorest	**1**	24.1	24.3	29.0	26.8	22.1	23.4
	2	31.5	31.2	37.0	37.7	30.3	30.0
	3	16.3	16.4	23.5	22.0	17.3	17.6
	4	16.2	16.2	7.0	9.7	16.8	17.3
Richest	**5**	11.8	11.9	3.5	3.7	13.5	11.7
Concentration Index		***-0.160***	***-0.159***	***-0.324***	***-0.297***	***-0.123***	***-0.144***

3-C.3 Concentration Curves for healthcare utilisation by individuals reporting acute sickness

GP consultations

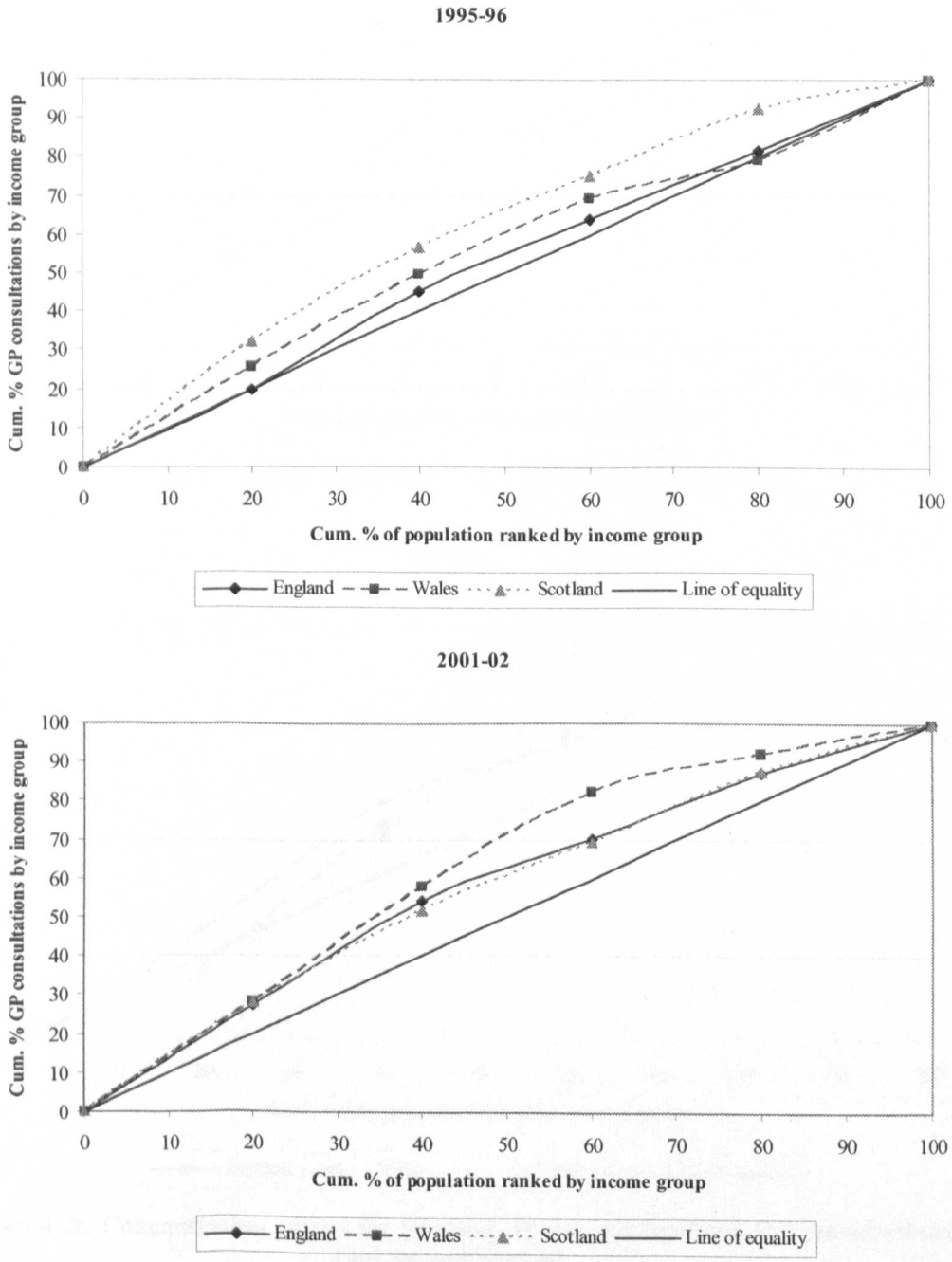
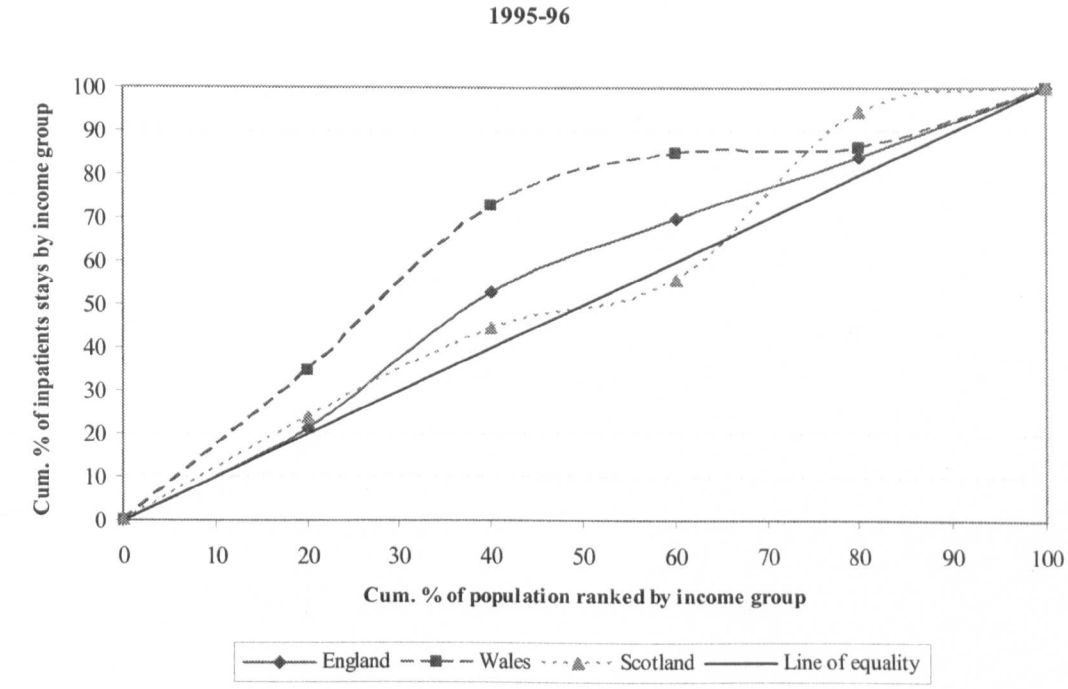


Figure 3-C.1: Concentration curves for England, Wales and Scotland, GP consultations, 1995/96 and 2001/02

Inpatient stays



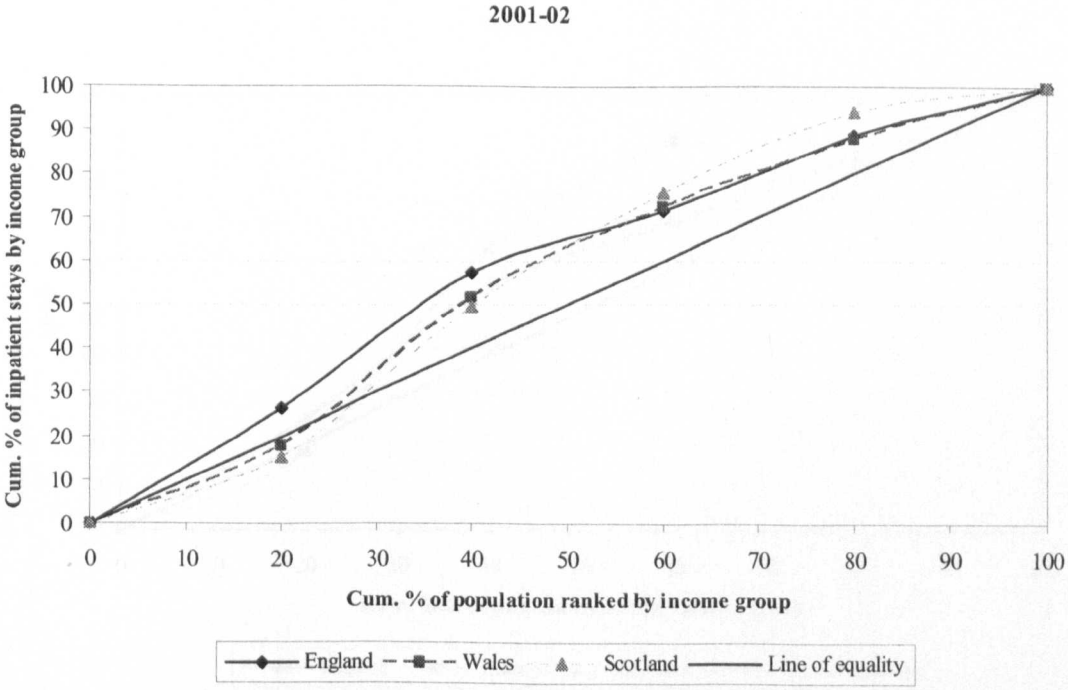


Figure 3-C.2: Concentration curves for England, Wales and Scotland, GP consultations, 1995/96 and 2001/02

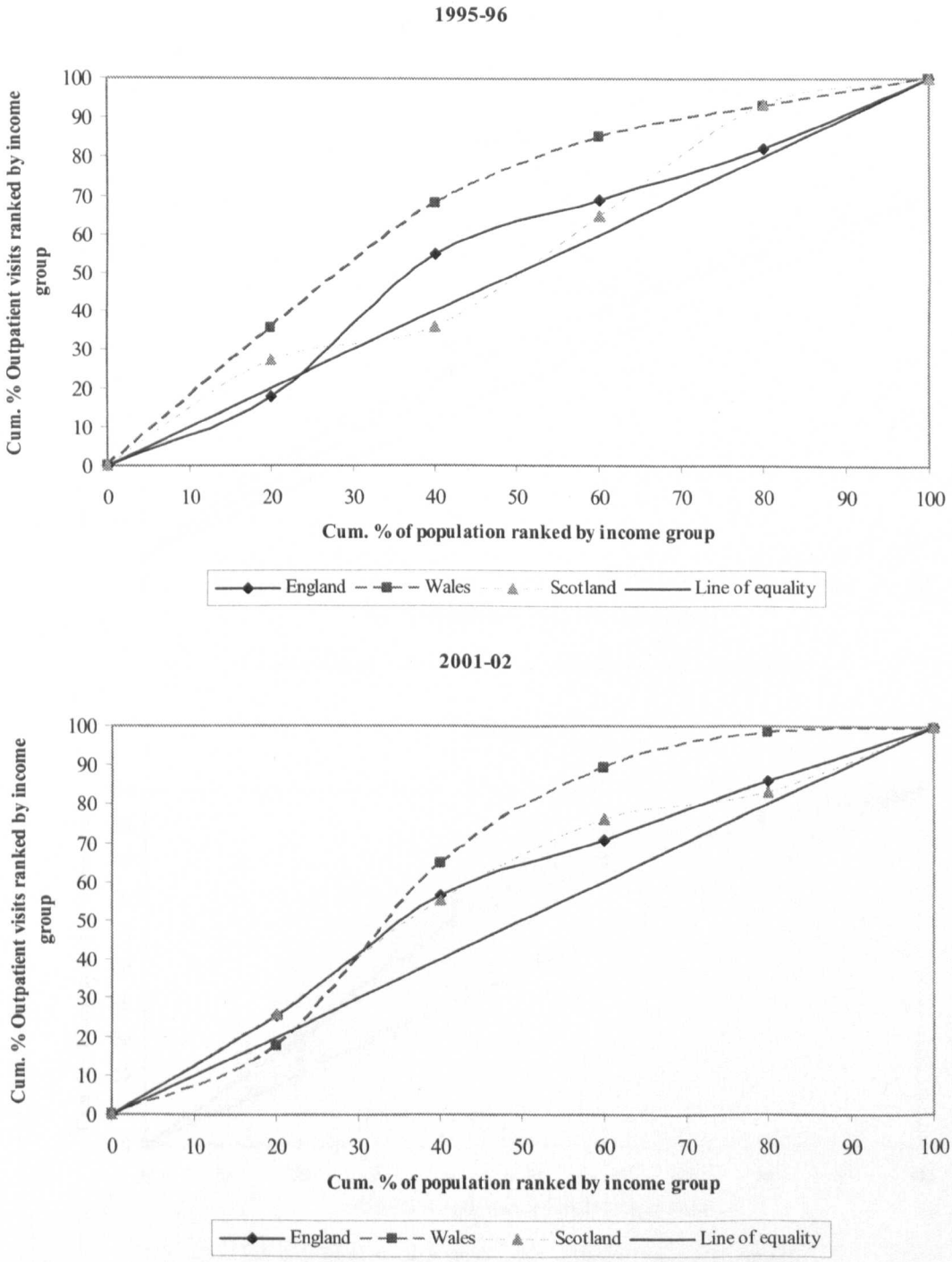


Figure 3-C.3: Concentration curves for England, Wales and Scotland, Outpatient visits, 1995/96 and 2001/02

3-C.4 Concentration Curves for healthcare utilisation by individuals reporting long-standing illness

GP consultations

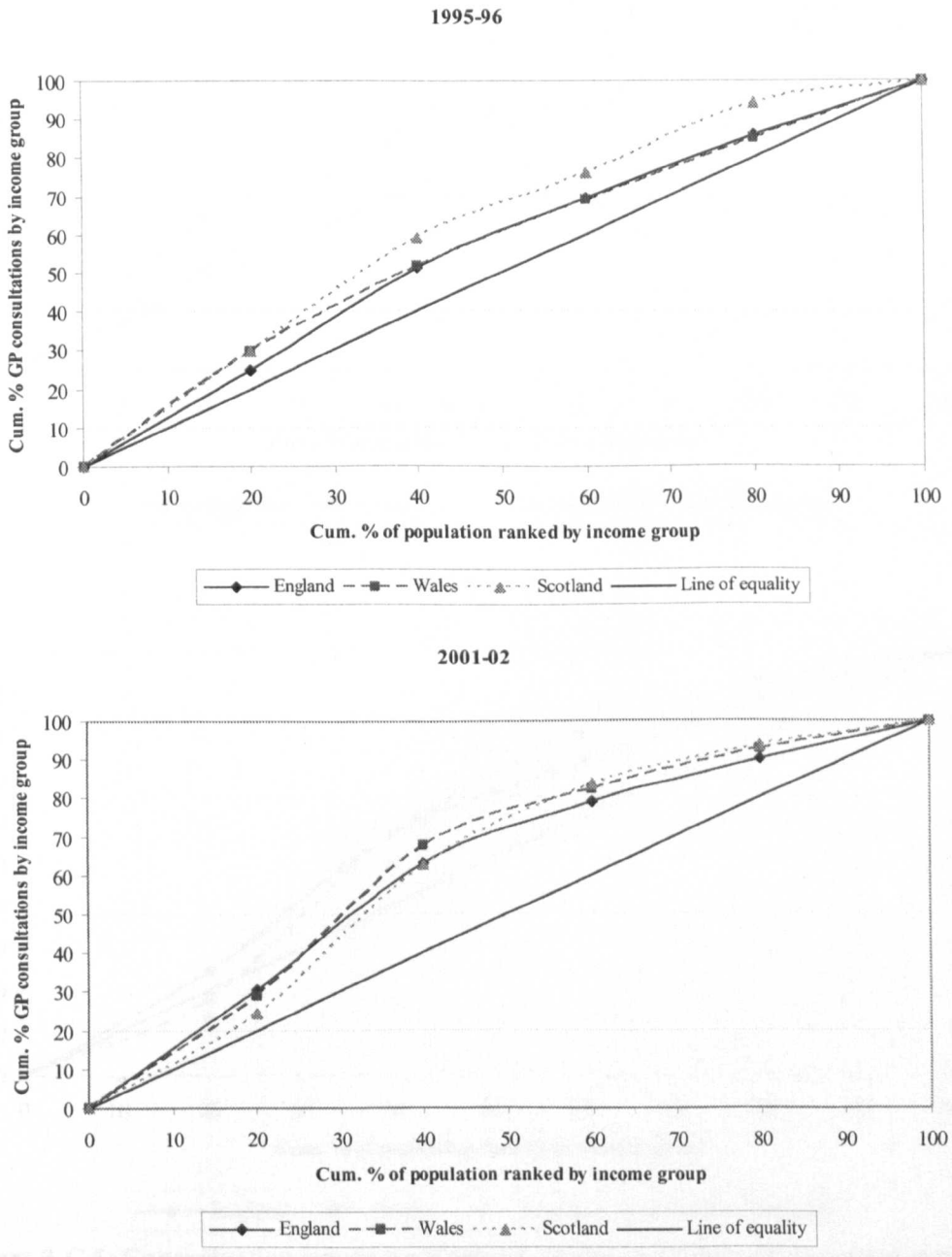
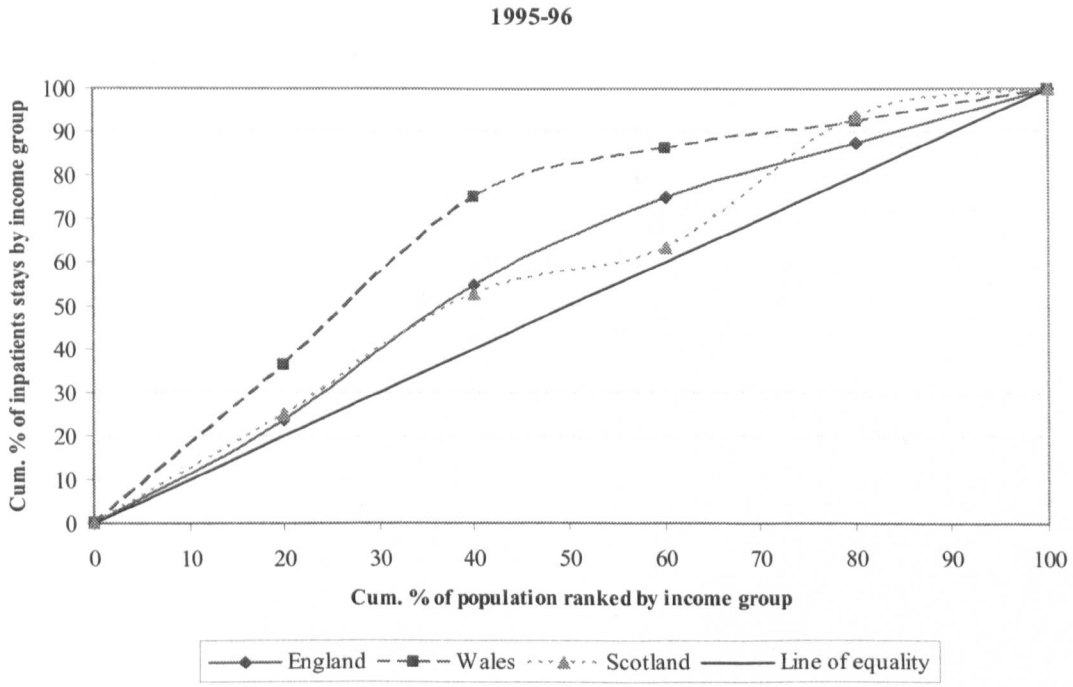


Figure 3-C.4: Concentration curves for England, Wales and Scotland, GP consultations, 1995/96 and 2001/02



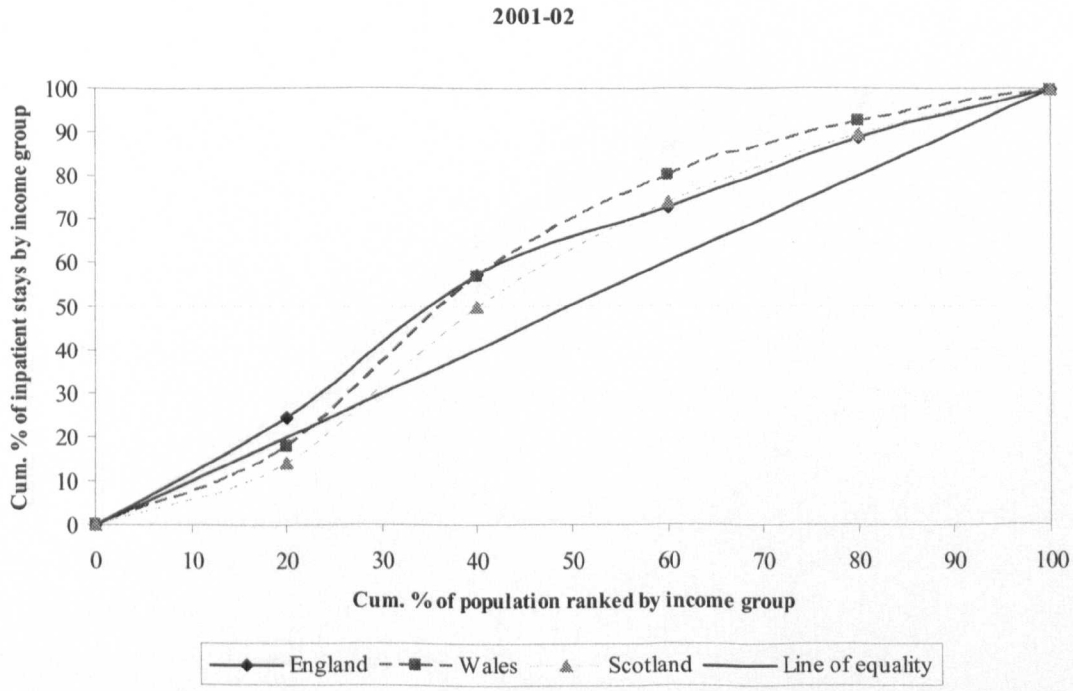


Figure 3-C.5: Concentration curves for England, Wales and Scotland, Inpatient stays, 1995/96 and 2001/02

Outpatient visits

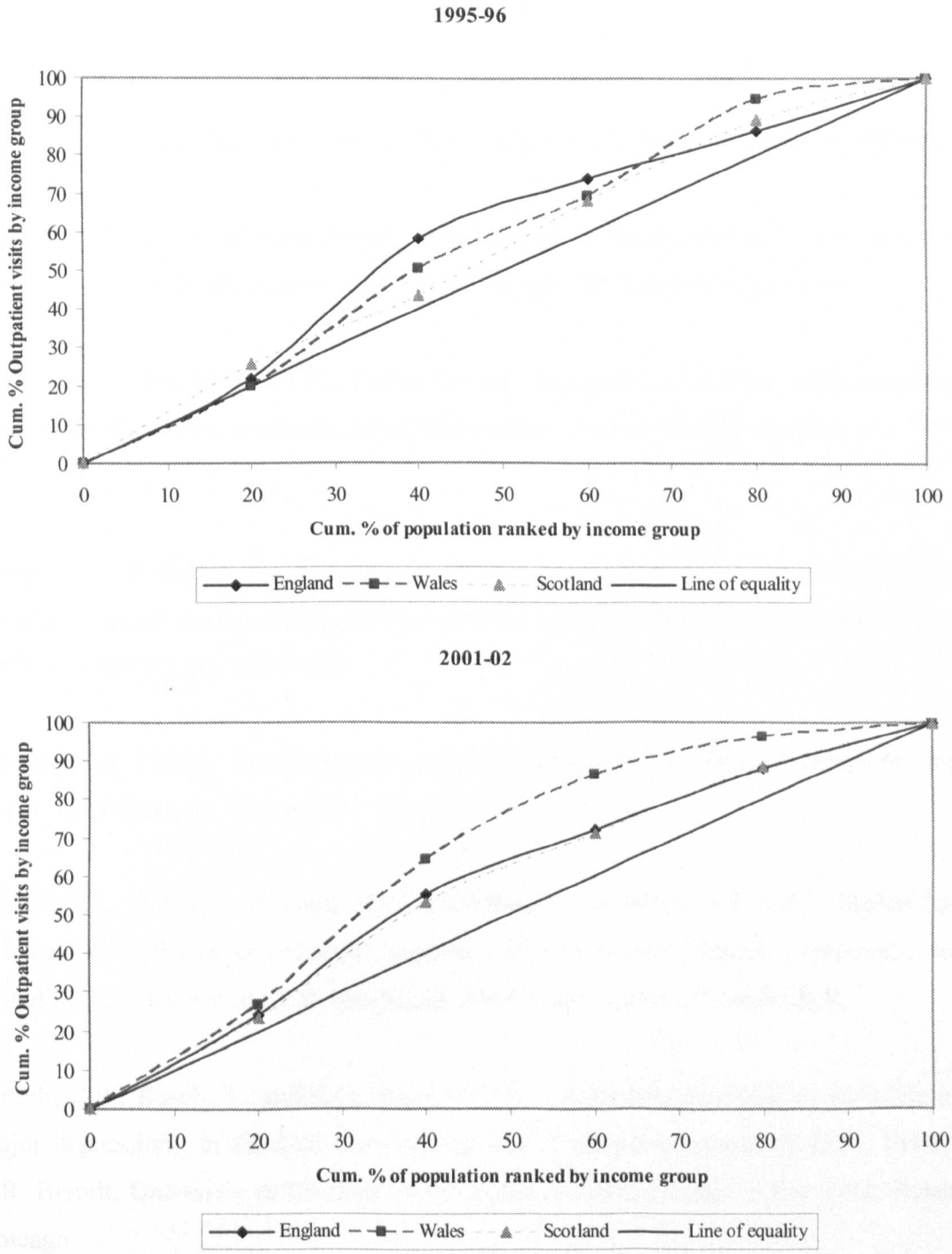


Figure 3-C.6: Concentration curves for England, Wales and Scotland, Outpatient visits, 1995/96 and 2001/02

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