Oxera

Tax-advantaged employee share schemes: analysis of productivity effects

Report 1: Productivity measured using turnover

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Executive summary

Background and objectives of the study
Oxera was commissioned by HM Revenue & Customs (formerly the Inland Revenue) to examine the impact of tax-advantaged share schemes on UK company performance (whereby companies reward their employees by granting them shares, or share options, as part of their remuneration package).

Such employee share schemes are a subject of public policy concern—in particular, is the cost of these schemes warranted in terms of the benefits to the economy? On the one hand, tax-advantaged share schemes are costly to the government—the cost of the schemes to the Exchequer was estimated at around £800m per annum in tax and National Insurance relief in 2002/03.[1] On the other hand, such incentives are currently deemed to be warranted because share schemes are associated with increased productivity and employment in the firms concerned.

This report presents new empirical research into employee share schemes in the UK, drawing on HM Revenue & Customs' own administrative data on share schemes. This data has been matched with financial information, providing a rich dataset of thousands of companies over a ten-year period, thus facilitating a quantitative and methodologically sound assessment of these schemes. The empirical research focuses on the following tax-advantaged share schemes:

– Approved Profit Sharing (APS);
– Save As You Earn (SAYE);
– Company/Discretionary Share Option Plan (CSOP/DSOP).

In particular, the research addresses the following questions:

– what are the characteristics of companies that operate these tax-advantaged employee share schemes in the UK?
– what is the impact of these tax-advantaged schemes on companies' productivity performance?

Comparisons with previous studies
While there is already a considerable body of empirical evidence linking employee share ownership to improvements in productivity, these studies differ from the new research in a number of respects, and this study highlights new insights concerning this issue. However, before turning to the results and the potential policy implications, it is worth bearing in mind some of the limitations of the present study (some, or all, of which also affect previous studies).

– Due to the dataset used, the impact of wider profit-sharing schemes (and other employee participation/workplace relations factors) cannot be fully examined and this may lead to the estimated effect of share schemes being biased.

– Again, due to the dataset used, many important firm/employee characteristics are not available for this study (such as scheme design and whether other organisational changes occurred at the same time as the scheme introduction). These characteristics may be related to the existence of share schemes in the workplace. Because these

[1] Source: HM Revenue & Customs.

cannot be included in the model, the estimated effect of share schemes may be biased since it may also capture the effect of these characteristics.

– One important variable—the extent of employee participation in the tax-advantaged share schemes—could not be included in the analysis due to the raw data being a flow[2] and some inconsistency in definition. As such, the analysis focuses on whether a firm has a particular tax-advantaged share scheme (represented by a simple dummy variable which takes the value of 0 or 1), and not on the amount of employee participation in the schemes, which may represent a more accurate measure of such participation. For example, one firm may have almost all employees participating in a tax-advantaged share scheme, while another firm may have only a few employees participating. If tax-advantaged share schemes have an impact on firm performance, the impact might be expected to be stronger in the former case; however, this difference is not examined in this study. The examined relationship between share schemes and company performance is therefore somewhat simplified in this study, with the impact of any variation in participation across firms averaged out.

– The sample of firms in this study may represent an issue since the dataset used in the analysis is almost exclusively based on surviving companies. If surviving companies differ in their overall characteristics from bankrupt companies, the estimated impact of the scheme may be biased. As a result, it may not be valid to draw conclusions about the effect of share schemes for the population as a whole since results are derived using part of the potentially non-representative population of surviving companies.[3]

It is not possible to state whether the biases discussed above result in the *estimated* effects of share schemes (discussed below) being lower or higher than their *actual* effects.

At the same time, however, this study has significant advantages compared with much of the previous UK work in this area.

– HM Revenue & Customs data used in this study is unique in that the analysis can examine the potentially differential effects of the various tax-advantaged schemes and those share schemes that are not tax-advantaged.[4]

– By merging the HM Revenue & Customs dataset with information from the FAME (Financial Analysis Made Easy) database, the complete dataset contains information on all companies that are listed on a UK stock market, plus a large number of unlisted companies, thus providing the possibility for some generalisations (other UK studies are often restricted to manufacturing or listed companies).

– Unlike studies based on survey data, this study has actual performance data rather than subjective performance measures, which have been found to over-report the effects.

– The use of panel data means that the dynamics of the effects of share schemes can be examined (although the length of the time series is relatively short).

– Panel data enables the use of more robust estimation techniques—in particular, this allows unobservable firm effects to be accounted for. [5]

[2] In other words, in any given year, the data reports only the number of employees who were granted *new* or *additional* shares/ share options, rather than the *total* number of employees participating in schemes.

[3] For example, if, on average, the productivity impact of schemes were higher in surviving companies, focusing the analysis only on these companies (rather than a representative sample of the population) would lead to an overestimate of the productivity effect of share schemes.

[4] Schemes that companies set up legitimately to remunerate their employees with shares, but that do not provide any tax advantages. There are also some schemes that are set up specifically to avoid tax/National Insurance Contributions. There is specific legislation in place to prevent this abuse.

Initial findings

The first stage of the analysis was to examine the data in order to provide a preliminary indication of some of the relationships. This descriptive analysis indicated the following.

– Larger companies, as measured by number of employees (but also turnover and amount of capital employed) are more likely to operate schemes. Large companies are also more likely to operate multiple schemes.

– Analysis of schemes by industry sector reveals that around 80% of all share schemes are concentrated in four sectors.[6] When taking into account the total size of each industry, companies belonging to the electricity, gas and water supply, mining and quarrying, financial intermediation, and manufacturing sectors are shown to be most likely to operate a share scheme.

– Companies in any industry are more likely to operate a discretionary CSOP scheme than either a SAYE or APS all-employee scheme.

– On average, across all industries and years examined, 36% of companies with schemes are listed. The number companies with a scheme that are listed has increased over time to almost 50% in 2001/2002. Between 38% (mining and quarrying) and 74% (manufacturing) of all listed companies across industries operate a share scheme.

– Companies in the electricity, gas and water sector are most likely to operate any type of share scheme. When focusing the analysis on listed companies, the sector in which companies are most likely to operate a share scheme is manufacturing (74%).

– Listed companies with schemes tend to have the same or higher levels of productivity (capital or labour) and profitability as listed companies without schemes.[7]

– Additional modelling shows that companies are more likely to operate schemes the more capital-intensive they are. The analysis also indicates that companies are more likely to have share schemes under favourable economic conditions.

Key findings

However, this only paints a partial picture and more complex analysis (namely econometric modelling) is required to examine the impact of share schemes, controlling for other factors. This econometric analysis therefore provides a more definitive assessment of share schemes and their impact. Using dynamic panel data modelling, Oxera identified the following key points at the aggregate level (ie, across all firms).

– On average, across the whole sample, the effect of tax-advantaged share schemes is significant and increases productivity by 2.5% in the long run.

– However, when the schemes are analysed on a disaggregated basis, there is a 4.1% long-run improvement in performance for companies using SAYE schemes, but no significant improvement for CSOP or APS schemes.

– Critically, there are further benefits to be gained from operating several types of scheme—when companies have both CSOP and SAYE schemes, productivity increases by 4.4% (ie, a greater increase than the effect of operating only SAYE).

[5] To the extent that they are constant over time (eg, other employee participation/workplace relations factors).

[6] Manufacturing; real estate, renting and business activities; wholesale and retail trade; and financial intermediation.

[7] The statistical measure employed is the median or midpoint of the partial (labour and capital) productivity and profitability series (over time or by industry). Due to the considerable variation of firms in the sample, the median provides a more accurate picture of the underlying differences in these variables than the arithmetic mean, which tends to be influenced by extreme observations.

The literature suggests that the impact of financial participation schemes varies according to employee and firm characteristics. For example, the impact of tax-advantaged share schemes may be linked to other performance management schemes, structures, and incentives within a firm, such that the adoption of tax-advantaged share schemes only may not be sufficient to improve performance. Similarly, improvements in productivity are more likely if the nature of the firm's activity implies that, when incentivised, employees can have a significant effect on output. The impact may also be greater for larger firms as human resource managers in these firms may be more experienced in employee relations and thus better placed to coordinate profit sharing with other policies; furthermore, the cost per worker of implementing a scheme is likely to be lower for larger firms.

Thus, the impact of share schemes was examined for different types of firm and the question of whether firms operate other financial participation schemes (as far as such additional information was available) was investigated. The four key results from this analysis were as follows.

– Listed companies show a 4.9% long-run improvement in productivity if they have tax-advantaged share schemes; unlisted companies show no significant improvement. However, this improved productivity may be due not only to the potentially greater incentive properties of schemes in listed companies, but also to the likely higher degree of participation in these schemes. The HM Revenue & Customs dataset does not provide information on the total number of employees with schemes in any one year. It is therefore not possible to distinguish the productivity effects due to potential greater incentive effects in listed companies from those arising from greater employee participation in schemes. Given suitable data, an important area of further research would be to establish whether the observed improvement in productivity for listed companies is attributable to the higher degree of employee participation or the greater incentive properties in listed companies.

– Tax-advantaged share schemes on their own do not appear to be sufficient to improve performance—companies that have a tax-advantaged scheme only do not appear to have significantly higher productivity. However, if companies have share schemes that are not tax-advantaged (at any point in time) *and* a tax-advantaged share scheme, their productivity increases by around 5.2% in the long run.

– When disaggregated by industry, productivity significantly increases by 5% for manufacturing, 24% for electricity, gas and water, and by 11% for financial intermediation when companies have tax-advantaged share schemes.

– The effect of a tax-advantaged share scheme increases as company size increases, with firms only in the upper quartile (ie, turnover greater than £36.3m) experiencing a statistically significant productivity effect.

These results indicate that the tax advantages of these share schemes are not sufficient on their own to increase company productivity. For tax-advantaged schemes to be effective in increasing productivity, other factors such as schemes that are not tax-advantaged, particular company size, and being a listed company are required for a significant productivity effect to be identified.

Table 1 summarises these results.

Table 1 Results from dynamic production functions

	Productivity effect (%)	Significance at 5%
Any tax-advantaged scheme	2.5	Yes
SAYE	4.1	Yes
APS	0.9	No
CSOP	1.6	No
Combinations of tax-advantaged schemes		
APS and CSOP	–3.3	No
APS and SAYE	–0.3	No
CSOP and SAYE	4.4	Yes
Listed companies with a scheme	4.9	Yes
Unlisted companies with a scheme	1.9	No
Any tax-advantaged scheme by turnover quartile		
Quartile 1 (less than £3.4m)	1.6	No
Quartile 2 (£3.4m to £11.2m)	1.1	No
Quartile 3 (£11.2m to £36.3m)	1.4	No
Quartile 4 (greater than £36.3m)	3.3	Yes
Companies with tax-advantaged schemes only	–1.9	No
Companies with tax-advantaged and non-tax-advantaged schemes	5.2	Yes
Industries where the effect is greatest		
Electricity, gas and water	23.7	Yes
Financial intermediation	11.1	Yes
Manufacturing	4.8	Yes

Source: Oxera analysis.

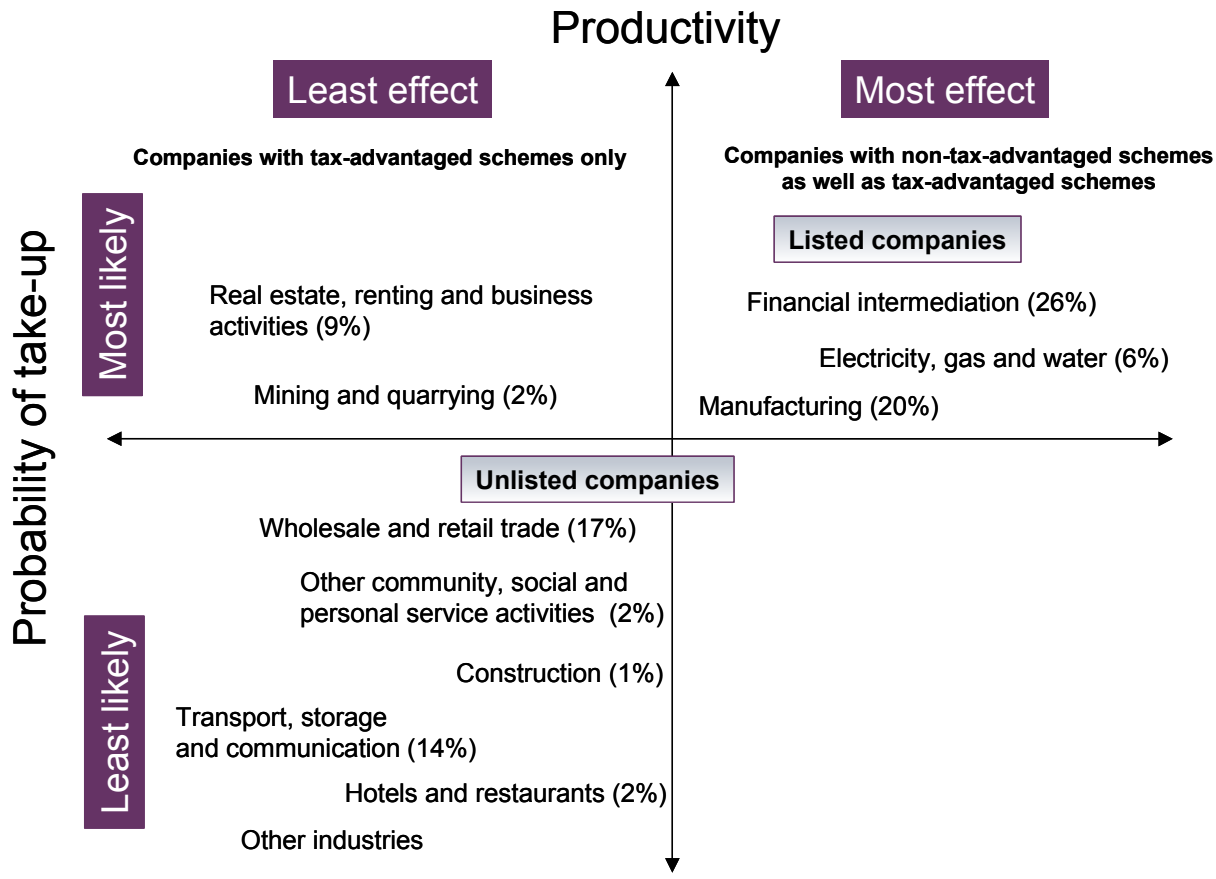
Comparisons with UK studies that provide specific estimates of the effect of schemes are mixed. Conyon and Freeman (2004) find a positive impact for listed companies from APS and CSOP of up to 18.9% and 12.2% respectively. However, they find no evidence of a positive impact for SAYE. In contrast, Addison and Belfield (2001) find some indication that the existence of a SAYE scheme is associated with higher productivity levels (significant only at the 10% significance level).

Policy implications

Figure 1 summarises the results of the research according to the probability of taking up a tax-advantaged scheme and the likely productivity effect. The figure also shows, for each industry, the approximate value of shares/options held by employees, expressed as a proportion of the aggregate share/option value across all industries.[8]

[8] The probability of scheme take-up is based on the binary choice modelling in section 9 and Appendix 3 (see separate appendices document). The productivity impact is derived from the econometric analysis in section 10 and Appendix 7. The value of shares/options held by employees in each industry can be found in section 8.

Figure 1 Summary of results



Source: Oxera.

Possible policy options therefore include:

– encouraging take-up of tax-advantaged share schemes by those companies that show the most productivity effect, namely, financial intermediation, electricity, gas and water companies, and companies in the manufacturing sector (ie, the top right-hand quadrant);[9]

[9] Furthermore, the underlying reasons for the observed effect of schemes in industries that are likely to offer schemes but do not display higher-than-average productivity rates could be further investigated (ie, the top left-hand quadrant).

– encouraging take-up in listed companies, encouraging employee participation in all companies (particularly in certain industries), or both.[10] Establishing which factor is most significant would be an important area of further research.

However, whether it would be necessary for the government to provide tax incentives to improve performance is not clear, since there is some evidence indicating that productivity is enhanced in companies with both types of scheme (ie, tax-advantaged and non-tax-advantaged) and not in those with tax-advantaged schemes only.

[10] It should be noted that the data employed for the analysis in this report does not enable researchers to establish whether the improved productivity effects observed in listed companies are attributable to the higher degree of employee participation in listed schemes or to the greater incentive properties in listed companies.

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Glossary

Acronyms

Term	Definition
AIM	Alternative Investment Market
APS	Approved Profit Sharing
ARD	Annual Respondents Database (Office for National Statistics)
CGT	capital gains tax
CINS	company identification number search
CRN	company registration number
CSOP	Company Share Option Plan
DEA	Data envelopment analysis
DSOP	Discretionary Share Option Plan
EBIT	earnings before interest and tax
EMI	Enterprise Management Incentives
EOI	Equity Ownership Index
ESOP	Employee Share Option Plan
FAME	Financial Analysis Made Easy (database)
FTE	full-time equivalent
GDP	Gross Domestic Product
GLS	generalised least squares
ISA	individual savings account
LSE	London Stock Exchange
OFEX	Off Exchange (over-the-counter market established in 1995, specialising in smaller companies)
OLS	ordinary least squares
REPO	Bank of England interest rate
RPI	retail price index
SAYE	Save As You Earn scheme
SEDOL	Stock Exchange Daily Official List
SIC	standard industrial classification
SIP	Share Incentive Plan
SME	small- and medium-sized enterprise
SQL	Structured Query Language
TFP	total factor productivity
WERS	Workplace Employee Relations Survey
WIRS	Workplace Industrial Relations Survey

Modelling terms

Term	Definition
Binary choice modelling	A model which predicts the probability of an event occurring (denoted by 0 or 1)
Cobb–Douglas production function	A standard equation used to describe how the inputs (usually capital and labour) in a production process affect output
Data envelopment analysis	A mathematical approach to assessing the performance of companies
Econometric modelling	A statistical technique for expressing, estimating and testing statistical relationships between economic variables
Endogeneity bias	When the direction of causality is not clear, coefficient estimates may be biased as the coefficient reflects causality in both directions
Logistic regression framework	A form of binary choice model, assuming that the probability of the binary outcome corresponds to a logistic cumulative distribution
Omitted variable bias	The estimates of coefficient for variables in the model may be biased if they are correlated with variables omitted from the model
Ordinary least squares	A form of econometric modelling, for estimating coefficients by minimising the sum of the squared differences between the observed dependent data points and those predicted by the linear regression model
Panel data	Data which is held across both companies and time
Parsimonious model	An econometric model which best describes the data with as few explanatory factors as possible
Probit modelling	A form of binary choice model, assuming that the probability of the outcome corresponds to a cumulative normal distribution
Production function	A function that expresses the relationship between an organisation's inputs and outputs
Productivity	A measure of a company’s effectiveness at turning inputs into outputs. A simple measure of productivity (a single factor productivity measure) is often given by output (eg, turnover) per head (ie, number of employees)
Total factor productivity	A measure of productivity which takes into account all factors of production—ie, capital, raw materials and labour
Translog production function	A more general production function compared with the Cobb–Douglas production function, allowing for non-linear relationships

1 Introduction

Oxera was commissioned by the Inland Revenue (now HM Revenue & Customs) to examine the impact of tax-advantaged share schemes[11] on UK company performance.

While there is already a considerable body of empirical evidence linking employee share ownership to improvements in productivity, the evidence is not always clear or easy to interpret. Studies in the UK have often relied on survey evidence, which does not allow econometric analysis to be undertaken using information across a number of firms and over time.

HM Revenue & Customs therefore requested that Oxera conduct new empirical research into tax-advantaged employee share schemes in the UK, drawing on HM Revenue & Customs' own administrative data on share schemes. This report represents the culmination of this commissioned research and provides a quantitative assessment of the impact of these schemes. The empirical research focuses on the following two questions.

– What are the characteristics of companies that operate tax-advantaged employee share schemes in the UK?

– What is the impact of tax-advantaged schemes on companies' performance?

Section 2 describes the issues the study seeks to address, explains the share schemes, and sets out the overall objectives and contents of the research.

In achieving these overall aims, the research in this report covers the following workstreams, each of which is addressed in a separate section.

– Section 3 provides details of Oxera's methodological approach.

– Section 4 describes the different share schemes being examined, and thus the differing impacts each type of scheme is expected to have—ie, it considers the possible hypotheses that can be tested in the econometric framework.

– Section 5 provides an overview of the relevant literature, focusing in particular on existing empirical evidence on employee share schemes in the UK.

– The next step is constructing the dataset and, in particular, combining HM Revenue & Customs' administrative data on companies with tax-advantaged employee share schemes with data from other sources that give wider information on company characteristics and other relevant variables (eg, macroeconomic variables).[12] Section 6 explains the matching procedure undertaken and its success rate.

[11] 'Tax-advantaged schemes' refers to three specific share schemes, CSOP, SAYE and APS (replaced in April 2001 by SIP) for which the government has decided to offer tax incentives to encourage employers to offer employees the opportunity to invest in the company. Each scheme is tax-advantaged in different ways, as discussed in section 4 and Appendix 1. Such schemes require formal approval from HM Revenue & Customs. This requires companies to submit their plan documentation and ancillary documents to HM Revenue & Customs prior to implementing a plan. HM Revenue & Customs formerly referred to these schemes as approved/unapproved schemes, but has replaced this distinction with that of tax-advantaged and taxed share schemes. This is in part to clarify the substantive difference between the two types of scheme, and is a result of the introduction of the Enterprise Management Incentive (EMI)—a tax-advantaged incentive available to certain companies, which does not require formal approval. The EMI is not examined in this study.

[12] The other main datasource used is FAME.

– Section 7 explains the construction of variables from the merged dataset, such as measures of company productivity and performance, employee participation rates in the schemes, and employees' monetary benefit from participation.

– Section 8 provides descriptive analysis of the matched datasets—for example, summary statistics on the characteristics and performance of companies, and comparisons between companies with and without tax-advantaged share schemes (and between companies with different types of tax-advantaged share scheme).

– Section 9 provides details of the econometric analysis, which complements the assessment in section 8 of the distinguishing characteristics of companies with employee share schemes.

– Section 10 details the econometric analysis of the matched datasets to assess the impact of the different schemes on company performance.

– Section 11 describes the data envelopment analysis (DEA) undertaken to assess the impact of the different schemes on company performance.

– Section 12 concludes by drawing out the key results and policy implications of the empirical analysis.

The report appendices, provided in the accompanying document, are structured as follows.

– Appendix 1 provides further detail on the share schemes analysed in this report.

– Appendix 2 provides a summary of the literature review.

– Appendix 3 provides detailed descriptive analysis and summary statistics of the datasets.

– Appendix 4 provides preliminary correlation analysis and plots of the variables prior to econometric modelling.

– Appendix 5 provides technical details of the econometric approaches.

– Appendix 6 discusses the sensitivity to excluding 1993 and 2003.

– Appendix 7 provides details of the developed econometric models.

– Appendix 8 explains DEA.

All descriptive statistical analysis and econometric modelling in this report were undertaken using Stata 9.[13]

[13] StataCorp. 2005. Stata Statistical Software: Release 9. College Station, TX: StataCorp LP.

2 Background and objectives of research

2.1 Background

Many companies reward their employees by granting them shares—or share options—as part of their remuneration package, thereby giving employees a personal stake in the company's future performance. Such employee share schemes are a subject of public policy concern, mainly because they have been associated with increased productivity and employment in the firms concerned, which may further public interest and therefore justify public action—eg, in the form of tax benefits—to encourage take-up of the schemes.[14]

In its 1998 consultation on the new share scheme proposals, the government set out the economic case for extending employee share ownership:

> Employee share ownership offers the prospect of bridging the gap between employees and shareholders, to the long-term benefit of employees, managers, and outside investors. By aligning more closely the interests of the workforce and the owners of the company, employee ownership can help increase cooperation. Over time, employees with a stake in the business have an incentive to contribute more actively to the development of the business of raising productivity. If the majority of employees have such an ownership stake, then individual efforts may become mutually reinforcing, and employees have an interest in the work of their colleagues.
>
> Once they have become shareholders, employees are more likely to feel greater commitment to the company for which they work. This in turn can help companies in their recruitment and retention, and enable them to obtain a better return from their investment in employee training. Finally, employees who are also shareholders may better understand the risks faced by the company and its investors, which in turn can encourage recognition of the case for pay responsibility. (HM Treasury 1998)

Two new tax-advantaged employee share schemes, the Share Incentive Plan (SIP) and Enterprise Management Incentive (EMI), were introduced in the Finance Act 2000 to phase out (in the case of the Approved Profit Sharing, APS, scheme) or complement (in the case of the Save as You Earn share scheme, SAYE, and Company Share Option Plan, CSOP) the existing schemes.

– SIP can be taken up by both small and large firms and must be open to all employees. It gives tax and National Insurance relief to employees receiving and holding the shares and relief to employers on Employers National Insurance contributions.

– EMI is open only to small firms in relatively high-risk trades, gives tax and National Insurance relief on gains realised by employees exercising options, and provides a more beneficial capital gains tax (CGT) treatment.

At the time, there were already three tax-advantaged schemes to promote employee share ownership: APS and SAYE—which must be offered to all employees—and CSOP, which may be offered to selected employees.

The new employee share schemes were introduced to promote the use of such schemes, spreading the benefits to more employees in more companies. By 2003, more than 6,070

[14] Employee share schemes may also be seen as consistent with the promotion of other public interest objectives such as the redistribution of income and wealth, since the schemes imply that enterprises share the profit and wealth created with their employees; and the promotion of economic democracy, since the schemes involve employee ownership.

companies had at least one tax-advantaged share scheme in place.[15] As shown in Table 2.1, take-up rates are higher among larger listed firms, with 97% (82%) of FTSE 100 (FTSE 250) companies having at least one scheme in place. The cost of these schemes (excluding SIP) to HM Revenue & Customs has been estimated at around £800m per annum in tax and National Insurance relief in 2002–03.[16]

Table 2.1 Companies with tax-advantaged employee share schemes, April 2003

	Number of companies	Percentage of total
All listed	**795**	**46.7**
FTSE 100	97	97.0
FTSE 250	204	81.6
Smaller listed	494	34.0
Total unlisted	**5,164**	–
AIM companies	482	63.9
Other unlisted	4,682	–
Overseas	**111**	**–**
Total companies	**6,070**	–

Note: Where possible, the percentage of companies is estimated by dividing the number of companies with at least one tax-advantaged scheme (APS, SAYE, CSOP, SIP or EMI) by the total number of companies in the group, based on statistics on listings on the London Stock Exchange (LSE) and quotations on the Alternative Investment Market (AIM) (the number of companies on the LSE and AIM as at December 31st 2002).
Source: Oxera calculations based on statistics from HM Revenue & Customs and LSE.

2.2 Expected benefits of share schemes and issues with previous research

The main expected benefit of share schemes is to align employees' interests with those of their company. In other words, the financial reward that employees receive from their share schemes increases as company performance improves, thereby incentivising employees to increase their effort to improve company performance. Ultimately, therefore, share schemes may lead to higher company productivity. As such, the schemes form part of the government's wider policies aimed at promoting higher productivity and reducing the 'productivity gap' between the UK and its main competitors.

While there is a considerable body of empirical evidence linking employee share ownership to productivity, the evidence is not conclusive (see section 5 for the literature review). Moreover, most empirical studies have focused on the US market, and the studies on the UK often rely on the Workplace Employee Relations Survey (WERS), or its predecessor, the Workplace Industrial Relation Survey (WIRS).[17] The survey data is largely qualitative and, because it is restricted in time, does not allow econometric analysis within a panel framework (ie, using data which has both a cross-sectional dimension and a time dimension—for further explanation refer to section 10).

In addition, while several studies have reported a positive, although not always statistically significant, relationship between employee share schemes and companies' productivity performance, a positive correlation between employee share schemes and productivity is not necessarily proof of a causal relationship. The following sources of bias need to be considered before inferring causality (see Kruse 1993a):

[15] The statistics on companies with tax-advantaged share schemes in April 2003 are taken from the HM Revenue & Customs website at www.hmrc.gov.uk.
[16] Source: HM Revenue & Customs.
[17] See http://www.dti.gov.uk/er/emar/1998wers.htm, http://www.psi.org.uk and http://www.esrc.ac.uk

– *endogeneity bias*—companies with high productivity may be more likely to adopt share schemes in the first place;

– *dynamic misspecification of the functional form*—an improvement in productivity following the introduction of a scheme may simply reflect an existing upward trend. If time series or panel data are used in specifying the functional relationship between performance share schemes, and the dynamic path is not correctly captured, the share scheme impact that is estimated using the incorrectly specified relationship will be biased;

– *omitted variable bias*—may take three forms:

  – *omitted variable bias (1)*—potential bias may arise due to tax-advantaged share schemes having positive correlations with other unobservable variables (including schemes that are not tax-advantaged). If companies operate share schemes that are not tax-advantaged alongside those that are, and information on the non-tax-advantaged schemes is not available, any observed performance impact may be (erroneously) attributed to the tax-advantaged schemes, although observed effects may be partially or entirely due to the non-tax-advantaged schemes;
  – *omitted variable bias (2)*—tax-advantaged share schemes may have a real effect on productivity for some firms that adopt them, but this effect may not occur in other firms—that is, some firms may be more suited to employee share schemes than others. If the variable explaining why some firms have an effect and others do not is not available, the model may underestimate the effect. This will be dependent on the specifics of the scheme design and how it is implemented within the firm if such information is not observed and the econometric framework does not correct for this;[18]
  – *omitted variable bias (3)*—other changes that coincide with the introduction of a share scheme but which are not observable—for example, other financial or organisational changes that are not observed in the data may be incorrectly attributed to share schemes' productivity impacts.

This suggests the need to conduct further research into employee share schemes and, in particular, to look at studies that make use of econometric modelling techniques that control for selection and other biases. This report addresses the first two sources of potential bias through the use of panel data in the modelling and a model specification that accounts for the possibility of an existing trend in productivity. The potential bias arising from possible complementarities with other practices is addressed by investigating the impact of schemes that are not tax-advantaged. However, this cannot be fully investigated since HM Revenue & Customs provides information on schemes that are not tax-advantaged only for companies that also have tax-advantaged schemes. Thus the impact of schemes that are not tax-advantaged in companies that do not offer tax-advantaged schemes cannot be investigated. The data also does not provide information on other potentially complementary practices. The potential sources of bias given by the fourth point above are addressed in part by investigating the use of scheme by industry sector and firm size (turnover, number of employees); however, more detailed information about firm characteristics, scheme design and implementation is not available in the HM Revenue & Customs dataset. The fifth potential bias cannot be addressed in the present study since information required to investigate this further is not available in the HM Revenue & Customs dataset.

The research in this report commissioned by HM Revenue & Customs is the first to use HM Revenue & Customs' own administrative data. It provides an opportunity to conduct new

[18] If there are indeed systematic differences in the productivity effect of share schemes between companies, and these differences are permanent and do not change over time, the estimates based on an econometric approach based on panel data (such as the one taken in the present study) will not be affected by such a bias.

quantitative analysis and thereby overcome some of the methodological concerns that have characterised previous UK studies into the effect of share schemes.

2.3 Objectives of this study

The empirical research of this study has two overall aims.

- *Analysis of the characteristics of UK companies with employee share schemes*—the research provides insight into the characteristics of companies that operate employee share schemes. This is interesting from a public policy perspective for several reasons.
  - first, finding out which companies set up share schemes may help HM Revenue & Customs understand how companies could respond to public policy in this area;
  - second, this information could be used by HM Revenue & Customs to target public policy at those companies where there is concern about inadequate take-up of share schemes;
  - a third reason for studying the circumstances in which companies set up schemes is to help in identifying the main characteristics of companies with share schemes that need to be taken into account when estimating the impact of the schemes in econometric analysis.

- *Assessment of the impact of employee share schemes on performance*—this research addresses key public policy questions: do employee share schemes indeed have the expected impact in terms of improving productivity of the companies that implement the schemes, and are the productivity increases sufficiently large to justify the cost of forgone tax and National Insurance revenue? The empirical assessment focuses on companies' productivity performance. The new schemes (SIP and EMI) have been implemented only recently: as a result (and in contrast with APS, SAYE and CSOP) HM Revenue & Customs does not have a large amount of data that would allow detailed analysis. In addition, it is likely that any potential measurable impact would take time to materialise. The analysis in this report therefore focuses on the impact of the older tax-advantaged schemes (APS, SAYE and CSOP).

Thus, the impact assessment evaluates the schemes that existed prior to SIP and EMI—ie, APS, SAYE and CSOP. However, the empirical research methodology developed to assess the impact of these older schemes could be used in future evaluations of SIP and EMI. Moreover, the quantified impact of the older schemes provides a benchmark against which to measure the impact of SIP and EMI in a future assessment.

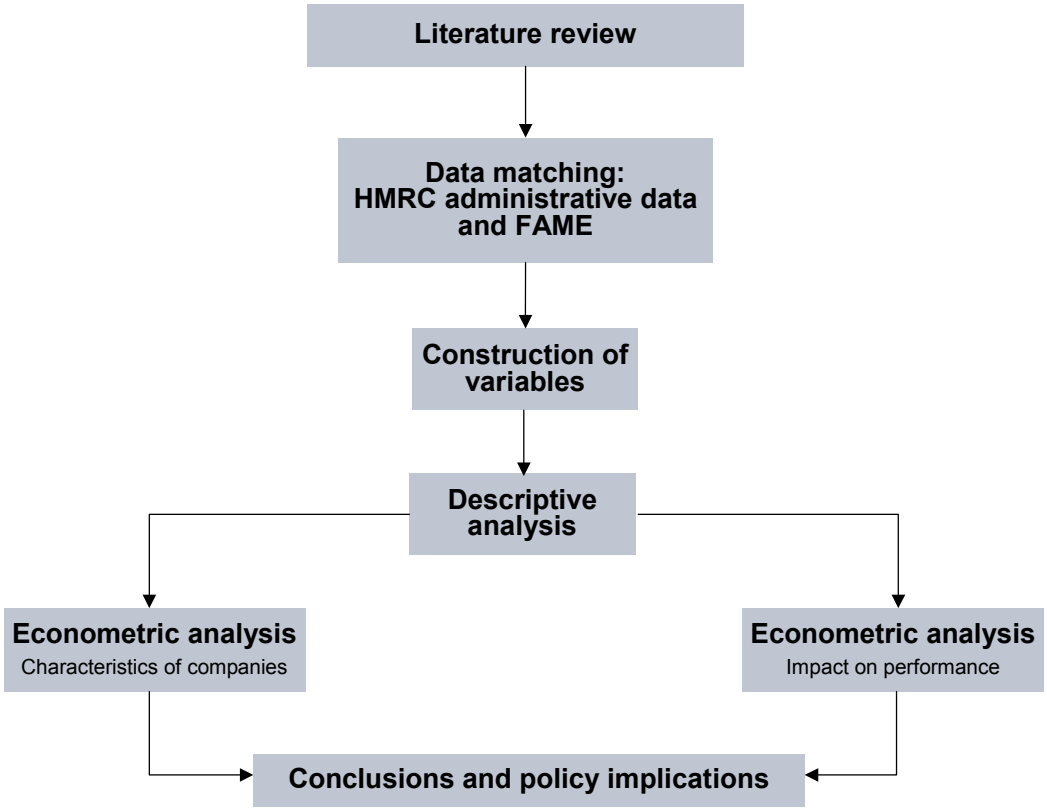
3 Methodological approach

The approach employed in this study has been to:

- review the relevant literature;
- construct the dataset (combining HM Revenue & Customs' administrative data on companies with tax-advantaged employee share schemes with data from FAME which gives information on company characteristics and other relevant variables);
- construct additional variables from the merged dataset;
- undertake descriptive analysis of the matched datasets;
- undertake preliminary econometric analysis to provide an assessment of the distinguishing characteristics of companies with employee share schemes;
- undertake econometric analysis to assess the impact of the different schemes on company performance (the main focus of the study);
- undertake preliminary data envelopment analysis (DEA) to illustrate the use of the approach in assessing the impact of the different schemes on company performance.

This is schematically presented below.

Figure 3.1 Methodological approach



Note: HMRC, HM Revenue & Customs; FAME, Financial Analysis Made Easy.

The next section explains each of the share schemes examined in this report and identifies hypotheses that can be tested in the econometric modelling in section 10.

4 Description of share schemes and testable hypotheses

4.1 Introduction

This section gives an overview of the main features of HM Revenue & Customs' tax-advantaged employee share and share option schemes covered in this study.

The three schemes are Save As You Earn (SAYE),[19] Approved Profit Sharing (APS), and the Company Share Option Plan (CSOP). Prior to the substantial amendments introduced by the Finance Act 1996, CSOP was known as Discretionary Share Option Plan (DSOP) or executive scheme. SAYE and APS are all-employee schemes—ie, they have to be offered to all employees on 'similar' terms. However, employers are permitted to choose criteria, such as tenure or salary, to differentiate between schemes offered to employees. CSOPs/DSOPs allow companies to offer share options to specific employees—in many cases, top management—on a discretionary basis.

Sections 4.2 to 4.4 describe each of the schemes. See Appendix 1 for further details of the share compensation schemes.

Section 4.5 explores theoretical characteristics of the schemes and identifies hypotheses that can be tested in the econometric framework (section 10). The section analyses:

– the theoretical incentive properties of financial participation schemes;
– the potentially differential incentive properties of the different schemes and their associated risk;
– structural breaks (eg, the effect on productivity/incentives in the event of a stock market downturn, or if company bankruptcy or takeover is anticipated);
– the suitability of the schemes for small companies;
– the impact of profit-sharing schemes that are not tax-advantaged.

4.2 Save As You Earn (SAYE)

Savings-related or SAYE share options schemes (Inland Revenue 2002) are tax-advantaged schemes which, if adopted, must be offered to all employees (including part-timers) with tenure of five years or more. However, companies can and do offer SAYE schemes to employees who have worked for less than five years. All employees must be entitled to participate on similar terms, but employers can choose to differentiate between employees—for example, on the basis of tenure or salary.

Under the scheme, employees are granted an option to purchase shares in the employer company. Companies can choose to grant the option at a discount of up to 20%. The employee enters into a related savings contract. This involves the employee saving a fixed monthly amount (from £5 to £250) for three or five years, with a financial services provider.[20] There are tax-free bonuses built into the savings contract.

At the end of the savings contract, employees can choose:

[19] It should be noted that SAYE schemes are referred to under a variety of names, such as Savings Related Share Schemes, and ShareSave. Such schemes are referred to as SAYE in this report.

[20] Under SAYE, APS and CSOPs, employees are exempt from income tax and National Insurance on their contributions to the scheme. In addition, employers realise savings through relief from employers' National Insurance Contributions and corporation tax.

– to exercise their option and purchase shares. The purchase price will be the prevailing market share price less any discount in the option; or
– they can choose to withdraw their savings and the bonuses they have attracted.

Those with a five-year contract can also be offered the opportunity to leave their savings for a further two years, at the end of which they can either exercise the option or withdraw their savings.

Shareholders are subject to normal tax arrangements when selling the shares—ie, they have to pay CGT.

The scheme has undergone few substantial changes since its introduction in its present form under the Income and Corporation Taxes Act 1988. However, since 1999, option holders may transfer shares bought via the scheme into tax-free savings accounts (ISAs).

4.3 Approved Profit Sharing (APS)

The now superseded APS schemes were employee-wide tax-advantaged schemes that had to be offered on similar terms to employees (including part-timers) with a tenure of five years or more (although companies can specify less).

Participants in APS schemes purchased company shares that were held in their name for three years by a trustee. The shares were purchased either by converting a profit-sharing bonus into shares, using a percentage of the basic gross salary ('salary forgone') or an employee buying shares ('contributory scheme'). The shares could be disposed of after a minimum of two years, at which point they may be subject to tax, becoming tax-free if left in trust for at least three years.

Employees were liable to pay CGT on the increase in value of the shares after exiting the scheme.

APS has been replaced by the Share Incentive Plan (SIP). No new schemes were introduced after April 2001, although awards under existing APS schemes could be made until the end of December 2002.

4.4 Company Share Option Plan (CSOP) and Discretionary Share Option Plan (DSOP)

CSOP is a discretionary scheme that allows companies to incentivise specific individuals or groups of employees—often senior management—with tax-advantaged share options worth up to £30,000 at any one time.

The increase in the share value between grant and exercise is exempt from income tax and National Insurance if the options are held for at least three years and, until April 2003, at least three years had to pass between each tax-advantaged exercise of options.

Schemes approved prior to May 1996 were known as Discretionary Share Option Plans (DSOPs) or executive schemes. After this date, all schemes became CSOPs unless companies with schemes informed HM Revenue & Customs that they did not wish their scheme to be tax-advantaged any longer. The main difference between the two schemes was the threshold—since July 17th 1995, the maximum value of options that a participant can hold from an individual company under the scheme is £30,000; prior to this date, option values in excess of £100,000 were possible.

4.5 Theoretical considerations of schemes

4.5.1 General considerations of financial participation schemes

There are two broad types of financial participation used by companies to help them achieve various objectives, including improving employee performance.

– C*ash-based* profit-sharing and employee rewards, which are paid from company profits more or less immediately.

– *Equity-based* remuneration, such as stock holdings or employee share schemes, in which the financial gains are mainly made through long-term increases in company share values.

Only the latter (and, in particular, tax-advantaged share schemes) is examined in this report.

The theoretical literature provides some broad insights into the incentive implications for employees and the circumstances under which financial participation schemes in general are likely to be effective in improving company performance.

– *Employee and firm characteristics*—agency theory suggests that the optimal amount of shared compensation is a function of the characteristics of the employees and the firm.

– *Firm activity*—firms are more likely to operate shared-compensation schemes if the nature of the firm's activity implies that, when incentivised, employees can have a significant effect on output. Firms may also be more likely to operate schemes if employees' efforts are difficult and costly to monitor, and scheme ownership motivates workers and reduces shirking.

– *Group incentives versus individual incentives*—group-based incentive schemes such as share schemes may be an inefficient way of motivating individuals since they induce free-riding behaviour—ie, the financial reward for an individual worker's extra effort decreases as the number of participants increases such that employees may choose to rely on the effort contributions of other employees.

– *Firm size*—supervision may be more difficult and costly in small firms than large firms. In theory, the effectiveness of schemes effect could go either way. If free-riding behaviour is prevalent, schemes may be more effective in smaller firms. On the other hand, human resource managers in larger firms may be more experienced in employee relations and thus better placed to coordinate profit sharing with other policies.

For a more detailed account of the theoretical characteristics of financial participation schemes refer to Appendix 1.

The remainder of this section discusses the specific theoretical properties of employee share schemes and identifies hypotheses that can be tested in the econometric modelling (section 10).

4.5.2 Scheme-specific theoretical considerations and testable hypotheses

All-employee share schemes

It is useful to compare APS and SAYE schemes since these are most closely comparable given that both are all-employee schemes.

The risk associated with the APS scheme is higher than that of SAYE. Under a SAYE scheme, employees may choose not to exercise their option, instead preferring to recoup their money. Such a decision would be rational during a general stock market downturn, or if

the company has performed poorly over the period, in which case the option price may be higher than the current share price. In contrast, under an APS scheme, employees are more directly exposed to stock market movements and poor company performance and, as such, participation in APS involves a risk of financial loss.

Thus, if employees are *risk-averse* and take a relatively short-term view of the stock market, the degree of participation could be higher under SAYE than under APS schemes, as there is no risk of a financial loss under SAYE. However, given the closer link between individual gains or, indeed, losses, with company performance under APS (there is no option not to buy the shares, and there is no discount), the individual incentive to improve company performance may be greater under APS than SAYE, despite a greater incentive to participate under SAYE.

However, there is still likely to be some incentive for individuals to improve company performance under SAYE, even if the link is not as direct as under APS. Given the likely higher employee participation under SAYE,[21] the aggregate effect at the company level is unclear, as it may be the case that the possible greater participation outweighs the likely lower individual incentive effect, such that the productivity effect *in total* (ie, at the company level) may be higher under SAYE. This could be investigated by controlling for intensity of participation at the company level.[22]

CSOPs and all-employee share schemes

CSOPs are share option grants largely aimed at senior management. While they are less likely to be targeted at more junior employees, they could give managers a greater incentive to ensure that their employees work productively. In companies where economic performance is more dependent on the work of certain key employees, or where effective guidance from senior management is more important than aligning the interests of the broader employee base with those of the firm, CSOPs may be more effective than employee-wide schemes. CSOPs may also be less risky if they are directly granted to employees without requiring them to purchase the options.

CSOPs and SAYE/APS schemes may also be offered jointly and can complement each other.

The extent to which different share schemes vary in their impact on productivity can be tested in an econometric specification.

Structural breaks

One potentially important aspect is to consider what happens to the incentive value of the stock options/shares in the event of the company merging with another company, or going bankrupt. If the company goes bankrupt and this is anticipated, the incentive effect (and productivity effect) during the period leading up to the bankruptcy would be absent.

In the event of a merger, shares are often sold, in which case income tax and National Insurance liabilities arise, thereby reducing the financial gain. This may diminish the incentive value of share schemes during such periods. Again, merged companies can either be excluded, or controlled for using dummy variables. However, this effect can probably not be discerned from other potentially employee-productivity-reducing/increasing influences arising during a merger, such as increased job insecurity, which may influence productivity either way.

Perhaps more importantly, if the value of the option/shares falls, as is likely to have occurred for many companies during 2000/01, the incentive properties and effects on productivity

[21] See section 8.1.2 for employee participation figures.

[22] In practice, due to issues with data definitions, it has not been possible to construct a statistic that captures the intensity of participation at the company level.

would differ from those during more stable periods. The value of options under SAYE appears to be least correlated to market conditions, given that savings can be recouped by not exercising the option (although incentives could also be reduced if they provide a smaller gain than that offered by a large increase in share value which may be realised during buoyant market conditions). These effects can be controlled for and investigated by testing for structural breaks in the econometric modelling.

Suitability for small companies

It appears that neither APS nor SAYE schemes are particularly well suited to very small companies. The schemes' set-up and day-to-day management costs are likely to decrease as the number of employees participating increases, and a minimum number of participants is likely to be required to make operating a scheme worthwhile for companies in terms of taxes saved.[23] In 2000, HM Revenue & Customs launched the EMI, a scheme specifically aimed at small and medium-sized enterprises, which can be targeted at certain key employees, unlike APS and SAYE, which are all-employee schemes.

From the firm's perspective, productivity- or profitability-enhancing effects may tend to compensate for the set-up costs, but given the uncertainty surrounding these effects, it is unlikely that very small companies in particular give this possibility much weight when choosing whether to implement a scheme. An employer's willingness to adopt a scheme may be further reduced if they believe that it may soon be replaced by another scheme, creating additional costs, or if it is abolished altogether—ie, the credibility of a scheme is important.

The analysis in this report, however, examines the impact across all companies, including listed and unlisted companies, allowing for the testing of the hypothesis that small companies below a certain size (eg, in terms of turnover) are unlikely to adopt employee share schemes.

Non-tax-advantaged profit-sharing schemes

While this study focuses on tax-advantaged employee share option schemes, there are also taxable schemes through which employers share profits with employees. As stated in the Green Budget 2001, employee share schemes may indeed contribute to creating a commonality of employee and shareholder interests, thereby leading to improved company performance. However, if schemes do indeed enhance productivity, it is not clear why tax advantages would be required, because firms would find it in their interest to implement such schemes even in their absence (Dilnot et al 2001). The absence of a market failure that may justify government intervention could apply in particular to larger companies that implement the schemes. Thus, larger companies may introduce share schemes even if the tax exemption did not exist.

However, the tax advantages may deter smaller—particularly unlisted—companies that may find it financially or otherwise difficult to introduce shared compensation schemes (ie, problems of spreading fixed costs for smaller companies.) The EMI may be more effectively targeted at addressing a potential market failure, and this could be investigated in future research.

The HM Revenue & Customs dataset contains only limited information on employee share schemes that are not tax-advantaged. Nevertheless, section 10 presents some findings of the effects of these schemes on productivity.

[23] A regulatory impact assessment for the relatively new SIP, undertaken by HM Revenue & Customs, provides estimates of one-off set-up and annual running costs, and these are taken here as a rough indicator of APS and SAYE costs (Institute of Fiscal Studies 2001). For large companies, the costs range between £200,000 and £750,000 (one-off set-up costs), with annual costs of £100,000–£200,000. For smaller, unlisted companies, one-off set-up costs range between £20,000 and £40,000, with annual compliance costs of £15,000–£30,000. The absolute minimum annual cost is estimated to be around £10,000 for a company with 50 employees.

4.5.3 Summary of implications and testable hypotheses

The different employee share schemes can be hypothesised as having the following impacts.

- SAYE could have a greater impact on participation than APS because of the reduced risk for participants involved in SAYE schemes (since employees may choose not to exercise their option).

- The individual incentive to improve company performance may be greater under APS than SAYE. This cannot be tested directly; however, the effect on performance at the company level may be relatively higher or lower under SAYE compared with APS (as a result of the interaction between participation and individual incentives).

- CSOP schemes may have a greater effect on company performance if monitoring and effective management rather than direct worker motivation is more relevant for improving performance, since CSOPs are often aimed at senior management within a company. This may vary according to company attributes, such as type of industry or company size.

- CSOP and SAYE/APS may be offered in conjunction and complement each other—their combined effect may be greater than the sum of their parts. This could be tested by examining interaction terms between the CSOP and SAYE/APS variables.

- The impact of share schemes may be affected by overall market conditions, with potentially lower participation, and thus performance effects, during downturns.

- Scheme influences may vary across industry type and firm size. CSOPs may be expected to have a stronger impact on very large firms (through supervision, for example), while SAYE and APS schemes may have stronger effects in smaller firms where supervision may be relatively less important and individual employee incentives more important. Scheme influences may also vary between listed and unlisted companies (the impact is likely to be stronger for listed companies due to higher participation rates or stronger incentives).

The testing of the above hypotheses was carried out in an econometric framework and the results are presented in section 10.

5 Literature review

This section reviews the existing academic literature on the relationship between financial participation (ie, employee share schemes *and* other forms of financial participation such as profit-related pay) and company performance. Although the focus of this report is the impact of share schemes, academic literature on both share schemes and other forms of financial participation has been reviewed since few studies focus exclusively on employee share schemes. In addition, the different types of financial participation share similarities and thus a review provides useful insights for the current study.

It is important to recognise the narrower focus of the present study—most previous papers have studied financial and/or non-financial participation in general (and more recently their interaction) rather than strictly focusing on employee share schemes. As highlighted in section 4.5, share schemes may have incentive properties that differ from those of profit-sharing schemes, and could differ in their effectiveness in increasing performance. For example, *Kruse (1992)* (italics denotes non-UK study, see below) finds that tax-advantaged share schemes do not produce consistently positive effects and often produce insignificant effects, whereas profit-sharing schemes are found to result in consistently positive effects. However, due to limited data availability (and the scope of this study), it is not possible to examine the impact of wider profit-sharing schemes that may also increase productivity. This may lead to omitted variable bias if the share schemes are more (or less) likely to be present in companies that also have other measures of financial participation of employees. This is due to the following.

– Where companies are more likely to have *both* (tax-advantaged) share schemes *and* other schemes, the estimated impact in this study, which may be solely attributed to share schemes, could, in fact, also be due to other schemes, implying a greater estimated effect for share schemes than actually occurs. (The impact of schemes that are not tax-advantaged is controlled for in this study.)

– If the control group—ie, those companies without (tax-advantaged) share schemes—is more likely to have other types of scheme, the estimated impact of share schemes (ie, relative to the control group) will be lower than that of share schemes relative to no schemes at all.

The literature review focuses on the impact of financial participation (including employee share schemes) in the UK on corporate performance measures in firms. These studies provide the most directly relevant results with which to compare the current study. However, the insights gained from a modelling perspective are limited, as the approach used in the current study is atypical with respect to the UK-based studies. As such, the literature review has been extended to include some studies from the USA, France and Japan in order to increase the number of studies based on a panel data approach (as this is the approach adopted in the Oxera study).

A review of the existing literature is a useful starting point for the descriptive and econometric analysis of the research carried out using HM Revenue & Customs data.

– First, the literature describes different empirical tools and applies a range of econometric techniques to conduct data analysis in order to assess the incidence and impact of employee share schemes (section 5.1).

– Second, the literature identifies a range of measurable variables that explain the incidence and impact of schemes, and that should be controlled for in the econometric analysis (section 5.2).

– Third, a critical evaluation of existing studies highlights any methodological problems and/or techniques that have been adopted to control for problems such as potential selection and simultaneity biases or measurement errors. Although the studies reviewed here employ different datasets, and it is therefore not possible to investigate certain issues raised by them, the insights provided by the literature review may be used to guide judgement in some areas—for example, whether certain estimates could be potentially biased (section 5.3).

– Finally, the empirical findings in the existing studies can be used as a suitable reference point against which to measure the results of the research in this report (section 5.4).

As such, the literature review that follows focuses on the above issues. For a more general overview of the existing economic analysis of share schemes and international empirical evidence regarding their impact on productivity, or other issues such as the characteristics of companies that choose to implement employee share schemes, see *Grimsrud et al (2003), Pérotin and Robinson (2002), Sesil et al (2001), and Kruse and Blasi (1997)*.

5.1 Empirical approaches

The basis of the Oxera study is a large panel dataset, with a main focus for the modelling on a dynamic econometric analysis of the impact of share schemes. Prior to this modelling, a probit analysis was undertaken as a precursor to the main analysis to examine the characteristics of firms with and without share schemes in order to identify the important firm characteristics for the dynamic panel data modelling (and as a result in its own right—namely to examine what types of firm are most likely to use share schemes).

As such, previous studies that have used a similar panel data framework are particularly pertinent. Nevertheless, some cross-sectional studies are also of relevance and these are considered first.

5.1.1 Cross-sectional studies

A majority of the studies that use the cross-sectional survey databases, including those that use the WERS and WIRS survey datasets, use probit modelling. However, they differ significantly from Oxera's probit modelling in their aim; in particular, the dependent variable does not reflect whether the firm has a share scheme (as per Oxera's modelling), but whether the *perceived* productivity is above average compared with firms in the same industry. As such, their focus is to explain whether share schemes increase the perceived level of performance (rather than to examine the type of firms that have share schemes). Examples of such studies include:

– Fernie and Metcalf (1995)—estimating an ordered probit model using data from WIRS3 (1990).[24]
– Blanchflower and Oswald (1988)—using a binary probit model based on WIRS2 (1984).[25]
– McNabb and Whitfield (1998)—using WIRS3 data and a univariate probit model.
– Pérotin and Robinson (2000)—using an ordered probit model.
– Addison and Belfield (2001)—based on WERS98, using an ordered probit model.

5.1.2 Panel data studies

Within a panel data framework, there are several approaches that can be used. These can be categorised as follows.

[24] Ordered probit models are used where the dependent variable represents a scale value of, for example, 1 to 5.
[25] Binary probit models are used where the dependent variable represents a value of 0 or 1.

– Theoretical basis:

  – production function models with output as the dependent variable—the majority of panel data studies employ these;
  – performance measure as a dependent variable—see Bhargava (1994).

– Functional form (refer to section 10 for details on Cobb–Douglas and translog models):

  – Cobb–Douglas—the majority of panel data studies, such as Conyon and Freeman (2004), Pérotin and Robinson (1998), Estrin et al (1996);
  – translog—Kruse (1993b).

– Panel data estimation approach (refer to Appendix 5 for details on fixed effects and random effects):

  – fixed effects (using ordinary least squares, OLS)—the majority of panel data studies (eg, Conyon and Freeman 2004, Whadhwani and Wall 1990, *Kruse 1993b*) state that random effects was tested but strongly rejected in favour of fixed effects;
  – random effects (using generalised least squares, GLS)—*Fati and Pérotin (2000)* state that they used GLS in a random effects panel framework because their panel was too short (with five years of data) relative to their cross-sectional dimension (around 5,000 per year).

– Static or dynamic model:

  – *static*—experiments with lag structures showed little impact, autocorrelation of the error term was tested and rejected. *Kruse (1993b)* and Conyon and Freeman (2004) used a static model with yearly dummies; however, Conyon and Freeman state that they would have liked to have included lagged compensation practice, but the time period of their dataset (four years) was too short to incorporate the dynamics;
  – *dynamic*—Arrellano–Bond estimator (for dynamic panel data estimation)—Bhargava (1994).

5.1.3 Summary

Probit modelling has been used in numerous studies in this area; however, much of it has been driven by the datasets used—namely, cross-sectional survey data with responses providing only a categorical dependent variable.

Where panel data has been used, the general approach has been to model a Cobb–Douglas production function within a fixed effects framework. Some of the studies reviewed have also modelled dynamic effects. These are the approaches used in this study.

5.2 Datasets and variables

5.2.1 Dataset

The literature reveals that there are two competing approaches to examining the impact that share schemes—or profit-sharing schemes in general—have on company performance.

The first approach, which represents the large majority of the UK-based studies reviewed, makes use of establishment-level data with the focus often on manufacturing or listed companies—eg, using the WERS series. In many respects, this is the preferred dataset for research at the establishment level because it is the most representative survey of its kind,[26]

[26] Except for small establishments with fewer than 25 employees and, in more recent surveys, fewer than ten employees.

and contains a rich set of workplace and employee characteristics and a comprehensive description of industrial relations information.

The second approach makes use of datasets based on actual financial data and which often provide panel data. The datasets used include:

– Thomson Financial Datastream;
– Exstat;
– Extel;
– special interview-based surveys carried out over time;
– survey data matched with Datastream.

The present study has some advantages over previous UK studies that tend to focus on the survey-based data.

– The findings from the survey-based studies[27] cannot generally be assumed to apply to all companies. In contrast, the present study contains information on all UK listed companies plus a large number of unlisted companies—ie, the sample is not restricted to a specific sector or listed companies. Due to the large sample size (other studies often use much smaller sample sizes and almost all UK studies are cross-sectional), some generalisations are possible. This also implies that a good control group without tax-advantaged schemes can be constructed. Although, these companies may have other profit-sharing mechanisms or share schemes that are not tax-advantaged, and may contaminate the pure scheme effect somewhat, information on those companies that have had a non-tax-advantaged scheme at some point in time is also available and the impact can be tested.

– Unlike UK studies based on WERS, this study has actual performance data rather than a subjective performance/output measure based on the subjective assessment of managers. Such measures have been found to over-report the effects and, as a consequence, effects may be upward-biased. According to Addison and Belfield (2000), managers tend to overstate profitability, and such self-reporting data should consequently be used with caution.

– This present study takes advantage of the nature of panel data. For example, panel data estimation within a fixed effects framework allows firm-specific effects that are constant over time to be captured within the fixed effect, and thus missing information on these firm effects is not required. Panel data estimation can also be used to assist in mitigating certain estimation problems (see section 5.3.2) and can allow for dynamic effects, something that is not possible in the context of cross-sectional datasets. However, this also means that there may be a need to take into account trends, structural breaks and controls for the macroeconomic environment.

Nevertheless, this study has some disadvantages over previous UK studies that tend to focus on the survey-based data.

– The richness of firm/employee characteristics from survey data is not available in this study. While a fixed effects framework eliminates time-invariant factors, it does not mitigate the omission of firm/employee characteristics, which may vary over time. This limitation suggests that there will be some omitted variable bias in the results (see section 5.3.1).

[27] With the notable exception of WERS, although the subjective measure of productivity, and thus associated problems mentioned below, are still relevant.

– Sample selection may be an issue since the dataset used in this analysis includes almost exclusively data on companies that were operating in 2002/03.[28] This may lead to sample selection bias (see section 5.3.3).

However, the richness of the panel dataset used is considered to outweigh the disadvantages.

The following sections describe the variables used in the modelling. However, it should be noted that the reviewed papers are not always specific in terms of the exact variable definitions used.

5.2.2 Dependent variables

Two approaches are common when measuring performance. First, performance is measured as perceived by management, employees and customers, based on self-reported data. Second, 'hard' data is used (eg, financial data on output).

In studies using cross-sectional survey data, the dependent variables are often categorical—eg, an indicator variable of whether productivity is perceived as equal to/above/below average, or an indicator variable of whether productivity, employment, absenteeism, or staff turnover have increased. This is not relevant to this study.

More relevant studies use two alternative approaches. The first estimates a *production function* (ie, a statistical relationship between the outputs and inputs of the production process) and therefore models *output* on the left-hand side. The second approach models a *productivity* (eg, the ratio of output:labour input) or *performance* (eg, profitability) measure on the left-hand side. The dependent variables can be categorised as follows.

– Production function approach—ie, output measures as the dependent variable:
  – (real) sales—Conyon and Freeman (2004), Whadhwani and Wall (1990), *Kruse (1992);*
  – value added—Pérotin and Robinson (1998), Cable and Wilson (1989), Estrin et al (1996), *Jones and Kato (1995)*.

– Financial performance measures:
  – return on capital employed—Bhargava (1994);
  – return on sales—Bhargava (1994);
  – annual stock returns—Conyon and Freeman (2004);
  – stock returns (ex post return)—Whadhwani and Wall (1990).

– Partial productivity measures:
  – sales per employee—*Kruse (1993b)*;
  – value added per employee—*Kruse (1993b).*

5.2.3 Explanatory factors

A large number of alternative explanatory factors have been considered in the literature. Financial participation variables of some kind are used in all studies (since the research interest in all studies examined is in establishing whether financial participation has a statistically significant impact on performance). The most relevant variables for the present study are as follows:

[28] According to FAME, only information on surviving companies is included in its dataset. However, Oxera found that a small number of companies that were no longer in operation in 2002/03 were also present, and these are included in the dataset.

– dummy variable (0/1) to represent the *existence* of a profit share or employee share scheme, often by type of scheme. These dummy variables are often *interacted* with other explanatory factors such as labour, technology and organisational variables;[29]
– *adoption* dummy (ie, a shock dummy for when a scheme was introduced);
– *lagged* effects of schemes or an interactive dummy defined as the number of years a profit-sharing arrangement/share scheme as been in existence multiplied by the trend;[30]
– participation rates (ie, the percentage of employees participating, and the proportion of total stock that is owned by employees).

As regards the final point, the measure of the number of participants in schemes that can be calculated from HM Revenue & Customs data is likely to be flawed (see section 8). Therefore, this study focuses on dummy variables rather than calculating the proportion of workers with schemes (which would be useful in capturing any depth of coverage effects). Nonetheless, the dummy approach is used by most studies (eg, *Kruse 1992* controls for participation and finds positive, although insignificant, effects).

Inputs into the production function

– Number of employees—all studies.

– Capital or capital intensity (ratio of sales to capital) of modelling returns.

  – capital stock—Whadhwani and Wall (1990), *Kruse (1993b);*
  – gross book value of production plant—*Kruse (1992);*
  – fixed assets at book value or deflated—*Fati and Pérotin (2000), Jones and Kato (1995);*
  – current real capital stock—Conyon and Freeman (2004).

– Technology (often available only in survey-based studies): recorded from survey evidence as a dummy (0/1)—Estrin et al (1996); proportion of unskilled workers (as a proxy for the level of technology)—McNabb and Whitfield (1998); percentage of batch-type technology—Pérotin and Robinson (1998).

– Wages and raw materials (relative) price or aggregate wage bill—Bhargava (1994).

Other control variables

– *Employee characteristics*—usually only available in survey-based studies. For example, the communication style within the firm, trade union presence, job flexibility/multi-skilling, working time and contract flexibility, workforce composition (proportion of skilled, manual, part-time, and white-collar workers; ratio of supervisors; etc), and equal opportunities practices.

– *Other employee characteristics*—such as the change in level of employment over the past year.

– *Firm characteristics*—usually only available in survey-based studies—eg, geographical market, changes in the organisational structure (due to takeovers, mergers or relocations), age of establishment, ownership structure/legal status, degree of competition indicator, and market share.

[29] For example, *Fati and Pérotin* (2000) test whether the presence of a profit-sharing scheme simply shifts the production function (ie, a scheme dummy), which they call a *disembodied effect*, or whether it affects output elasticities of inputs (ie, a scheme dummy interacted with capital and labour), which they call an *embodied effect*.

[30] *Jones and Kato (1995)* state that 'it is unlikely that owning a scheme will instantly create either significant interest alignment of groups of employees with the firm or greater cooperation among different groups of workers. Furthermore it typically takes a while for a newly established ESOP [Employee Share Option Plan] to mature in terms of employee participation and employee stake' (p. 398).

– *Other firm characteristics*—eg, firm dummies (private, manufacturing, UK-owned), industry dummies (standard industrial classification, SIC, for example), size (market capitalisation, employee numbers categorised into groups, etc), location, profits, and the debt to equity ratio.

– Macroeconomic factors—eg, aggregate unemployment rate, whether demand is falling, return on FTSE All-share (when modelling annual stock returns).

  – Instead of including macroeconomic factors and other time-varying non-observed factors, some authors have modelled general macroeconomic conditions by including time dummies and/or specific time dummies to control for any changes in productivity and or prices common to firms in any industry in a given year

5.3 Methodological issues

5.3.1 Omitted variable bias

As noted above, the survey-based data used in some studies provides a rich source of firm/employee-specific information and thereby control variables for the model estimation. Such information is unavailable in the current study and this may result in omitted variable bias (see discussion above and section 2.2). The literature has identified a number of instances where the use of firm/employee-specific information is important.

– *Kruse (1993b)* tests whether other policy changes at the time of the introduction of schemes may be responsible for changes in productivity by excluding observations around an event that may affect productivity, or by including a dummy for the event. However, no significant change to the coefficient estimates on financial schemes was found.

– Fernie and Metcalf (1995) note that it is important to investigate coverage versus depth of financial participation schemes—ie, while financial participation schemes may exist, this does not reveal what proportion of total remuneration is accounted for by such schemes.

– Cable and Wilson (1989) state that the introduction of profit-sharing schemes alone will not necessarily have productivity-enhancing effects; accompanying changes in other dimensions of organisational design are likely to be required. More recent studies, such as Pérotin and Robinson (2000), have shown that non-financial employee participation policies enhance the positive effects of financial participation policies.

The richness of the panel dataset used in this study is considered to outweigh the disadvantage of possible omitted variable bias, and a fixed effects framework captures the firm-specific effects within the fixed effect, thus mitigating to some extent the impact of this disadvantage.

5.3.2 Simultaneity bias or the direction of causation

According to McNabb and Whitfield (1998), the problem of endogeneity is that financial participation *reflects* rather than *causes* favourable financial performance. That is, the causation is not that financial participation improves performance, but rather that strongly performing companies are more likely to decide to implement share schemes, for example, than poorly performing companies—indeed, more profitable firms have been found to be more likely to introduce financial participation (see *Kruse 1993a*). This may lead to simultaneity bias in the estimates of the financial participation effects—ie, the estimates do not reflect the average effect of schemes on productivity since companies that are more productive even without schemes may adopt the schemes in the first place. The estimate would be thus upwardly biased relative to the 'true' effect.

Arguments or approaches relating to this problem include the following.

– Fernie and Metcalf (1995) state that, while contingent pay may be introduced in workplaces with below-average productivity to raise productivity to average levels, financial participation is spreading so quickly due to tax breaks that it is difficult to argue that schemes are endogenous with respect to outcome variables.

– Causality can be tested within the panel framework by considering the dynamics—for example:

  – *Jones and Kato (1995)* test whether productivity affects employee share option plans (ESOPs), rather than ESOPs influencing productivity, by including a one-year lead of the scheme dummy. They find the coefficient to be negatively signed (suggesting some possible negative causality effect). However, these coefficients are estimated with high standard errors, suggesting that the effect is not statistically significant—as such, Jones and Kato state that: 'we should not overemphasise the reverse causality effect';
  – *Kruse (1993b)* presents results suggesting that it is favourable profitability in the previous two years (rather than the current year) that determines whether an establishment introduces financial participation—financial participation is therefore not *simultaneously* determined with current profitability.

5.3.3 Sample selection bias

Sample selection may arise due to data not being available for a certain group of companies. For example, the dataset used in this report has data only on surviving companies such that poorly performing companies that go bankrupt are not included in the sample. If surviving companies differ in their overall characteristics from companies that have gone bankrupt, the impact effect of the scheme variable may be biased. As a result, it may not be valid to draw conclusions about the effect of share schemes for the population as a whole since results are derived using part of the potentially non-representative population of surviving companies. In other words, a cross-sectional model could be estimated, or a pooled OLS or cross-sectional models could be estimated year by year to obtain a sense check for the main results—see, for example, *Kruse (1992)*. However, as indicated in section 6, the potential bias introduced by sample selection is likely to be small.

5.4 The estimated impact of financial participation schemes from previous studies

This section provides an overview of the findings regarding the relationship between financial participation schemes and company performance. The main focus is on UK studies due to their more direct relevance to the current study. For a summary of the UK studies reviewed in this section, refer to Appendix 2.

5.4.1 Studies focusing on the productivity impact

Conyon and Freeman (2004) examine the use and consequences of shared compensation plans (profit-related pay, APS, SAYE and CSOP) in a sample of UK firms and workplaces in the 1990s. Their evidence shows that companies and workplaces adopting shared compensation schemes tended to have, on average, a higher productivity and better financial performance than other firms, although the effects vary among schemes and among datasets used. Their first dataset contains a sample of 299 UK companies listed on the LSE, which responded to a survey conducted by Conyon (with Reid, L.) in 1999. The survey data is matched with accounting data from Datastream for 1995–98 to estimate the parameters of Cobb–Douglas production functions. The results suggest a positive correlation between firm productivity and two HM Revenue & Customs-approved schemes (APS and CSOP), with

estimated productivity effects of up to 18.9% and 12.2%, respectively. However, no evidence of a positive impact is found for profit-related pay and SAYE.

The second dataset employed by Conyon and Freeman contains UK workplaces responding to WERS98. The relationship between different employee participation schemes and the qualitative indicators on financial performance and labour productivity is generally found to be positive. More specifically, they find that employee share ownership and profit-related pay have the largest and most significant effects on financial performance and productivity. Deferred profit-sharing schemes have the least significant effect on performance or no effect at all.

Robinson and Wilson (2005) find that SAYE is associated with a productivity premium of 23%, and that consultative/representative forms of employee participation also raise productivity. Whadhwani and Wall (1990) concur with the view that profit sharing boosts productivity. However, they recommend caution in interpreting their results, given that the results are based on a relatively small sample size of 90 firms.

Pérotin and Robinson (2000) use WERS98 data to study the impact of anti-discrimination policies and employee participation schemes on productivity. This empirical evidence shows that company policies that promote equality of opportunity for the workforce have a positive impact on performance. Moreover, their positive effect is further enhanced if implemented in conjunction with employee participation schemes of either a financial (eg, employee share or profit sharing) or non-financial nature, suggesting complementarity between equal opportunities practices and employee participation schemes.

Fernie and Metcalf (1995) investigate the relative performance of different workplace governance structures, which they define as ‘workplaces with collective bargaining’, ‘workplaces with employee involvement’ (ie, financial participation), and ‘workplaces with no employee involvement or collective bargaining', using data from WIRS3. They compare the economic performance of these three types of governance structure with a hypothetical ‘typical workplace’. Regarding the relative economic performance of these different workplaces, the workplace with heavy employee involvement (including contingent pay systems) had the highest probability of being above average compared with otherwise similar workplaces in terms of labour productivity levels and productivity growth. In contrast, workplaces with no financial participation and collective bargaining registered the highest growth in employment over the previous six-year period. Their results also indicate that financial participation schemes, including profit-sharing and employee share ownership schemes, have a positive relationship with productivity levels or growth.

Using WIRS3 data, McNabb and Whitfield (1998) report that employee share schemes and other financial participation schemes are important for financial performance. They report that the introduction of financial performance schemes often follows the introduction of employee involvement schemes and their combined effect can differ from their individual effects. As such, focusing on only one type of financial participation may not provide an accurate picture of the impact of financial participation in general on financial performance. More specifically, employee share schemes and profit-related pay are found to be substitutes rather than complements. When introduced together, financial performance was found to be not better than average, whereas establishments with either type of scheme performed better than average.

Cable and Wilson (1989) examine the extent to which profit sharing influenced productivity in a sample of 52 firms in the UK engineering industry from 1978–82. Their main finding is that firms operating profit-sharing schemes had productivity differentials of between 3% and 8% compared with firms without such schemes. With respect to the distribution of productivity gains, the authors report that workers’ non-share income is, on average, some 4.4% higher in profit-sharing firms, with a slightly larger differential of 4.9% for manual workers, but only 2.3% for white-collar workers. The reported rate of return on capital is 129% higher for firms with profit-sharing schemes, reflecting a substantial capital–productivity enhancement in

profit-sharing firms. The calculated effects come from estimating Cobb–Douglas production functions in which profit sharing interacts with factor-input levels and the firm's technological, organisational and labour force characteristics. The authors therefore note that it may not be the introduction of profit sharing per se which has productivity-enhancing effects, but that accompanying changes in other dimensions of organisational design are likely to be required for financial participation to be effective.

Estrin et al (1996) estimate the impact of profit sharing on the productivity of 93 manufacturing firms during 1988–91. The dummy variable introduced to control for these firms is reported as positive and significant, suggesting that profit sharing increases productivity. More specifically, the results suggest that firms that practise profit sharing obtain levels of productivity that are around 6% higher on average than firms that do not implement such schemes.

5.4.2 Impact on share prices and profitability

In addition to productivity, Conyon and Freeman (2004) estimate the employee schemes' impact on stock market returns of the companies. The effect of APS remains positive and significant, with an impact on stock returns of about 9.8%. The economic effect is smaller than on productivity, but nevertheless statistically significant. In contrast to the productivity results, the effect of CSOP on stock returns is not significant, whereas that of SAYE is significantly positive.

Bhargava (1994) examines the dynamic relationship between profit sharing and profitability in a sample of UK firms that introduced profit sharing during 1979–89. Since all companies in the sample introduced profit sharing at some point during the period of analysis, the empirical test is a 'before and after' assessment of the effects of introducing profit sharing, rather than a comparison of profitability between profit-sharing and non-profit-sharing companies. The estimates indicate a positive short-run effect of the introduction of profit-sharing schemes on the financial performance of the companies. There is also evidence of a persistence of profitability in UK profit-sharing firms.

A UK study by Richardson and Nejad (1986) examines the impact of share-ownership schemes on movements in the share prices of listed firms in the multiple stores sector. They study the differential share price performance of firms with and without financial participation schemes, and argue that, by focusing on stock market prices rather than the more objective measure of profitability, potential sources of bias can be avoided. For example, if relatively successful firms with more competent management are more likely to introduce these schemes, there should be no confusion between the effect on share prices of better management practice and participation schemes. This follows from the proposition of standard stock market theory, which postulates that management effects should already be embodied in share prices. The authors recognise, however, that this may break down if the best-performing companies introduced profit sharing as part of a wider review of management practices, in which case financial participation may act as a proxy for improved management rather than improved performance. Richardson and Nejad find a clear and statistically significant relationship between share price movements and the operation of share-ownership schemes. In addition, they find that firms experienced a relatively faster increase in their share prices after they introduced financial participation schemes.

Indication of outperformance of the market average by companies with employee share schemes is also supported by findings from Equity Incentives Ltd, which, since 1992, has maintained an index of share prices of UK-quoted companies with a significant level of employee share ownership. The UK Equity Ownership Index (EOI) has generally outperformed the FTSE All-share index. For example, an investment of £100 in the EOI in 1992 would have been worth £249 by the end of June 2003; the same amount invested in the FTSE All-share on the other hand would have been worth £161 (Equity Incentives Ltd 2003). Although this outperformance in share prices is consistent with better financial

performance, the stronger share price growth may be due to the over-representation of technology shares in the index.

5.4.3 Studies using internationally comparable data

Festing et al (1999) examine the impact of employee participation on profitability in UK, German, French and Swedish companies. The study finds a positive and significant relationship between profitability and both employee share ownership and profit sharing. Employee share ownership was also associated with lower absenteeism, but higher staff turnover.

Similarly, in an international context, Pérotin and Robinson (1998) investigate the effect of profit sharing on firm performance in (and across) Great Britain, France, Germany and Italy. They find a productivity differential for their sample of manufacturing firms with profit-sharing schemes in the order of 15–16% for Great Britain, although they state that these estimates may be upward-biased. In a specification that controls for the potential bias, the positive productivity differential for UK firms with schemes is found to be somewhat lower at 9%. They also find evidence that other forms of employee involvement such as deferred profit sharing—which they use as a proxy for employee share ownership—have a positive impact on productivity. It is also of note that, although profit sharing in the British manufacturing sample has the second-highest productivity effect among the countries compared, none of the British schemes was subsidised (ie, there were no tax breaks). The authors suggest that this may be due to other forms of (unobserved) employee participation in profit-sharing firms, which may therefore tend to bias their estimates upwards.

5.4.4 Some studies disagree

Not all studies find a statistically significant positive association between firm performance and financial participation schemes. Therefore, the positive relationship between performance and financial participation cannot be regarded as the unambiguous (average) outcome. For example, Blanchflower and Oswald (1988) used WIRS2 to study how the financial performance of workplaces was related to three types of financial participation—employee share ownership, profit sharing and value-added bonuses. They found that none of the variables, either individually or when interacting with others, significantly influenced profitability (measured as the probability of an establishment having 'above-average performance'). The authors note, however, that the lack of adequate longitudinal information and the use of self-assessed data are liable to bias their results. In addition to finding no differences in profitability, the authors show that establishments with financial participation have similar employment growth rates and levels of quality of industrial relations as establishments without such participation schemes.

Addison and Belfield (2001) examine the determinants of establishment performance in the UK, using cross-sectional data from WERS98, to replicate earlier work by Fernie and Metcalf (1995), which was based on WIRS3 (referred to above). Specifically, they test whether contingent pay (profit sharing and employee share schemes), employee representation and other efforts to boost employee participation affect a set of economic and industrial relations outcome indicators. In relation to productivity impacts, there is limited evidence that contingent pay has a significant impact on productivity. For example, the existence of a SAYE scheme is associated with higher productivity levels, but the effect is significant only at the 10% significance level, and no significant effect on productivity increases is found. Profit sharing and executive share options are not found to have a significantly positive effect on productivity.

Pendleton (1997) compares the characteristics of manufacturing workplaces with various types of financial participation with those workplaces that have no scheme at all, using data from WIRS3. In the sample of 591 workplaces, 232 have no scheme of any sort; 106 workplaces have cash-sharing schemes only; 125 have a SAYE scheme only; and 79 have both cash schemes and SAYE. The main finding is that there is little support for most of the

arguments from economic theory explaining the use of financial participation. Many of the variables used to explain the existence of the various types of scheme (including the size and the productivity performance of an establishment) are found to be insignificant. Variables that matter most relate to industrial relations characteristics, such as the existence of white-collar union representation.

5.4.5 Summary

It is important to recognise that most of the literature does not focus on employee share schemes but on financial participation in general. As shown above, these have different incentive properties as do deferred versus instantaneous profit-sharing schemes. Some studies use a dummy for the presence of any scheme; others focus only on profit sharing. What emerges from those that specifically investigate employee share schemes is that the effects are usually found to be much smaller than the effects of profit sharing more generally, and are not consistently significant. The two UK studies reviewed in this paper that have examined the specific impact of tax-advantaged share schemes (rather than financial participation overall) have not provided a consistent range of their impact on productivity. Conyon and Freeman (2004) find for listed companies a positive impact for APS and CSOP of up to 18.9% and 12.2% respectively. However, no evidence of a positive impact is found for SAYE. Addison and Belfield (2001) find some indication that the existence of a SAYE scheme is associated with higher productivity *levels*, but the effect is significant only at the 10% significance level, and no significant effect on productivity *increases* is found.

5.5 Concluding remarks

This study should not be considered in isolation, but instead should be viewed in conjunction with the existing literature. The above literature review has highlighted several important issues for the current study.

- The impact of wider profit-sharing schemes (and other employee participation/workplace relations factors), with the exception of schemes that are not tax-advantaged, cannot be examined. This may lead to omitted variable bias.

- However, information is available for share schemes that are not tax-advantaged, and their interaction with tax-advantaged share schemes is examined in this study.

- There is a trade-off between using a cross-sectional survey dataset and a panel data approach using actual financial performance (as undertaken in this study):

  - many important firm/employee characteristics are not available in this study, which may suggest that there is some omitted variable bias in the results;
  - sample selection bias may be an issue since the dataset used in the Oxera analysis has data only on surviving companies;
  - the nature of panel data means that certain problems can be mitigated (eg, with simultaneity bias);
  - unlike UK studies based on WERS, the present study has actual performance data rather than subjective performance/output measures based on the subjective assessment of managers, who have been found to over-report the effects and, as a consequence, these effects may be upward-biased;
  - the use of panel data means that the dynamics of the effect of share schemes can be examined;
  - panel data means that more robust estimation techniques can be used—eg, a fixed effects framework enables unobservable firm effects (such as those referred to above) to be accounted for.

- Most studies that have used a panel dataset use a Cobb–Douglas model rather than a translog model. However, the validity of either functional form can be tested.

– The HM Revenue & Customs data used in this study is unique compared with that of previous UK studies, in that the analysis can examine the potentially differential effects of the various schemes. (Due to data limitations, UK studies to date have often analysed the aggregate impact of financial participation or employee share schemes.)

– The dataset contains information on all UK listed companies, plus a large number of unlisted companies, enabling some generalisations to be made (other UK studies are often restricted to manufacturing or listed companies).

– The literature review has identified variables that have been used in other studies.

– Overall, the review of the existing UK literature indicates that employee share schemes, and financial participation in general, may have significant, positive effects on productivity in the UK and, although perhaps somewhat less pronounced, on profitability and share prices. However, not all studies confirm these findings. From UK studies that provide specific estimates of the effect of schemes, Conyon and Freeman (2004) find for listed companies a positive impact for APS and CSOP of up to 18.9% and 12.2% respectively. However, they find no evidence of a positive impact for SAYE. In contrast, Addison and Belfield (2001) find some indication that the existence of a SAYE scheme is associated with higher productivity levels (significant only at the 10% significance level).

6 Explanation of datasets and the creation of the database

This section details all the data sources used to create the matched datasets, and explains the matching methodology, the degree of matching achieved, the sample selection process and the final sample, and the information contained in the datasets.

For this research, HM Revenue & Customs has made available detailed data on tax-advantaged share schemes covering the period 1989/90 to 2002/03 (section 6.1). This data is held on a scheme-by-scheme and tax-year basis, but for analysis purposes has been linked to form a panel dataset at the company level (section 6.2).

To conduct the analysis and answer the main research questions, this dataset must also be matched with detailed quantitative information about company productivity and other operating and financial characteristics of the companies offering such schemes (section 6.3 onwards).

6.1 HM Revenue & Customs administration dataset

The HM Revenue & Customs data contains all companies with one or more tax-advantaged share scheme in the period 1989/90 to 2002/03 for APS; 1988/89 to 2002/03 for SAYE; and 1984/85 to 2002/03 for CSOP,[31] with data for all schemes available from 1989/90 to 2002/03. This dataset includes information on:

– company name and address;
– share scheme number (unique to a specific company scheme);
– company registration number (CRN) (unique to a specific company);
– number of employees and directors awarded shares/granted options;
– number of shares/granted options (including replacement options);
– date on which shares were awarded or options granted (including replacement options);
– date on which options were exercised (including replacement options);
– value of shares at date of grant and exercise;
– total value of options at exercise, gross and net of acquisition price;
– information to calculate the monetary gain at exercise.

6.2 Collapsing the HM Revenue & Customs dataset to a company-level dataset

The HM Revenue & Customs data was summarised from a scheme level to a company level using company identifiers. Oxera identified which scheme belonged to each company and collapsed the data to the company level, counting the number of each type of scheme present for each company. This process also allowed the identification of companies, which, at some point in time, had a non-tax-advantaged scheme, denoted 'U' in the HM Revenue & Customs dataset.

6.3 FAME

To supplement the HM Revenue & Customs data, Oxera used FAME (Financial Analysis Made Easy) to provide accounting data for UK companies, both listed and unlisted. The latter is important since the HM Revenue & Customs dataset contains data on *all* companies with

[31] In earlier years, the HM Revenue & Customs CSOP dataset does not contain information on all variables. The analysis in this report is always undertaken on the longest possible time series.

one or more tax-advantaged share scheme in the period 1989/90 to 2002/03, and while some of these companies are quoted, many are not (see Table 2.1). In addition, most variation in terms of whether a company has a share scheme occurs in the unlisted companies.

The following data collected from FAME was employed:

- company name
- company address
- postcode
- year
- accounting reference date
- SEDOL number[32]
- registered number
- primary UK SIC (2003) classification[33]
- fixed assets (£)
- tangible assets (£)
- total assets (£)
- total assets less current liabilities (£)
- shareholders' equity (£)
- annual turnover (£)
- annual operating profit (£)
- annual profit (loss) before tax (£)
- annual profit (loss) after tax (£)
- annual market capitalisation (£)
- number of employees

This data is only available from FAME from 1993. Although Oxera considered using Datastream, the FAME database was chosen because it includes information on listed and unlisted companies; Datastream contains information on listed companies only.

The next step was to match the data collated from FAME with the HM Revenue & Customs dataset.

6.4 Matching FAME and HM Revenue & Customs data

The database of scheme information provided by HM Revenue & Customs contains 29,125 scheme observations. Of these, many are multiple schemes (of one type or different types) run by a single company. It also still includes scheme observations that are duplicates.

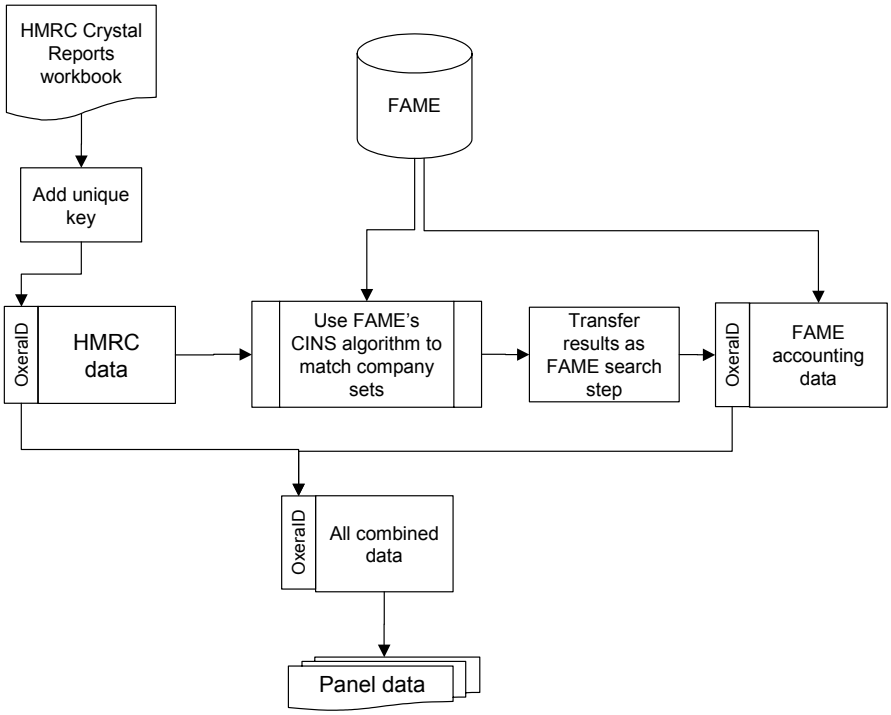
To eliminate the risk of incorrectly removing observations at this stage, the various company identification fields (including company name and CRN) of the entire HM Revenue & Customs dataset were imported into the company identification number search (CINS) function in FAME. Since none of the fields in the database could be used as a unique key, an artificial number sequence (OxeraID) was added to serve this purpose.

FAME's CINS algorithm was then used to identify companies in the FAME dataset that matched the companies in the HM Revenue & Customs dataset. A FAME search provided the accounting data for all these matched companies. This data could then be matched with the original HM Revenue & Customs data. Figure 6.1 summarises this process.

[32] Stock Exchange Daily Official List number, a code used by the LSE to identify stocks.

[33] Standard Industrial Classification, a code used for classifying business establishments by type of economic activity or industry in which they are engaged.

Figure 6.1 Overview of the matched panel creation process



Note: HMRC, HM Revenue & Customs.

The following provides a more detailed explanation of the matching process.

6.4.1 Matching with the CRN

First, the CRN was identified as the preferred variable with which to undertake the matching process. However, it was noticed that the CRNs in the HM Revenue & Customs data, where wholly numerical, often had fewer than the standard eight digits of FAME CRNs. This was assumed to be a result of leading zeros of the data being removed when imported into Excel by Crystal Reports. Since this could potentially lead to a mismatch—eg, a CRN of 6,254 being matched to 00006254 or 00062540—a formula was used to pad the CRN with leading zeros. In addition, many CRNs were tagged as being Scottish or Irish—eg, 123456 (SCOTLAND). While this may be a valid CRN, it is not a format that FAME can recognise. Therefore, any clearly Scottish or Irish CRNs identified in this way were reformatted with the appropriate two-letter code—eg, SC123456.

There were several instances of companies where the CRN appeared to find a match, but where there were discrepancies between the name identified in FAME and that held by HM Revenue & Customs. Possible reasons for these differences include:

– companies in groups may use the parent company's shares;
– differences between registered and trading names;
– changes of company name;
– data entry errors in the CRN field.

Investigation into many individual cases of name discrepancy showed that these were a result of company name changes or mergers rather than errors in the data.

6.4.2 Matching with the other criteria

Since 5,370 CRNs were missing, it was necessary to include other fields in the matching process—FAME allows matching to take place based on comparison between databases within many fields (as the CRN was identified as the ideal field to match, this field was given the highest priority in the matching process). Of the other possible fields available, the

company name and postcode were initially selected as the best criteria, although the postcode was later found to be of little value to the process and subsequently dropped. It should be noted that the match steps are applied in series; the CRN is looked at first and only if no match is found is the name searched for.

To aid the matching process when using the company name, FAME allows the use of a custom dictionary to give equivalent words and phrases the same weight in the match. Therefore, a list of common company terms and their derivatives (eg, 'Limited' and 'Ltd') was compiled and added to the process.

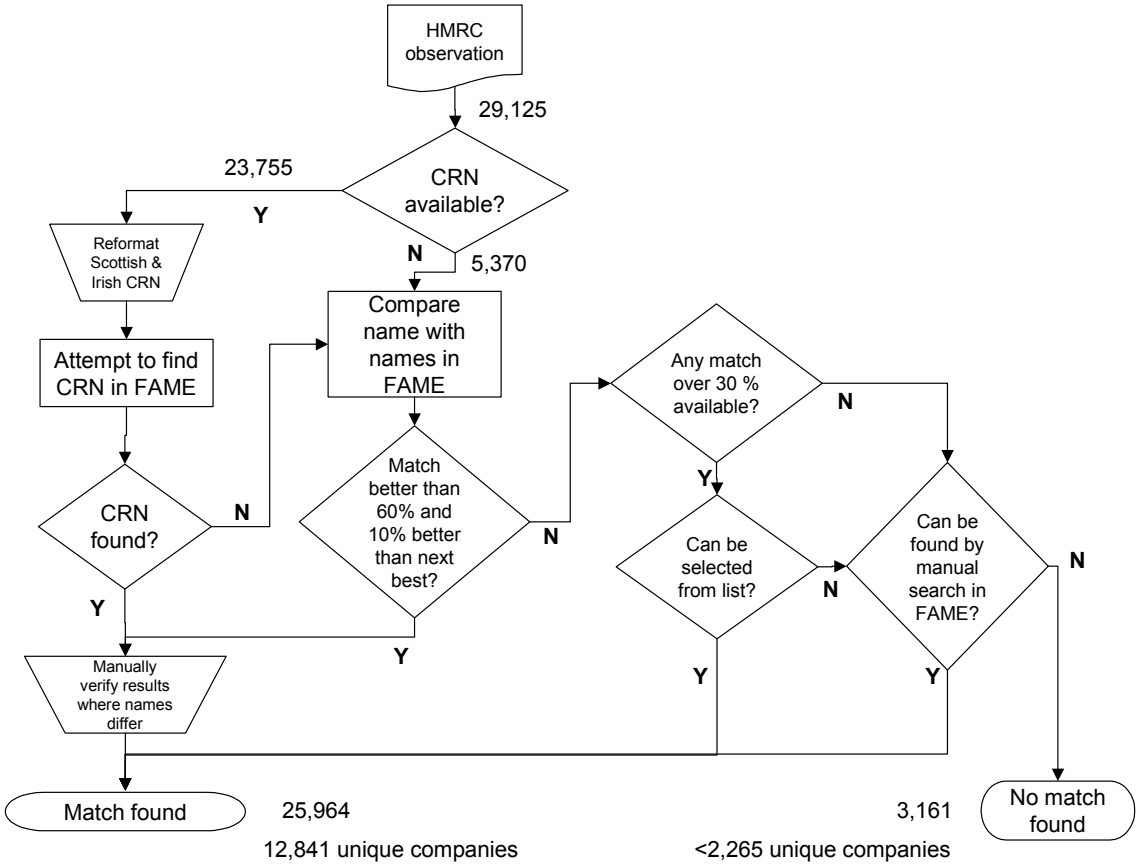
When matching on a text field such as the name, FAME rates the proximity of the match as a percentage. Manual analysis of early experiments showed that a match rated over 60%, and at least 10% better than the next best match, produced a consistently correct result, although all matches in this field below 80% needed to be verified manually. Similarly, matches rated below 30% had a very low chance of matching satisfactorily and were therefore excluded. It was decided that these were the boundaries that produced the highest number of successful matches while remaining confident of no incorrect matches.

Where the match percentage lay between these boundaries, or was less than 10% better than the next best alternative, FAME suggested multiple match possibilities. These were examined manually and the appropriate match was selected where it could be confidently identified.

This process left a remainder of companies that could not be matched at all by the CINS wizard. To ensure the maximum possible number of matches, all of these companies were searched for manually in FAME. Some extra matches were found at this stage, although it became clear that a large majority were US and other foreign companies, or simply no longer in operation.

Figure 6.2 summarises the matching process (the left-hand part of the diagram illustrates the matching procedure using CRN and the remainder illustrates the matching procedure using other criteria).

Figure 6.2 Detail of FAME matching criteria



Note: Unless otherwise stated, numbers are related to observations—ie, one observation represents a scheme that operates at some point over the sample period.
Source: HMRC, HM Revenue & Customs.

The result of this matching process, further described in the next section, was that 12,841 individual companies were matched, accounting for 25,964 of the original 29,125 scheme observations from HM Revenue & Customs dataset. Of these, many are multiple schemes (in terms of one scheme type or different scheme types) run by a single company. It also still includes scheme observations that are duplicates.

6.4.3 The resultant matched dataset downloaded

The resultant company list was set as a search step in FAME and relevant profile and financial data, including SEDOL number, number of employees, assets, liabilities and year-on-year turnover, was returned. This data was then exported as a spreadsheet.

The resultant spreadsheet contained a unique list of companies matched, reordered alphabetically by company name. It was therefore necessary to join the relevant records from the matched dataset with the original HM Revenue & Customs spreadsheet. The most effective way to accomplish this was a database join query, and therefore both spreadsheets were imported into MS Access. An SQL (Structured Query Language) query was defined to join every record in the HM Revenue & Customs data with only those records in the FAME results where the artificial key OxeraID was equal.

The recordset resulting from this SQL query was the desired output from the FAME matching process. It was then examined manually to verify that the match had been made correctly; cases where company names differed were also investigated further to ensure that they were being matched correctly.

When creating the final dataset for use in the econometric analysis, this data was matched with company data from FAME (see below). Some observations were removed in this process because FAME only provides this type company-specific data from 1992/93–2002/03. In addition, FAME does not provide company-specific data for all companies in the HM Revenue & Customs dataset.

6.5 Annual Respondents Database

Although Datastream has been used by researchers in previous work on the productivity of UK companies, recent studies have used data from the Annual Respondents Database (ARD), provided by the Office for National Statistics. A summary of the work using the ARD is provided in Barnes, Haskel and Ross (2001).

The ARD contains business micro data focused on productivity—ie, measures of employment, turnover/output, capital, gross value added, etc. The database is not limited to quoted companies, but includes business data for all businesses that respond to the annual business surveys conducted by the Office for National Statistics.[34] Although the response rate varies from year to year, and not all businesses respond in every single year, the database nevertheless provides sufficient information to create a very large panel of all types of business, whether quoted or not, and captures even very small firms. However, given the additional use of the FAME database, the key advantage of the ARD is the availability of data that enables superior productivity measures to be constructed—for example, the ARD includes value added, FTEs (full-time equivalents) rather than headcount, plus a more robust definition of capital.

While this is a clear advantage over Datastream, the ARD does have disadvantages and cannot be used as the only, or indeed the main, data source to carry out the analysis. In particular, it contains no information on accounting information and no market data, which are necessary for addressing questions relating to financial performance.

ARD data has been matched successfully with other databases in previous research studies.[35] In particular, the ARD provides the CRN, enabling the matching process to be fully automated within Stata/Access programs, as well as company name and address.

The results of the ARD data analysis are provided in a separate document.

6.6 Other issues

6.6.1 Tax year versus accounting year

Another complexity to consider in the matching process relates to the time period. The HM Revenue & Customs data relates to share schemes over the tax year, which do not in general coincide with the companies' accounting year—although some companies close their accounts at the end of March, the majority tend to have December accounting year-ends. Two approaches are possible:

– match the datasets to obtain the greatest overlap between tax year and accounting year—eg, data from accounting year-end December 2002 is matched with share scheme data for tax year 2002/03, whereas accounting year-end March 2002 is matched with tax year 2001/02;

[34] The ARD contains information at plant, establishment and enterprise group level. It categorises establishments into seven types: incorporated or company; sole proprietor; partnership; public corporation; central government body; local authority; and other (including non-profit-making bodies). For this analysis, the sample was restricted to the first type only.

[35] For example, Griffith and Simpson (2004) match the ARD data with information from the Annual Inquiry into Foreign Direct Investment to assess productivity differences between domestic and foreign-owned firms.

– adjust the data—eg, data from accounting year-end December 2002 is matched with three-quarters of the value of share scheme data for tax year 2002/03, and one-quarter of the value of share scheme data for tax year 2001/02.

The first option was considered the more robust approach for this study.

6.6.2 Sample selection bias

The market constituents change over time, and considering the current constituents only may introduce a bias in the results. Since FAME almost exclusively contains data of companies that were in operation 2002/03, and excludes foreign companies, the possibility of sample selection bias arises. As a consequence, the analytical results based on this sample may not accurately represent the true relationship between company performance and the existence of a share scheme. The dataset excludes foreign companies, although it is unlikely that these companies display systematically different responses to share schemes to UK companies, so their exclusion from the analysis is unlikely to bias the results. Using the numbers of companies matched and unmatched in Figure 6.2, it can be shown that only 12.1% of company observations (or 17.6% of unique companies) were not matched. The unmatched companies under foreign ownership for which FAME data is not available represent a majority of total cases of unmatched companies. Hence the bias introduced through sample selection is, if anything, likely to be small since it represents only a small proportion of the total number of companies in the HM Revenue & Customs dataset.

6.6.3 Mergers and acquisitions during the period of analysis

Some companies may not remain the same entity over the period of analysis as a result of mergers and acquisitions. This causes a number of problems:

– the company name changes, making the construction of the panel dataset more complex;
– the acquired company may disappear completely from the panel;
– the acquiring company becomes a different entity post-merger;
– share schemes are disrupted as a result of the merger.

6.6.4 Companies without share schemes

The ARD and FAME datasets contain a large number of companies, potentially leading to an imbalance between the number of companies with employee share schemes and those without. This imbalance is likely to be a function of firm size, with the incidence of employee share schemes being lowest among small companies.

This problem can be partly addressed in the econometric analysis by controlling for firm size.

6.7 The final dataset

The aim of the data-merging procedure was to create datasets that are based on as large and diverse a sample of companies as possible. This was achieved by:

– matching as many companies as possible from the HM Revenue & Customs dataset—both quoted and unquoted companies using FAME; and
– adding to the dataset—in addition to those matched companies, it is important to ensure that a control group is included in the data (ie, companies that do not have share schemes).

The matched HM Revenue & Customs/FAME dataset consisted of 12,841 unique companies with share schemes.

The control group was identified by including the following companies.

– All listed companies, including the largest companies on the FTSE 100 and FTSE 250, as well as the smaller companies listed on London's Main Market were included in the control group. The latter were particularly important for inclusion in the sample in that they increase variation across companies in terms of share scheme take-up rates—eg, as shown in Table 2.1, virtually all FTSE 100 firms (97%) had at least one share scheme. Thus, in this too-restrictive sample, the only variation comes from differences in participation rates or possibly in the type of scheme offered. In addition to FTSE constituents, companies quoted on the AIM or OFEX were selected, provided that FAME data was available. Since FAME only provides information from 1993 onwards, the time period over which the data is available is shorter than that of the HM Revenue & Customs share scheme dataset.

– Unquoted companies without share schemes—to expand the dataset further, unquoted companies without share schemes were included. However, such a dataset is too large—missing data is more problematic for unquoted companies and these companies do not represent significant value in the economy relative to quoted companies. Thus, to supplement the dataset, FAME was used to obtain a random sample of 125,000 unquoted companies without share schemes.

A complete list of FAME companies was returned from FAME within each of the three income brackets and allocated a sequential index number. 125,000 random numbers were generated from the range 1 to 1.8m. The companies with an index number within the random set were retained as a potential sample, with the remainder discarded.

Two SQL queries were then run: one to remove duplicates from this group, and another to query the CRNs against the HM Revenue & Customs data to remove any companies with tax-advantaged share schemes from the control group. This left a total control group size of 122,515.

Financial information was then downloaded from FAME in exactly the same format as for the companies with share schemes and this dataset was merged with the HM Revenue & Customs dataset.

Further cleaning of the data was undertaken, and the process generated a dataset sufficiently large and diverse to produce statistically robust results. This dataset contained companies both with and without tax-advantaged share schemes. Certain elements of the analysis focus only on companies with share schemes, and the relevant dataset was created by ignoring or deleting companies without share schemes.

For the main parts of the analysis, however, it was important for the dataset to contain a sufficient number of comparators against which to benchmark the characteristics and performance of companies with share schemes. These comparator companies were identified in the matching process as companies that appear in the FAME dataset but not in that of HM Revenue & Customs because they have no tax-advantaged share schemes. In the matched dataset, a simple indicator variable was created to identify these companies as not having a share scheme, and any variables relating to share schemes were correspondingly set equal to zero (or marked otherwise where appropriate).

7 Measurement of company performance and other variables

The two main aims of this research are to assess the characteristics of companies with employee share schemes and to examine the relationship between usage of the schemes and companies' performance. The following outlines how Oxera defined, measured and constructed company performance and other main variables.

7.1.1 Productivity

To assess productivity, most studies in the literature apply a production function approach. That is, output is assumed to be a function of different inputs, of which some are tangible (eg, labour and capital) and some are intangible (eg, employee share schemes). Productivity is then measured as either output per employee (or per man-hour) or as total factor productivity (TFP). In the former case, total output is divided by total labour input. In the latter, TFP is defined as the portion of output which is not accounted for by tangible factor inputs. This approach generally requires econometric estimation and is considered in the econometric analysis described in section 10. A descriptive analysis of labour and capital productivity is presented in section 8.

Total output is measured as real sales, obtained by deflating a company's reported turnover by the RPI, and total labour input as the number of employees.

In this study, as with most panel data studies, the collated data is used within a production function context in order to consider the impact on productivity, rather than modelling productivity directly. However, in the descriptive analysis, levels of labour and capital productivity are examined.

7.1.2 Financial performance and control variables

Although the focus is on productivity, the research also examines in detail companies' financial performance, particularly profitability. The relationship between employee share schemes and profitability is less well established than that between schemes and productivity, and most hypotheses regarding the effectiveness of share schemes relate to productivity rather than profit. For example, even if employee share schemes increase productivity, this may not necessarily imply higher profitability since the operation of a scheme may result in higher labour costs due to the additional compensation for employees.

The accounting-based indicators of financial performance cover those used in many academic studies:

- *return on capital employed*—the ratio of earnings before interest and tax (EBIT) to capital employed;
- *return on equity*—the ratio of net income to shareholders' equity;
- *return on sales*—the ratio of EBIT to total sales.

These indicators were constructed using information from the FAME database.

In addition, the empirical analysis controls for a range of other company-specific characteristics that may affect productivity and performance, and FAME data was collected to construct these control variables. These include in particular:

– *industry classification*—FAME provides a disaggregated level of SIC for each company.[36] Oxera aggregated this information into 17 categories using the breakdown of definitions provided by the Office for National Statistics;[37]
– *company size*—as measured by turnover, number of employees and the capital stock;
– *listing status*—ie, whether a company is listed on the stock market. The listing status of a company is identified through the SEDOL (Stock Exchange Daily Official List) code available in FAME, a stock code that is issued by the London Stock Exchange and used to identify all securities issued in the UK or the Republic of Ireland.

7.1.3 Usage of employee share schemes and gains to employees

The analysis of usage of employee share schemes was somewhat restricted by a lack of suitable data (see section 8). As a consequence, the analysis was limited to using information provided by HM Revenue & Customs:

– 0/1 indicators of whether a company has an employee share scheme in place, whether a specific share scheme is in place and whether more than one scheme is in place;
– gains realised by the company's employees at the exercise of SAYE and CSOP options.

7.1.4 Macroeconomic variables

In addition to company-specific variables, Oxera used the Office for National Statistics database to download time-series data on macroeconomic variables to control for any macroeconomic influences on the incidence and impact of employee share schemes (eg, GDP) and to deflate variables measured in monetary terms (RPI). Share index information and Bank of England interest rates were downloaded from Thomson Datastream.

[36] FAME does not provide industry codes for some companies; analysis by industry therefore excludes those companies without SIC.
[37] http://www.statistics.gov.uk/methods_quality/sic/contents.asp.

8 Descriptive analysis: employee share schemes, gains to employees and company characteristics

This section provides summary descriptive statistics of the data analysed in this report.[38] The insights gained are used to help understand the data and provide some guidance on the econometric approaches adopted in sections 9 and 10. The descriptive statistics are supplemented by tests to assess the statistical significance of any observed differences between types of company and share schemes.[39] Section 8.1 provides a general overview of the scheme data provided by HM Revenue & Customs, and section 8.2 uses the FAME dataset matched with the HM Revenue & Customs data to explore the characteristics of companies with employee share schemes.

The HM Revenue & Customs scheme data (relating to tax year) was matched with accounting data referring to financial year, as described in section 6.6.1. The statistics published by HM Revenue & Customs and those shown in this report therefore differ when looking at individual years of data.

The statistics calculated in this section have been derived using the largest possible number of observations. That is, the statistics in section 8.1 are based exclusively on the data from the HM Revenue & Customs database. The statistics in the remainder of the section require company-specific information and are therefore derived from somewhat smaller samples (due to missing information on certain variables or non-matched observations).

8.1 Descriptive analysis: share schemes

This section presents a general overview of the usage of employee share schemes among the aggregate of firms and employees, and the monetary gains realised by employees. It provides descriptive statistics on:

– the number of companies with schemes and multiple schemes;
– the number of employees participating in schemes;
– the monetary gains accruing to scheme participants.

8.1.1 Company use of share schemes over time

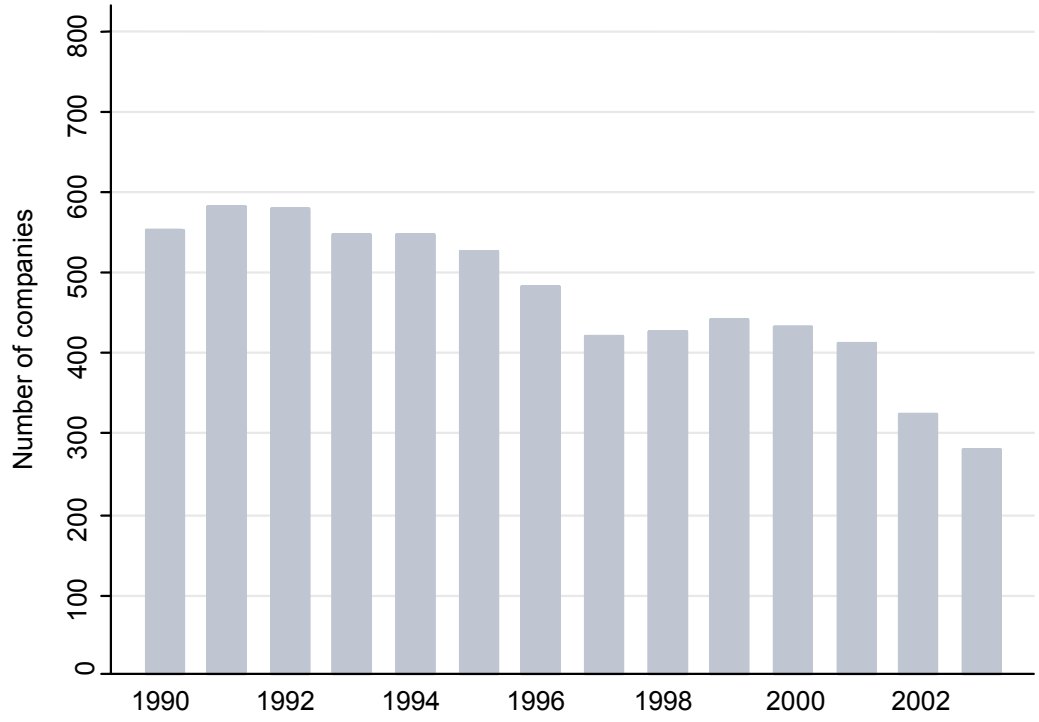
The three share schemes (APS, SAYE and CSOP) have exhibited different growth patterns in terms of the number of companies that have schemes over time, as demonstrated in Figures 8.1 to 8.3.

The definition adopted to measure the number of companies with an employee share scheme is the number of companies that reported operating a particular scheme in any given year via annual returns forms. The margin of error on this variable is likely to be small, although there is scope for missing returns or data entry errors.

[38] Several UK studies have examined the characteristics of firms with financial participation. For example, Robinson and Wilson (2001) show that employee share schemes are found in larger firms with a higher proportion of white-collar workers. Pendleton (1997) shows that financial participation is positively associated with, among other factors, union presence.

[39] Throughout this section, the sample selection criteria adopted to perform the statistical analyses were the least stringent possible. This ensures that the resulting statistics are as representative of the population as possible. However, the more information required to produce a statistic (eg, labour productivity by industry), the greater the reliance on different statistics being available simultaneously for every company. Given that all data was not always available for all observations, the sample sizes were reduced somewhat and vary across statistics. However, due to an overall large sample size, the sample reduction resulting from unavailable data does not have major implications for the representativeness of the statistics.

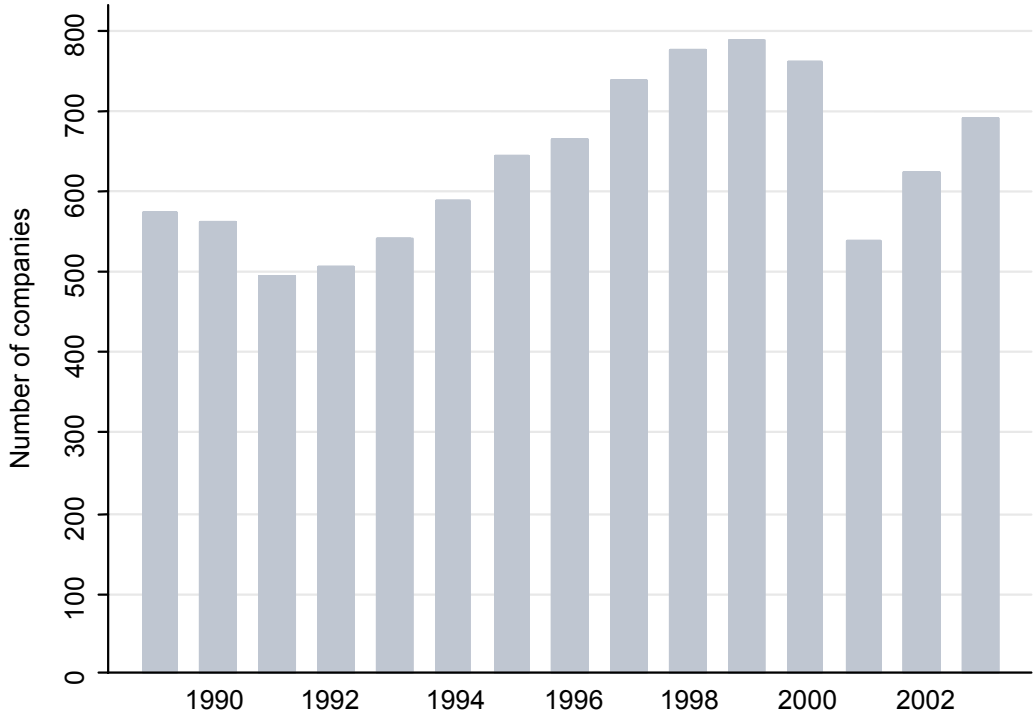
Figure 8.1 Number of companies with APS (financial year ending)



Source: HM Revenue & Customs; and Oxera calculations.

The reduction in the number of companies offering APS after 2000 coincides with the Finance Act 2000, which introduced a new share scheme, SIP, designed to replace APS. As part of the introduction of the new scheme, HM Revenue & Customs has not approved any new schemes since April 2001 (ie, financial year ending 2002). However companies were permitted to continue awarding options under existing schemes until December 2002 (financial year ending 2003).

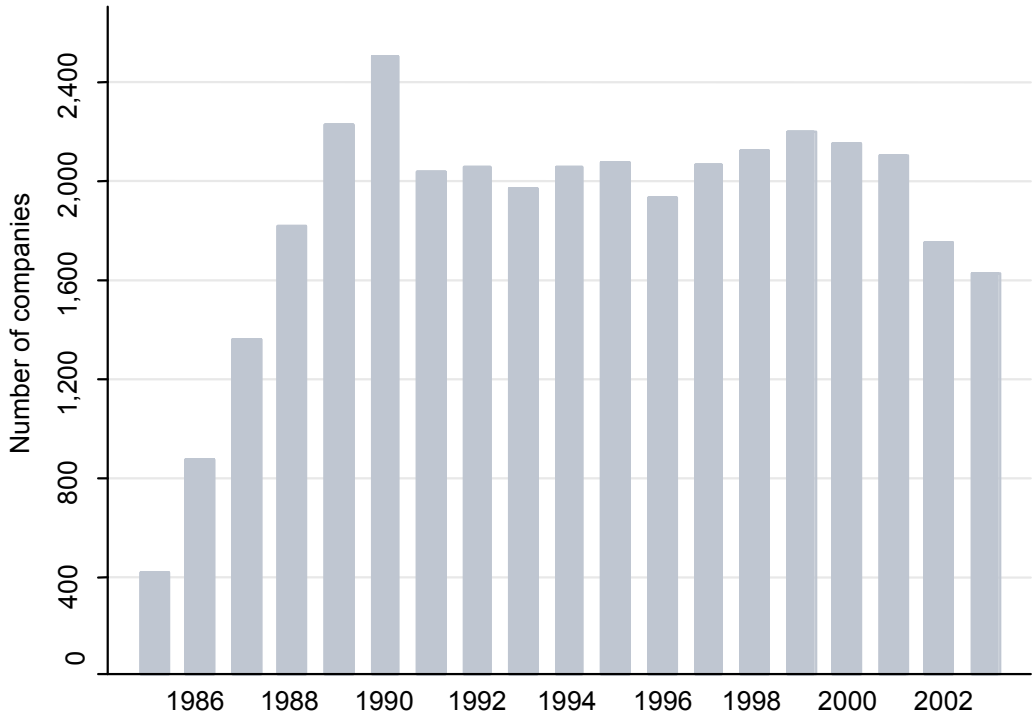
Figure 8.2 Number of companies with SAYE (financial year ending)



Source: HM Revenue & Customs; and Oxera calculations.

The sudden reduction in companies offering SAYE schemes in 2001 follows the stock market downturn and the introduction of SIP in 2000.

Figure 8.3 Number of companies with CSOP (financial year ending)



Source: HM Revenue & Customs; and Oxera calculations.

The number of companies offering CSOPs declines after 2001 rather than 2000. This may be due to the different nature of the scheme, which targets specific key employees rather than employees as a whole. It may have taken time for companies to adjust their CSOP strategy following the introduction EMI in 2000 and expansion of eligibility in 2001.[40] Statistics published by HM Revenue & Customs show the decline in CSOP to be concentrated among unlisted companies, while take-up of EMI has been similarly concentrated, suggesting switching behaviour.

Appendix 3 contains further descriptive statistics, namely the number of new schemes in each year (Table A3.1) and the proportion of companies that have more than one scheme (Table A3.2). As shown in Table A3.2, companies are most likely to have both a CSOP and a SAYE scheme. This is at least partly because, after 1993/94, more companies offered either CSOP or SAYE schemes than APS schemes (see Figures 8.1 to 8.3) and few companies offered all three types of scheme simultaneously.

8.1.2 Employee participation in schemes

The definition of the extent of participation in schemes is somewhat less straightforward than the number of companies operating schemes and is dictated by the availability of data. Companies are required to report to HM Revenue & Customs details of individual share awards, options grants, option exercises and taxable events that occurred during the tax year for their tax-advantaged schemes. To minimise the compliance burden on companies, they are not required to report the total number of participants for each tax year or the overall scheme. Therefore, due to a lack of statistical information, it is not possible to calculate a stock measure of the *total* number of employees that participate in schemes in any single year.[41] Employee participation is instead measured as a flow—ie, the number of employees who were granted options (SAYE and CSOP) or purchased shares (APS) during any single year. The participation measure used in this report thus represents employees that are either new participants, or existing participants who are awarded additional options or purchase shares under an existing scheme in any given year.

Figures 8.4 to 8.6 demonstrate how employee participation in each of the schemes has changed over time. Note that it is not possible to determine the level of employee participation as measured by the proportion of employees participating in any one scheme, although this would be highly informative.

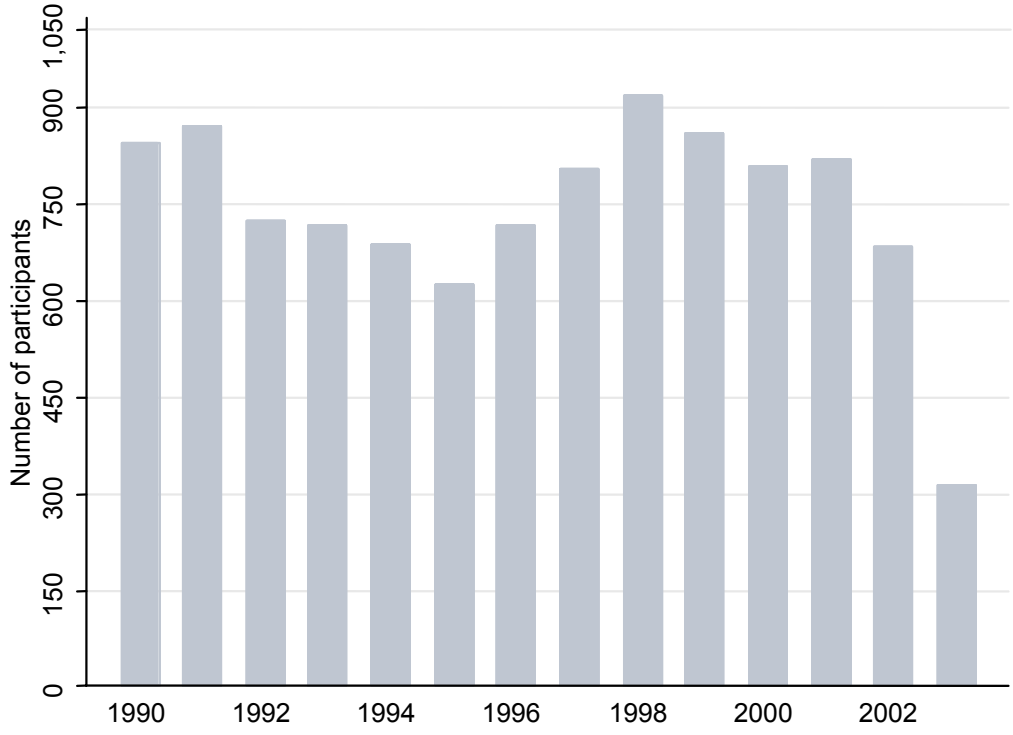
Figure 8.4 shows the number of employees who purchased shares under APS over time. As expected, the number of employees purchasing shares declined after financial year ending 2001. This decline is mainly is due to HM Revenue & Customs no longer approving new schemes after April 2001. Although awards under existing APS schemes could be made until the end of December 2002 (ie, some companies would have their accounts classified as financial year ending 2003) a closer inspection of the data reveals that relatively few companies continued to award shares since the median number of employees purchasing shares in financial year ending 2003 is zero.[42]

[40] EMI was initially limited to 15 employees per company and relatively small, high-risk companies with gross assets no greater than £15m. See http://www.hmrc.gov.uk/budget2001/revce1.htm and http://www.hmrc.gov.uk/pbr2001/revce1.htm.

[41] As a result it has not been possible to calculate statistics that require stock measures, such as the intensity of use of schemes measured by the ratio (employees with scheme:total number of employees) or measures of the total stake that employees have in their company given by the ratio (total number of shares held by employees:total number of shares issued by company).

[42] A median of zero means that less than 50% of companies continued awarding schemes in financial year ending 2003. In 2003, 121 companies awarded schemes compared with 158 companies that did not. In contrast, in 2002, 219 companies awarded schemes whereas 105 companies did not. See Appendix 3, Tables A3.3–A3.5 for the median number of companies offering schemes by year,.

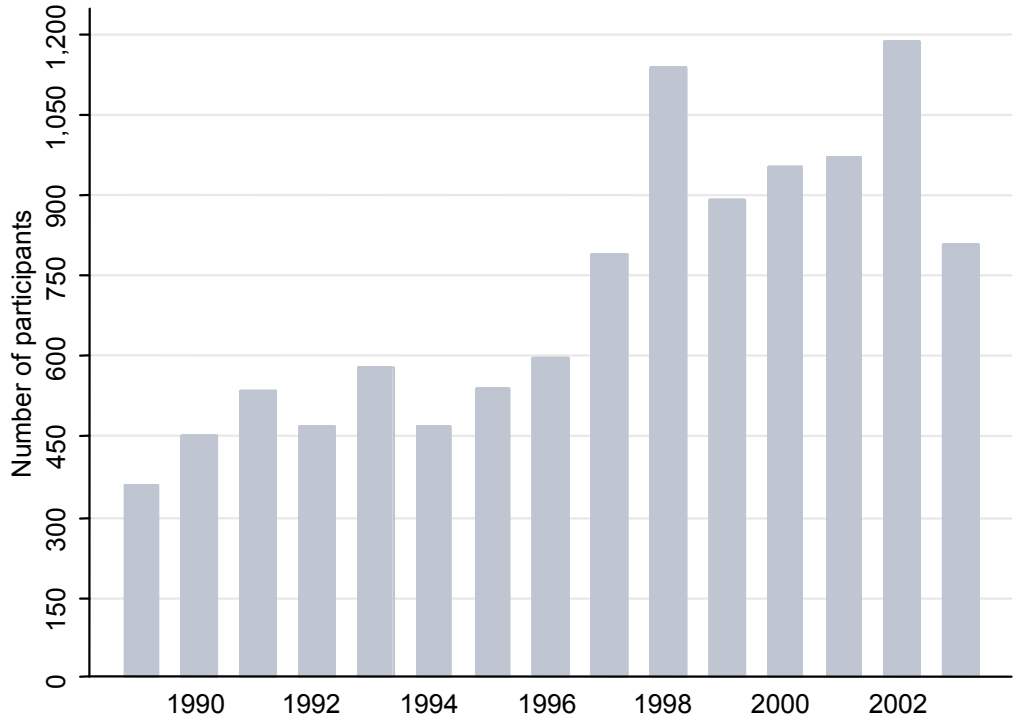
Figure 8.4 Number of employees who purchased shares under APS (financial year ending, '000s)



Note: See Table A3.3 for further summary statistics.
Source: HM Revenue & Customs; and Oxera calculations.

Figure 8.5 shows that the number of employees who were granted options under SAYE has broadly increased since 1989, particularly after 1996.

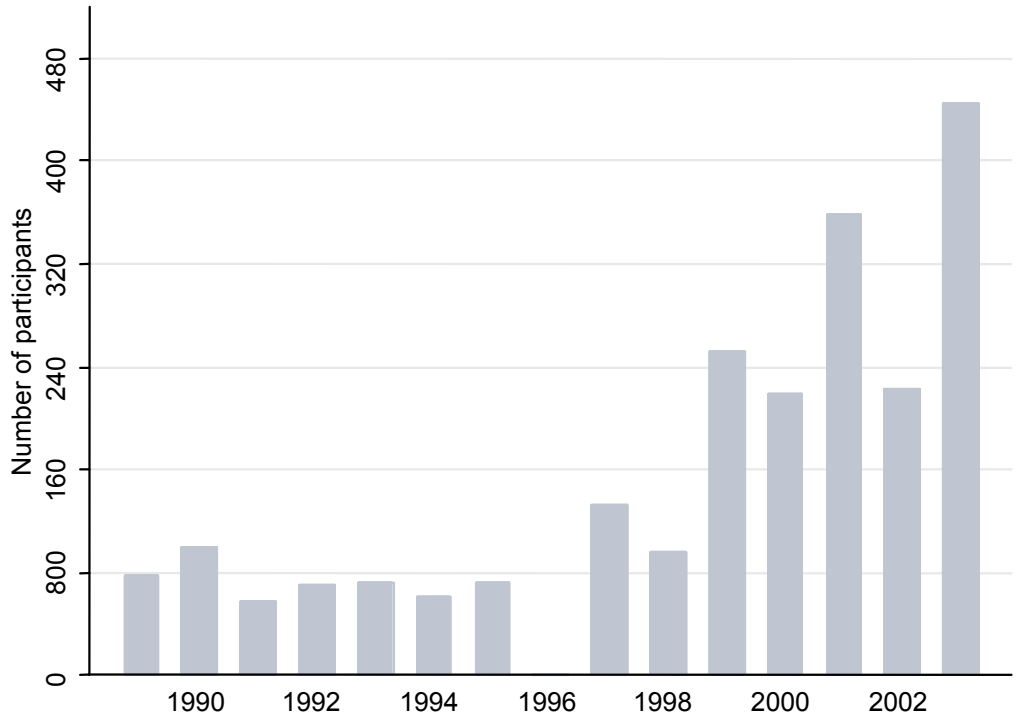
Figure 8.5 Number of employees granted options under SAYE (financial year ending, '000s)



Note: See Table A3.4 for further summary statistics.
Source: HM Revenue & Customs; and Oxera calculations.

As shown in Figure 8.6, the number of employees granted options under CSOP has been broadly increasing since 1997. The reduction in 2002 may be due to the downturn in the market after 2000. The 1996 data for the number of employees with options granted is incomplete in the database provided by HM Revenue & Customs and therefore the figure for this year is not included in the graph.

Figure 8.6 Number of employees granted options under CSOP (financial year ending, '000s)



Note: The data for 1996 participation is incomplete in the database provided by HM Revenue & Customs and therefore the figure for this year is not included. See Table A3.5, Appendix 3, for further summary statistics.
Source: HM Revenue & Customs; and Oxera calculations.

8.1.3 Monetary gains to employees

It is possible to calculate a measure of the aggregate gains realised by employees who exercised SAYE and CSOP options. It is not possible to calculate the gains from the data for APS because a reportable event only occurred on acquisition of shares—when the shares were sold (free of tax) after three years, their price was not captured by HM Revenue & Customs for statistical purposes.

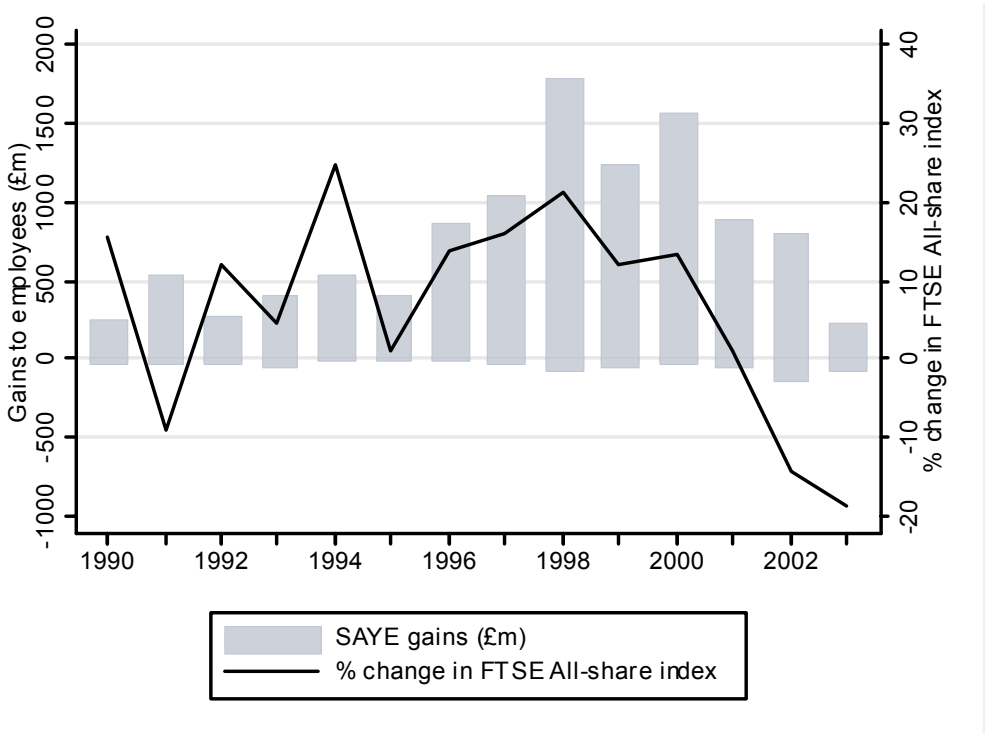
To calculate the gains from a scheme, the market value of the shares at the point at which they were exercised is required. In practice, the actual share value at the time of exercising an option is not available since this would increase the cost of data collection considerably. Instead, the company share price at the end of the financial year is used to derive an approximation of the gains. As a result, it is possible to obtain negative gains if the reported market value of the shares is lower than the actual selling price and this point estimate of the actual selling price is lower than the original value of the options. Negative gains could further be explained by potentially non-rational behaviour by individuals (eg, exercising options that are 'underwater'[43]).

[43] 'Underwater' refers to options when the stock's current market price is below the grant price on the option.

Figure 8.7 shows the aggregate annual gains (and losses) that employees participating in SAYE have realised since 1990. The largest aggregate gain occurred in 1998/99 during a period of strong stock market growth. The largest aggregate losses occurred in 2001/02 during the market downturn. Note that, under SAYE, employees can allow their options to lapse and instead collect their tax-advantaged savings, including an interest payment, at the end of the savings contract. Employees are therefore highly unlikely to incur losses. Instead, losses (see Figure 8.7) can be attributed to the use of an *estimated* selling price instead of the *actual* selling price.

It is also instructive to examine the gains to employees relative to general stock market conditions. Figure 8.7 also shows the year-on-year growth in the FTSE All-share index. As may be expected, there is an indication that the gains are related to market performance—namely, that gains to employees increase as the general market grows, while gains fall as the market declines. Note, however, that the increase in gains is not only related to stock market performance, but is also likely to be a function of the overall broad increase in the number of participants in schemes over this period.

Figure 8.7 SAYE gains over time compared with FTSE All-share index

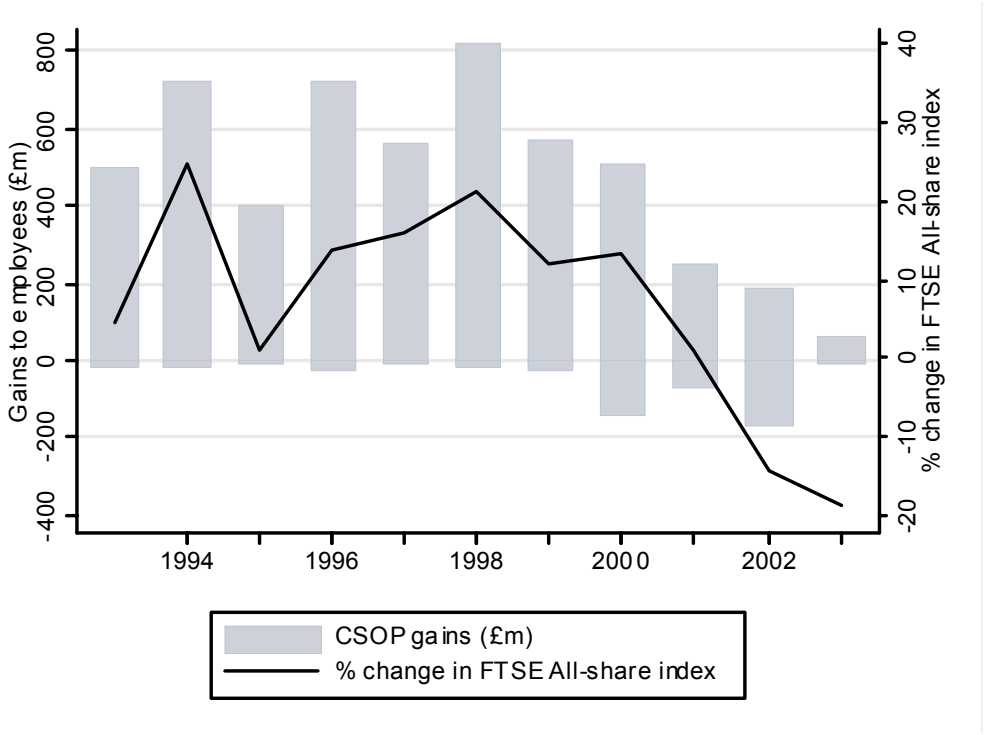


Note: Results for 2002/03 should be interpreted with caution since around 30% of companies do not have all data required to calculate the gains. In all other years, the data contains information on 90% or more of companies. All figures are expressed in 2003 prices.
Source: HM Revenue & Customs; and Oxera calculations.

Similarly, Figure 8.8 shows the aggregate annual gains (and losses) that employees participating in CSOP have realised since 1994. The largest aggregate gain occurred in 1997/98, during a period of strong stock market growth. Similar to SAYE, the largest aggregate losses occurred in 2001/02 during the market downturn.

Again, the inclusion of the growth rate of the FTSE All-share index shows that the size of gains is broadly related to market conditions.

Figure 8.8 CSOP gains over time compared with change in FTSE All-share index



Note: Results for 1994/95, 1995/96 and 2002/03 should be interpreted with caution since around 30% of companies in the HM Revenue & Customs database do not have all the data required to calculate the gains. In all other years, the database contains information on 95% or more of all companies. Figures are expressed in 2003 prices.
Source: HM Revenue & Customs; and Oxera calculations.

Tables A3.6 to A3.9 in Appendix 3 contain further descriptive statistics on the gains (and losses) to employees.

A further dimension in which the benefits to employees can be analysed is in terms of the distribution of the value of options and shares across industries. For the purpose of this report, this value is defined as the total number of options in the scheme (SAYE, CSOP) or shares appropriated (APS) during any given year multiplied by the average market value of the shares at the time.[44]

The value of shares/options held by employees in each industry is expressed as a proportion of the aggregate share/option value across all industries. To remove the potential effects of stock market movements on the share value, this was calculated as the average across the period 1998/99–2002/03.

The total monetary values are not shown since FAME does not provide industry codes for all companies (total values would not therefore represent the average total value of schemes). However, the proportions are unlikely to be systematically affected by this and are therefore a good indicator of the relative values by industry.

Table 8.1 shows the proportion of the aggregate share/option value that is held by scheme participants in different industries. Around two-thirds of the total value of all schemes is concentrated in financial intermediation, manufacturing, and wholesale and retail.

[44] This value measure is influenced not only by the number of employees participating but also by the actual value of the shares. These tend to be higher in certain industries, such as financial intermediation.

Table 8.1 Proportion of aggregate share and option value by industry (%)

Industry (SIC)	All schemes	APS	SAYE	CSOP
Financial intermediation	26	41	24	25
Manufacturing	20	19	22	14
Wholesale and retail trade	17	15	19	12
Transport, storage and communication	14	6	14	18
Real estate, renting and business activities	9	4	7	18
Electricity, gas and water supply	6	7	7	3
Hotels and restaurants	2	3	2	3
Other community, social and personal service activities	2	n/a	2	5
Mining and quarrying	2	5	1	2
Construction	1	1	1	1

Note: Figures represent the value of shares/options held by employees in each industry expressed as a proportion of the aggregate share/option value across all industries. Figures are calculated as the average over five-year period from 1998/99–2002/03. Industries or categories with a share of less than 0.5% are not shown.
Source: HM Revenue and Customs; Oxera analysis

8.2 Descriptive analysis: characteristics of companies with employee share schemes

The previous sub-section has provided some broad descriptive statistics relating to the share schemes. This section focuses on the wider characteristics of companies that operate employee share schemes, and is intended to provide an indication of:

– whether companies that choose to operate a scheme differ in a statistically significant way from those that do not;
– which companies are more likely to choose a particular type of scheme or operate more than one scheme.

The evidence gathered from the descriptive analysis regarding the characteristics of companies with and without schemes in this section is complemented by econometric analysis in section 9 in order to control for the multiple factors that may affect company decisions regarding share schemes. A formal econometric assessment of the impact of share schemes on productivity is provided in section 10.

8.2.1 Company size

The existing evidence suggests that larger companies have tended to be more likely to operate a share scheme than smaller companies (see Table 2.1 and Pendleton 1997).

The following tables examine company size by share scheme. Similar analysis was also undertaken to examine turnover and capital. However, given the strong correlation between all these variables, this analysis has not been tabulated as it shows much the same pattern as employee numbers.

Table 8.2 examines the number of employees over time for those companies with and without share schemes over the sample period—there is a clear indication that larger companies are more likely to have share schemes than smaller companies, both in terms of

the mean and median. The significance of these size differences is supported by statistical tests (see Table A3.13 in Appendix 3).

The dataset is very heterogeneous—ie, there is a large variation across companies in terms of workforce size and other characteristics. The distribution of the number of employees is skewed to the right—ie, the distribution has values that are bunched together below the mean, but has a long tail above the mean. It is therefore more informative to focus on the median number of employees (ie, when ordering the dataset by number of employees, the median number of employees divides the distribution in half). The mean represents a distorted picture of the 'true' average number of employees since it is influenced a few large observations, whereas the median is not sensitive to unusually large values.

Table 8.2 Number of employees for companies with and without share schemes

	Scheme		No scheme	
Year	**Mean**	**Median**	**Mean**	**Median**
1992/93	2,498	367	509	98
1993/94	3,659	429	458	79
1994/95	3,712	459	468	80
1995/96	3,856	504	493	81
1996/97	3,702	483	495	83
1997/98	3,678	449	519	87
1998/99	3,858	404	499	85
1999/2000	4,153	377	492	88
2000/01	4,317	341	572	90
2001/02	4,983	392	538	91
2002/03	6,434	671	502	87
Weighted average	4,025	437	507	86

Note: Employee figures for companies with schemes are calculated for all schemes combined.
Source: HM Revenue & Customs; and Oxera calculations.

Tables A.3.10–A3.12 in Appendix 3 contain summary statistics for each of the three schemes. It is notable that the size discrepancy is more significant for SAYE and APS share schemes than for CSOPs. This is to be expected since SAYE and APS are all-employee share schemes and, due to set-up and operating cost considerations, are therefore more suited to larger companies. At the aggregate level—ie, across all share schemes (as shown in Table 8.2), the size discrepancy is more in line with the position on CSOPs. This is because there are significantly more companies with CSOP schemes than SAYE or APS, as illustrated in Figures 8.1 to 8.3.

Companies may also operate more than one employee share scheme of any one type. Since the set-up costs for schemes are relatively high for smaller companies, this suggests that larger companies are more likely to offer multiple schemes. This is confirmed when analysing the likelihood of companies operating multiple schemes (see Tables A3.14–16 in Appendix 3).

8.2.2 Industry sector

This section examines whether the usage of share schemes differs across industry sectors. The analysis was carried out at the most aggregate level of SIC.[45]

Table 8.3 provides a breakdown of the distribution of schemes by industry (multiple schemes included).[46] The proportion of share schemes by industry sector remains broadly constant over the sample period. The table thus shows the average of annual industry proportions for the period 1989/90–2002/03.

The table demonstrates that around one-third of all three types of share scheme are run by companies in the manufacturing sector. Manufacturing, together with real estate, renting and business activities, wholesale and retail trade, and financial intermediation companies operate around 80% of all share schemes.

Table 8.3 Proportion of total number of schemes by industry

Industry (SIC)	APS		SAYE		CSOP	
	%	Rank	%	Rank	%	Rank
Agriculture	0.2	(13)	0.1	(12)	0.5	(12)
Mining and quarrying	4.0	(7)	1.7	(10)	1.8	(9)
Manufacturing	38.2	(1)	40.8	(1)	33.8	(1)
Electricity, gas and water supply	5.3	(5)	4.3	(7)	1.5	(10)
Construction	2.9	(8)	4.9	(6)	4.3	(5)
Wholesale and retail trade	12.0	(3)	13.6	(3)	13.4	(3)
Hotels and restaurants	2.0	(10)	2.7	(8)	2.0	(8)
Transport, storage and communication	4.0	(6)	5.1	(5)	3.9	(6)
Financial intermediation	11.2	(4)	8.3	(4)	8.2	(4)
Real estate, renting and business activities	16.6	(2)	15.4	(2)	26.3	(2)
Education	0.5	(11)	0.1	(13)	0.2	(13)
Health and social work	0.5	(12)	0.6	(11)	0.6	(11)
Other community, social and personal service activities	2.6	(9)	2.4	(9)	3.6	(7)

Note: Table figures are calculated using the mean of 1989/90–2002/03. The figures calculated on an annual basis do not differ substantially from the figures in this table.
Source: HM Revenue & Customs; Oxera calculations.

Table 8.3 focuses only on companies that have schemes and does not take account of the total size of the industry. For example, manufacturing companies hold a relatively large proportion of shares since this constitutes the largest SIC category and includes a relatively large number of companies. Tables 8.3 to 8.5 examine the number of share schemes across different industry sectors when the total size of the industry is taken into account.

[45] A useful extension of the analysis provided here would be a more detailed examination of adoption of schemes using a more disaggregated classification of SIC. This may provide additional insights, particularly into those sectors where the use of schemes is most frequent since it is possible that scheme adoption is concentrated among certain SIC sub-groups. However, an analysis of scheme use by disaggregated SIC is limited by the fact that, for most industries, there are no or only very few observations in each of the sub-categories. Some analysis has been carried out for those industries where scheme use is most widespread, namely manufacturing, wholesale and retail trade, financial intermediation, and real estate, renting and business activities. The tables showing scheme usage by disaggregated SIC for these sectors can be found in Appendix 3.

[46] This table was compiled using the dataset containing scheme data only. The remainder of the statistics in this sub-section were compiled from the dataset that merges HM Revenue & Customs and FAME data to include financial data and companies without schemes. As a consequence, due to sample selection, the proportions in the final dataset differ somewhat from Table 8.2.

Table 8.4 examines the number of APS share schemes across different industry sectors over the sample period. When total industry size is taken into account—ie, when analysing the proportion of companies in each industry that have share schemes—the electricity, gas and water supply sector is most likely to operate APS (31%). Mining and quarrying, followed by financial intermediation are, on average, most likely to operate more than one APS.

Table 8.4 Use of APS share schemes by industry sector

Industry (SIC)	Number of companies with an APS scheme	Rank	Companies in sector with an APS scheme (%)	Rank	Average number of APS schemes per company with APS	Rank
Mining and quarrying	15	(6)	10	(2)	1.14	(1)
Manufacturing	135	(1)	4	(4)	1.05	(5)
Electricity, gas and water supply	19	(5)	31	(1)	1.01	(9)
Construction	10	(8)	1	(9)	1.04	(6)
Wholesale and retail trade	42	(3)	2	(6)	1.03	(7)
Transport, storage and communication	14	(7)	2	(5)	1.06	(4)
Financial intermediation	41	(4)	5	(3)	1.10	(2)
Real estate, renting and business activities	59	(2)	2	(7)	1.07	(3)
Other community, social and personal service activities	10	(8)	2	(8)	1.03	(8)
Weighted average			**3**		**1.06**	

Note: Table figures are calculated using the mean of 1993/94–2001/02. For confidentiality reasons, figures were included only for industry sectors with ten or more companies. The average number of schemes per company could be influenced by two schemes overlapping in terms of timing of operation (eg, during a merger), potentially leading to an upwards bias in the average.
Source: HM Revenue & Customs; and Oxera calculations.

Table 8.5 shows that, similar to APS, companies from the electricity, gas and water supply sector are most likely to have SAYE schemes (37%). Although the manufacturing sector accounts for a substantial proportion of the total number of schemes due to its size (Table 8.3), take-up for manufacturing companies is only 4% and 7% for APS and SAYE respectively. This is likely to be attributable in part to differences in company size between the manufacturing and electricity, gas and water supply sectors. The median number of employees in the former is 180, compared with 1,400 employees in the latter. As with APS schemes, mining and quarrying and financial intermediation are, on average, most likely to operate more than one APS.

Table 8.5 Use of SAYE share schemes by industry sector

Industry (SIC)	Number of companies with a SAYE scheme	Rank	Companies in sector with a SAYE scheme (%)	Rank	Average number of SAYE schemes per company with SAYE	Rank
Mining and quarrying	10	(9)	7	(4)	1.20	(2)
Manufacturing	236	**(1)**	7	(2)	1.17	(3)
Electricity, gas and water supply	23	(7)	37	**(1)**	1.12	(7)
Construction	27	(6)	3	(8)	1.12	(8)
Wholesale and retail trade	77	(3)	3	(7)	1.17	(4)
Hotels and restaurants	15	(8)	6	(5)	1.14	(6)
Transport, storage and communication	32	(5)	5	(6)	1.16	(5)
Financial intermediation	54	(4)	7	(3)	1.26	**(1)**
Real estate, renting and business activities	97	(2)	3	(9)	1.10	(9)
Weighted average			**4**		**1.16**	

Note: Table figures are calculated using the mean of 1993/94–2001/02. For confidentiality reasons, figures were included only for industry sectors with ten or more companies. The average number of schemes per company could be influenced by two schemes overlapping in terms of timing of operation (eg, during a merger), potentially leading to an upwards bias in the average.
Source: HM Revenue & Customs; and Oxera calculations.

Table 8.6 shows that, overall, a greater proportion of companies across all industries have CSOP share schemes. However, as with SAYE and APS, companies in the electricity, gas and water supply, manufacturing, mining and quarrying, and financial intermediation sectors are most likely to have CSOP share schemes. Hence a larger total number of companies and a larger percentage of companies by industry operate targeted share schemes rather than all-employee share schemes. Firms in the construction and manufacturing sectors are, on average, most likely to operate more than one CSOP scheme.

Table 8.6 Number of CSOP share schemes by industry sector

Industry (SIC)	Number of companies with a CSOP scheme		Companies in sector with a CSOP scheme (%)		Average number of CSOP schemes per company with CSOP	
		Rank		Rank		Rank
Mining and quarrying	29	(9)	20	(2)	1.26	(3)
Manufacturing	559	**(1)**	17	(4)	1.29	(2)
Electricity, gas and water supply	24	(10)	38	**(1)**	1.11	(11)
Construction	68	(5)	7	(11)	1.30	**(1)**
Wholesale and retail trade	223	(3)	9	(10)	1.25	(4)
Hotels and restaurants	35	(8)	13	(5)	1.24	(5)
Transport, storage and communication	68	(6)	10	(8)	1.18	(7)
Financial intermediation	140	(4)	18	(3)	1.21	(6)
Real estate, renting and business activities	464	(2)	13	(6)	1.14	(8)
Health and social work	11	(11)	10	(7)	1.12	(9)
Other community, social and personal service activities	62	(7)	9	(9)	1.14	(10)
Weighted average			**12**		**1.23**	

Note: Table figures are calculated using the mean of 1993/94–2001/02. For confidentiality reasons, figures were included only for industry sectors with ten or more companies. The average number of schemes per company could be influenced by two schemes overlapping in terms of timing of operation (eg, during a merger), potentially leading to an upwards bias in the average.
Source: HM Revenue & Customs; and Oxera calculations.

8.2.3 Stock market status

Table 8.7 explores whether companies with schemes are more likely to be listed than not. The first 'proportion listed' column of the table shows that around 30% or more of companies with schemes are listed and that this proportion has increased over time to 68% by 2002/03.[47] Since the number of unlisted companies without schemes in the sample is considerably higher, a relatively small proportion of the sample of companies without schemes is listed (second 'proportion listed' column). From all listed companies, as can be seen by comparing the two 'listed' columns, 50% or more of all listed companies have a scheme in any one year.

This may have implications for the econometric analysis in section 10. As highlighted in section 4, scheme influences may vary between listed and unlisted companies, since

[47] Note that 1992/93 and 2002/03 should be interpreted with caution due to data concerns. As can be seen in Table 8.6, the number of companies for which data was available in FAME to calculate these statistics is noticeably lower than in other years. Therefore, the figures for 1992/93 and 2002/03 may not be representative of the 'true' economy-wide characteristics.

participation rates may be higher or incentives greater in companies that are listed. As outlined in section 8.2.1, it is not possible to define a measure of the proportion of employees that participate in a share scheme that could be included in the econometric analysis. Since the listing status of a company and the degree of employee participation in a scheme are likely to be closely related, the inclusion of a listing status variable in the econometric modelling captures both effects. It is not possible to distinguish the productivity effects that are due to greater potential incentives in listed companies from those arising from higher employee participation in schemes.

Table 8.7 Operation of scheme by listing status and year

		Scheme			No Scheme		
	Total number companies	Not listed	Listed	Proportion listed (%)	Not listed	Listed	Proportion listed (%)
1992/93	3,797	905	104	10	2,700	88	3
1993/94	10,621	1,404	534	28	8,366	317	4
1994/95	11,479	1,433	574	29	9,120	352	4
1995/96	12,363	1,301	572	31	10,055	435	4
1996/97	12,789	1,354	634	32	10,350	451	4
1997/98	13,604	1,350	693	34	11,123	438	4
1998/99	14,972	1,349	741	35	12,416	466	4
1999/2000	15,876	1,262	811	39	13,224	579	4
2000/01	16,222	1,135	854	43	13,612	621	4
2001/02	16,469	864	842	49	14,096	667	5
2002/03	14,053	322	692	68	12,581	458	4

Source: HM Revenue & Customs; FAME; and Oxera calculations.

Table 8.8 splits the sample between those companies with schemes and those without. The table shows the number of companies in each sub-sample that are listed and those that are not. On average, across all industries and years, 36% of companies with schemes are listed.

Table 8.8 How many of those companies that operate schemes are listed?

		Scheme			No scheme		
Industry (SIC)	**Total number of companies**	**Not listed**	**Listed**	**Proportion listed (%)**	**Not listed**	**Listed**	**Proportion listed (%)**
Mining and quarrying	152	21	15	41	92	25	21
Manufacturing	3,305	395	257	39	2,560	92	3
Construction	957	40	33	45	871	14	2
Wholesale and retail trade	2,561	167	87	34	2,263	44	2
Hotels and restaurants	279	23	15	39	227	14	6
Transport, storage and communication	707	40	36	48	608	22	4
Financial intermediation	774	98	57	37	567	51	8
Real estate, renting and business activities	3,722	356	152	30	3,053	162	5
Other community, social and personal service activities	665	47	23	33	559	36	6
Total (weighted average)	**13,122**	**1,187**	**675**	**36**	**10,800**	**460**	**4**

Note: Table figures are calculated using the mean of 1993/94–2001/02. For confidentiality reasons, figures were included only for industry sectors with ten or more companies. Figures were excluded where it would be possible to infer information about specific companies. Listing status is defined as a company being listed at the last date for which company information is available (mainly 2001/02).
Source: HM Revenue & Customs; FAME; and Oxera calculations.

Table 8.9 provides similar information but with the sub-sampling undertaken in a different order. The table splits the sample between those companies that are listed and those that are not. It shows the number of companies for each sub-sample that are listed with a scheme and those which are not listed with a scheme. From the listed companies in the sample, 38–74% operate share schemes of some type.[48] This is particularly high for companies in the manufacturing sector, for which 74% of all listed companies operate some type of share scheme (note that percentages do not sum to 100% since the figures are based on a sample of companies).

Table 8.9 How many of those companies that are listed and unlisted operate schemes?

		Listed			Not listed		
Industry (SIC)	**Total number of companies**	**Scheme**	**No scheme**	**% listed with scheme**	**Scheme**	**No scheme**	**% not listed with scheme**
Mining and quarrying	152	15	25	38	21	92	19
Manufacturing	3,305	257	92	74	395	2,560	13
Construction	957	33	14	70	40	871	4
Wholesale and retail trade	2,561	87	44	66	167	2,263	7
Hotels and restaurants	279	15	14	51	23	227	9
Transport, storage and communication	707	36	22	62	40	608	6
Financial intermediation	774	57	51	53	98	567	15
Real estate, renting and business activities	3,722	152	162	48	356	3,053	10
Other community, social and personal service activities	665	23	36	39	47	559	8
Total (weighted average)	**13,122**	**675**	**460**	**59**	**11,874**	**10,800**	**10**

Note: Table figures are calculated using the mean of 1993/94–2001/02. For confidentiality reasons, figures were included only for industry sectors with ten or more companies. Figures were excluded where it would be possible to infer information about specific companies. Listing status is defined as a company being listed at the last date for which company information is available (mainly 2001/02).
Source: HM Revenue & Customs; FAME; and Oxera calculations.

8.2.4 Productivity and profitability

This section examines the evidence of a positive relationship between productivity and profitability and the usage of share schemes. These measures provide some indication of the broad performance of companies. However, since these are partial measures of

[48] This range excludes companies from the education sector, which has only 44 listed companies, of which 18% have a scheme.

performance, they should be regarded as indicative. A more robust assessment of the impact of share schemes on productivity, which takes into account multiple factors, is provided in section 10.

The considerable differences in sample size of companies with and without schemes mean that performance measures vary across the panels. This is due to actual aggregate differences in performance, and also possible outliers that distort descriptive statistics, particularly means. Since the sample size of control groups is significantly larger than that of companies with schemes, large variations in performance are more likely to occur in the larger dataset. As a consequence, to the extent that the actual or recorded (with measurement errors) performance measure in the larger dataset tends to be higher, performance measures, particularly those based on the mean, tend to be distorted.

Productivity

It is therefore more insightful to focus on a smaller subset of companies that share a characteristic that is common in both types of company (ie, those with schemes and those without). Comparisons in this section are thus made for listed companies only. See Appendix 3 for descriptive statistics that analyse the dataset as a whole.

Table 8.10 shows the labour productivity in listed companies in each year. It is apparent that companies with schemes generally have higher partial labour productivities when measured by both mean and median labour productivity. However, due to greater variability shown by the standard deviations, it would be more meaningful to focus on median rather than mean productivity because this summary measure is less likely to be biased as a result of unusual observations or measurement error.

The definition for labour productivity is real turnover divided by the number of employees, with turnover defined as total sales, and employees defined as employee headcount. The unit of measurement of labour productivity is turnover per worker per annum (£'000s). A superior measure of productivity could be constructed using more accurate input and output measures. Employee input could be more accurately defined using total FTE workers or total hours worked. A superior measure for output would be value added, since this takes into account the intermediate inputs that are employed in the production process. However, such output measures cannot be constructed from the information available in the FAME dataset, and the analysis in this report therefore employs labour productivity defined as real total sales divided by employee headcount.

Capital productivity is measured as real turnover divided by fixed assets, where fixed capital is defined as total assets minus current liabilities. The unit of measurement of capital productivity is annual turnover per £ of capital employed.

Table 8.10 Average annual labour productivity in listed companies: all share schemes versus companies with no tax-advantaged share scheme (£'000s per worker per year)

	Mean		Median		Standard deviation		Number of observations	
Year	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme
1992/93	200	154	84	97	450	203	88	104
1993/94	197	151	86	97	535	221	317	534
1994/95	194	159	82	100	621	244	352	574
1995/96	225	164	85	105	752	205	435	572
1996/97	194	168	85	98	482	440	451	634
1997/98	170	172	83	100	355	304	438	693
1998/99	167	182	92	98	320	367	466	741
1999/2000	191	207	72	103	747	515	579	811
2000/01	171	196	70	99	775	498	621	854
2001/02	173	197	78	102	573	626	667	842
2002/03	154	179	85	107	248	308	458	692

Note: Labour productivity is defined as real turnover:number of employees. See Table A3.17 in Appendix 3 for figures for all companies (ie, listed and unlisted).
Source: HM Revenue & Customs; FAME; Oxera calculations.

However, this simple measure ignores the fact that listed companies with or without schemes may be operating in different industries, and that performance differences are attributable to differences in industry composition. An analysis of performance by industry thus provides further insights.

Table 8.11 confirms the result of higher median productivity for listed companies with schemes. The problem of multiple factors affecting an outcome variable is addressed most effectively using multivariate econometric techniques (see section 10).

Table 8.11 Average labour productivity in listed companies by industry: all share schemes versus companies with no tax-advantaged share scheme (average 1993/94–2001/02, £'000s per worker per year)

	Mean		Median		Standard deviation		Number of observations	
	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme
Mining and quarrying	296	336	97	113	607	774	15	14
Manufacturing	99	113	74	91	168	103	86	257
Electricity, gas and water supply	n/a	250	n/a	175	n/a	194	n/a	11
Construction	159	256	118	217	195	149	13	33
Wholesale and retail trade	301	158	116	128	1,104	125	41	87
Hotels and restaurants	45	87	32	53	51	141	14	15
Transport, storage and communication	143	159	99	121	133	169	21	36
Financial intermediation	299	306	100	120	1,324	1,158	27	27
Real estate, renting and business activities	215	272	86	96	443	614	137	149
Other community, social and personal service activities	121	143	62	118	237	114	34	23

Note: Labour productivity is defined as real turnover:number of employees. For confidentiality reasons, figures were included only for industry sectors with ten or more companies (not shown or denoted by n/a).
Source: HM Revenue & Customs; FAME; and Oxera calculations.

Table 8.12 shows that listed companies with schemes have equal or higher partial median capital productivities compared with companies without. This result is replicated when analysing capital productivities by industry sector (Table 8.13).

Table 8.12 Average annual capital productivity in listed companies: all share schemes versus companies with no tax-advantaged share scheme (turnover per £ of capital employed)

	Mean		Median		Standard deviation		Number of observations	
Year	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme
1992/93	6	6	2	3	15	7	88	104
1993/94	8	6	3	4	20	8	317	534
1994/95	11	7	3	4	39	12	352	574
1995/96	12	7	4	4	57	11	435	572
1996/97	18	7	3	4	201	10	451	634
1997/98	8	9	2	3	17	33	438	693
1998/99	22	8	2	3	280	32	466	741
1999/2000	9	7	1	2	41	32	579	811
2000/01	14	7	1	2	86	39	621	854
2001/02	18	7	2	2	203	40	667	842
2002/03	9	6	2	3	68	11	458	692

Note: Capital productivity is defined as real turnover:fixed assets. See Table A3.18 for figures for all companies.
Source: HM Revenue & Customs; FAME; and Oxera calculations.

Table 8.13 Average capital productivity in listed companies by industry: all share schemes versus companies with no tax-advantaged share scheme (average 1993/94–2001/02, turnover per £ of capital employed)

	Mean		Median		Standard deviation		Number of observations	
Industry (SIC)	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme	No scheme	Scheme
Mining and quarrying	1.3	1.3	0.4	0.6	2.7	1.8	16	14
Manufacturing	6.5	4.4	3.0	3.0	21.4	7.3	87	257
Electricity, gas and water supply	n/a	0.7	n/a	0.4	n/a	0.7	n/a	11
Construction	35.3	24.0	9.3	13.3	128.6	32.7	14	33
Wholesale and retail trade	10.6	7.6	6.2	5.0	17.4	9.1	41	87
Hotels and restaurants	1.1	1.6	0.9	0.6	0.9	7.6	14	15
Transport, storage and communication	6.6	4.4	1.7	1.7	15.2	13.2	21	36
Financial intermediation	45.2	18.1	2.2	3.4	379.6	90.9	29	27
Real estate, renting and business activities	13.5	7.5	1.6	2.8	116.0	35.4	148	150
Other community, social and personal service activities	15.2	2.7	0.7	1.1	209.7	5.5	35	23

Note: Capital productivity is defined as real turnover:fixed assets. For confidentiality reasons, figures were included only for industry sectors with ten or more companies (not shown or denoted by n/a).
Source: HM Revenue & Customs; FAME; and Oxera calculation.

Profitability

A similar analysis was conducted for several measures of profitability. The measures investigated were:[49]

- return on capital—operating profit ÷ capital, where capital is defined as total assets less current liabilities;
- return on sales—operating profit ÷ turnover;
- return on equity—net income ÷ shareholder's equity.

Table 8.14 shows the median for the three measures of profitability of listed companies. A similar pattern to that of productivity emerges, with listed companies with schemes having higher levels of profitability compared with those without. This is confirmed when comparing the differences by industry (Table 8.15).

[49] Alternative measures were not calculated since FAME did not provide this information for a sufficient number of observations.

Table 8.14 Profitability of listed companies (median %)

	Return on capital		Return on sales		Return on equity	
Year	**No scheme**	**Scheme**	**No scheme**	**Scheme**	**No scheme**	**Scheme**
1992/93	5	12	5	7	4	11
1993/94	7	14	7	7	7	13
1994/95	6	15	7	8	6	14
1995/96	9	16	6	8	9	13
1996/97	7	17	7	8	7	14
1997/98	6	15	5	8	6	14
1998/99	4	13	5	7	5	13
1999/2000	–1	10	1	6	–1	9
2000/01	–3	7	–1	4	–6	5
2001/02	–3	7	–1	5	–5	6
2002/03	–1	8	1	5	0	8

Note: Not all performance measures are based on the same number of observations since data for constructing measures was not available in every instance.
Source: HM Revenue & Customs; FAME; Oxera calculations.

Table 8.15 Profitability of listed companies by industry (median %, average 1993/94 to 2001/02)

	Return on capital		Return on sales		Return on equity	
	No scheme	**Scheme**	**No scheme**	**Scheme**	**No scheme**	**Scheme**
Mining and quarrying	–2	6	4	10	–3	7
Manufacturing	6	13	4	7	5	11
Electricity, gas and water supply	n/a	10	n/a	22	n/a	12
Construction	14	15	3	5	15	14
Wholesale and retail trade	11	17	4	5	9	14
Hotels and restaurants	7	8	9	13	6	7
Transport, storage and communication	5	10	3	6	4	10
Financial intermediation	–1	0	2	10	4	15
Real estate, renting and business activities	1	7	3	6	1	6
Other community, social and personal service activities	–2	9	–2	8	–1	6

Note: Not all performance measures are based on the same number of observations since data for constructing measures was not available in every instance. For confidentiality reasons, figures were included only for industry sectors with ten or more companies (not shown or denoted by n/a).
Source: HM Revenue & Customs; FAME; and Oxera calculations.

8.3 Summary

The descriptive statistics in this section indicate the following points.

– The reduction in the number of companies offering APS has perhaps been most affected by the introduction of the SIP as a replacement for APS. Although SIP is also a possible substitute for SAYE schemes, the number of SAYE schemes increased in 2001/02 and 2002/03, following a large drop in 2000/2001, suggesting that stock market conditions may have been influential in companies' decisions to offer the schemes. The reduction in CSOP schemes broadly coincides with the introduction of EMI in 2001, and the expansion of eligibility in 2002, potentially leading to switching behaviour.[50]

– The number of employees who bought shares or were granted options in any one year has been broadly increasing since 1995/96 (SAYE, APS) or 1996/97 (CSOP). This measure does not reflect the total number of participants that hold shares or options within companies but rather the flow of participants in schemes; as a result, changes in overall participation cannot be inferred.

– The size of the gains to employees from owning shares under the tax-advantaged CSOP or SAYE schemes, as would be expected, appears to be related to economic conditions and stock market performance. This is reflected by changes in the size of aggregate gains in accordance with stock market performance (growth in the FTSE All-share index).

– Larger companies, as measured by the number of employees, turnover, and amount of capital, are more likely to operate schemes. Large companies are also more likely to operate multiple schemes.

– Analysis of schemes by industry reveals that around 80% of all share schemes are concentrated in manufacturing, real estate, renting and business activities, wholesale and retail trade, and financial intermediation. When taking into account the total size of each industry, companies belonging to the electricity, gas and water supply, mining and quarrying, financial intermediation and manufacturing sectors are shown to be most likely to operate a share scheme. Companies in any industry are more likely to operate a discretionary CSOP scheme than either a SAYE or APS all-employee scheme.

– On average, across all industries and years examined, 36% of companies with schemes are listed. The number of companies with a scheme that are listed has increased over time to almost 50% in 2001/02. Between 38% and 74% of all listed companies across industries operate a share scheme.

– Listed companies with schemes have tended to have a productivity level that is higher than that of listed companies without any share schemes, across years and industries.

[50] Source: HM Revenue & Customs.

9 Econometric analysis: characteristics of companies with employee share schemes

The descriptive statistics in section 8 highlight several key attributes of companies that operate share schemes—they tend to be larger and are more likely to be in certain industries than others. Furthermore, listed companies with schemes have relatively higher levels of performance when measured with simple statistics, such as company performance measured using partial productivity (ie, the amount of output that can be produced with a given set of inputs such as capital and labour) and profitability indicators.

Descriptive statistics can be problematic in that they highlight a particular aspect of the characteristics of companies with and without share schemes. The econometric analysis presented in this section allows an assessment of the distinguishing characteristics of companies with employee share schemes, while simultaneously controlling for other factors that may influence companies' decisions to operate share schemes. This complements the analysis in the previous section and provides further insights.

9.1 Approach

The decision to operate a share scheme can be modelled as a discrete choice within a logistic regression framework.[51] Applying the logit model provides estimates of the likelihood of a particular company adopting a share scheme given its individual characteristics, the prevailing macroeconomic conditions and the statistical significance of the factors that affect this likelihood. Equation 9.1 describes the logit model employed in obtaining estimates of the impact of firm characteristics on the probability of having a scheme.

$$p(ESS)_{it} = \alpha + \beta X_{it} + \theta Z_t + \mu \qquad \text{(Equation 9.1)}$$

where:

- p(ESS) is the probability of having an employee share scheme. It takes the form of a simple 0/1 indicator, which represents whether a specific company, i, operates a share scheme or a certain type of share scheme;
- X is a vector of firm-specific characteristics, such as size, productivity, profitability, and capital structure, which are related to a company's decision to operate a share scheme. X is allowed to vary both over time t and across companies;
- Z is a vector of macro variables, varying through time and including, for example, GDP, stock market performance or interest rates, which are related to the decision to operate a share scheme;
- β is the regression coefficients vector of firm-specific variables. These coefficients are to be determined by the modelling. β provides an indication of whether a variable from the vector X has, on average, a positive or negative impact on the probability of a company having a scheme;
- θ is the regression coefficients vector of Z. These coefficients are to be determined by the modelling. θ provides an indication of whether a variable from Z has, on average, a positive or negative impact on the probability of a company having a scheme;

[51] Alternatively, a probit regression may be used. However, probit and logit frameworks are broadly equivalent, and in many instances may be used interchangeably.

Following suitable transformation, a combination of the β and θ coefficients could be interpreted as probability—ie, what is the probability of having a scheme given certain characteristics of X and Z?

Estimation of the models as shown in Equation 9.1 therefore allows the quantification of the importance of each factor and provides a statistical measure of the significance that each factor has in determining the likelihood of observing a share scheme for a particular firm.

9.2 Model specification

The regression modelling was carried out in a panel data framework at the company level.[52] In addition to cross-sectional variation across firms, this introduces the time dimension and increases the potential explanatory power of the modelling. To utilise the nature of panel data fully, fixed and random effects estimation was used to capture firm-specific effects. For more detail on fixed and random effects and the methods of choosing between different estimation techniques, see section 10 and Appendix 5.

Where appropriate, variables were converted to natural logarithms (denoted *l* in Table 9.1) and 2003 prices. The industry variables are represented by 0/1 variables, where 1 indicates that a company is from a certain industry and 0 indicates that it is not. The remainder of the variables range between 0 and 1.

A range of variables was considered for inclusion in the econometric modelling, including the performance and macroeconomic measures and the industry sector indicators analysed in section 8.

To reach the preferred model specification, a general-to-specific approach was adopted—that is, a general model is estimated first and insignificant variables are systematically deleted and the model re-estimated (see section 10 for a more detailed description of this methodology).

9.3 Model testing and interpretation

It should be noted that a test of the stability of the coefficient estimates showed that, in the models using random effects (models 1 and 2 in Table 9.1), these estimates cannot be interpreted with accuracy (despite their statistical significance).[53] Thus, while providing a broad indication of the direction in which a company characteristic affects the likelihood of that company having a scheme (eg, a positive coefficient indicates an increase in the likelihood of scheme presence), the regression coefficients should not be used to derive probability scenarios.

9.4 Results

Table 9.1 presents the results from the binary choice models. This section discusses the findings regarding the impact of explanatory factors on the likelihood of companies in adopting share schemes.

[52] During the modelling process, the possibility of modelling the impact of company and macroeconomic characteristics at the individual scheme level was also considered. While these results were qualitatively broadly similar to those presented in Table 9.1, due to a reduction in sample size, the reliability of the estimates was reduced considerably and, in some instances, only a small number of variables were statistically significant.

[53] A sensitivity test of the accuracy of the coefficient estimates can be conducted by changing the specification of the statistical estimator used to obtain the estimates. If the results change as a consequence, the model's results cannot be interpreted with confidence (the statistical command used is 'quadchk' in Stata 9).

Company size
The models use turnover as a proxy measure for company size. The results confirm the finding (see section 8) that larger companies are more likely to adopt schemes. In all model specifications, turnover is found to have a positive and statistically significant effect on the likelihood of adopting a scheme.

Labour and capital productivity
The modelling also provides insights regarding the impact of productivity on the likelihood of scheme presence. This is important since the descriptive analysis in Appendix 3 shows that, for the sample as a whole (ie, listed and unlisted companies), companies that operate schemes have lower labour and capital productivity. This finding is confirmed using binary choice modelling (models 1 and 3 in Table 9.1), where the coefficients on capital productivity (lcapitalprod) and labour (llabourprod) productivity are negatively signed. This appears to suggest that more productive companies are, on average, less likely to operate share schemes. This effect is prevalent even when statistical outliers that may influence the results are excluded from the models. However, this counterintuitive result is likely to be attributable to a number of factors, including:

– missing information that has not been taken into account in the modelling;
– not including the dynamics in the modelling. This results in two issues not being captured. First, the full effect of a scheme may not felt for several years. Second, as well as tax-advantaged schemes increasing productivity, companies with high levels of productivity may be more likely to have a scheme.

The second issue is taken into account in section 10. As regards the first point, since the dataset contains a range of companies with very different characteristics, and which are not accounted for sufficiently in the modelling, this is likely to bias the results. Although it would be desirable to include other factors that influence companies' choice to operate schemes, these cannot be included in the model due to data availability.

To investigate this further, the models were run for the sample of listed companies only, leading to a more comparable set of companies and thereby possibly avoiding the above-mentioned issues of missing information. The results show that, in the models for the sample of listed companies, the size of the coefficients of capital and labour productivity is significantly smaller and the capital productivity impact is no longer statistically significant (see Appendix 3). Therefore, the counterintuitive finding that more productive companies are less likely to operate share schemes should be interpreted with care especially as the dynamics have yet to be accounted for.

Capital intensity
The modelling also considered whether the amount of capital employed by companies affects the choice to operate schemes (models 2 and 4). This was measured with a ratio of capital to the number or employees. The results show that companies with a relatively large amount of capital are more likely to implement schemes than those without. This is even the case when manufacturing (which is likely to exhibit the largest capital intensity) is controlled for in model specifications 1 and 2 (result not reported separately).[54] There is thus an indication of complementarity between capital-intensive work and the operation of employee share schemes—ie, the more capital-intensive a company, the more likely it is to operate a scheme.

Profitability
The impact effect of profitability was investigated using the three measures of profitability considered in section 8 (ie, return on capital, return on sales and return on equity). However,

[54] The industry coefficients should be interpreted relative to the omitted industry dummies, namely manufacturing and other non-statistically significant variables. Manufacturing is excluded since, in order to provide meaningful robust industry coefficients, one dummy variable representing a sufficiently large number of companies needs to be excluded.

the only statistically significant profitability measure in three out of the four models in Table 9.1 (albeit in model 1 only at a level of significance of 10%) is the return on capital. However, although return on capital enters the model negatively, the size effect, if any, would appear to be relatively small. Hence it does not follow that companies with lower capital profitability are more likely to set up schemes.

This observed effect of profitability on scheme adoption is also likely to be influenced by the larger variation and sample presence of companies without schemes. The effect of profitability as measured by the return on capital is not statistically significant in models that are estimated using listed companies only.

General economic conditions

The modelling also considered the impact of general economic conditions on the likelihood of scheme adoption. The results indicate that when general economic conditions—as measured by the Bank of England interest rate (REPO) and real GDP growth rate—are favourable, companies are more likely to set up share schemes. There is therefore no indication of potential substitution between interest-bearing (eg, government bonds) and dividend-yielding (company shares) financial instruments.

Industry

Companies from the financial intermediation sector are more likely to adopt a scheme than companies from other industries.[55]

[55] See Appendix 3 for a model, which includes control variables for all industries and where financial services is used as a reference group for estimating the industry effects.

Table 9.1 Results from binary choice models (whole sample)

Model	1	2	3	4
lturnover	1.300	1.116	0.869	0.733
	(50.5)**	(46.4)**	(17.3)**	(16.3)**
llabourprod	–0.746		–0.375	
	(14.0)**		(4.4)**	
lcapitalprod	–0.440		–0.222	
	(16.6)**		(5.03)**	
returncapital	–0.002	–0.008		
	(1.8)	(6.4)**		
lcapintensity		0.302		0.117
		(11.3)**		(2.89)**
repo	0.389	0.296	0.191	0.151
	(14.0)**	(3.8)**	(6.3)**	(1.86)
changegdp	24.466	18.449	13.330	10.70
	(9.5)**	(3.7)**	(5.0)**	(5.23)**
agriculture	–1.149	–1.670		
	(2.97)**	(–4.9)**		
construction	–1.929	–2.139		
	(11.02)**	(–10.5)**		
wholesale & retail	–1.534	–1.990		
	(12.32)**	(–16.5)**		
hotels and restaurants	–2.461	–0.842		
	(10.36)**	(–3.8)**		
transport	–1.874	–1.680		
	(9.63)**	(–5.2)**		
financial intermediation	0.954	0.898		
	(5.66)**	(6.0)**		
health and social work	–1.444			
	(4.71)**			
other service activities		–0.874		
		(–2.4)**		
constant	–15.288	–17.727		

Notes: Absolute value of t statistics in parentheses. * indicates significance at 5% level; ** indicates significance at 1% level.
Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

9.5 Summary

The binary choice modelling, which investigates the impact of company performance measures, macroeconomic conditions and industry membership on the likelihood of companies operating schemes, broadly confirms some of the results emerging from the descriptive statistics in section 8 and provides additional insights. In the sample as a whole, labour and capital productivity are, on average, lower for companies operating schemes than for companies without such schemes. This is most likely to be attributable to factors that

influence company choice to operate schemes, due to data availability, not being included in the modelling, and the relatively more weighted sample presence of companies without share schemes. When estimating the models for listed companies only, the negative impact effects are reduced considerably and are no longer statistically significant. The modelling also provides an indication of complementarity between capital-intensive work and the operation of employee share schemes. General economic conditions represented by the Bank of England interest rate (REPO) and real GDP growth rate are found to be positively correlated with the likelihood of operating a scheme.

10 Econometric analysis: impact of employee share schemes on company performance

In order to quantify how much each type of share scheme affects company performance, a panel of data was constructed, as explained in sections 6 and 7. The modelling in this section estimates company performance given company-specific factors, macroeconomic conditions and rates of participation in share schemes.

10.1 Approach

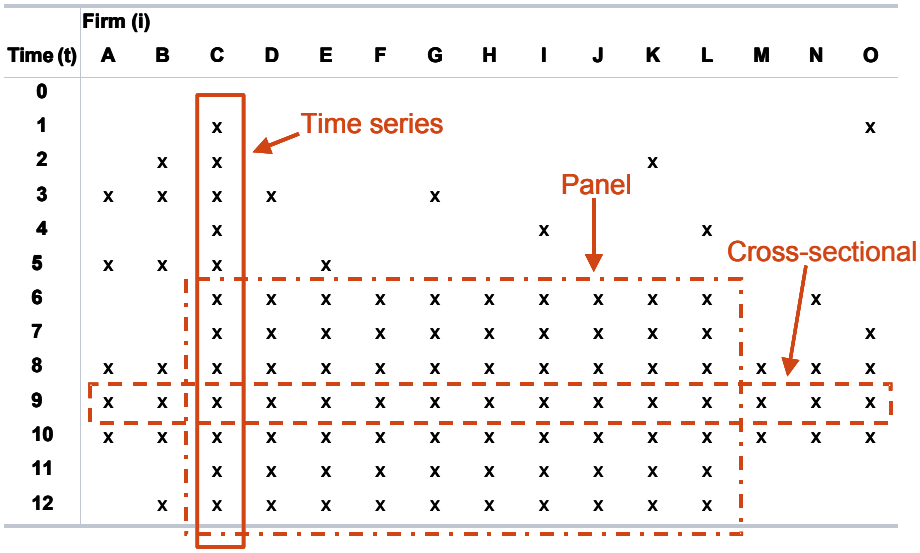
To assess the effect of share schemes, Oxera estimated a general production function including as many potential drivers of output as possible, and used a general-to-specific procedure to test down to models that are parsimonious and robust. This is explained in more detail below.

10.1.1 Examining firm productivity performance

The focus of the analysis in this section is on productivity performance, based on a production approach, using a Cobb–Douglas production function. This is consistent with approaches used in the existing literature. For example, Conyon and Freeman (2004) apply a Cobb–Douglas specification to estimate the impact of tax-advantaged compensation systems on productivity performance. However, due to data limitations, the authors' econometric specification was static over time.

This contrasts with the dynamic panel data approach used in this study. In addition to cross-section variation across firms, this introduces the time dimension and therefore increases the potential explanatory power of the modelling because it can track specific firms operating each type of scheme over time (see Figure 10.1).

Figure 10.1 Types of data



Oxera used the following generic *dynamic* Cobb–Douglas production function as a 'general' model (Equation 10.1), which is refined to a parsimonious 'specific' model.

$$Q_{it} = \alpha + \sum_{n=1}^{t} \beta_{1,t-n} Q_{i,t-n} + \sum_{n=0}^{t} \beta_{2,t-n} L_{i,t-n} + \sum_{n=0}^{t} \beta_{3,t-n} K_{i,t-n} + \sum_{n=0}^{t} \beta_{4,t-n} D_{i,t-n} + \sum_{n=0}^{t} \beta_{5,t-n} Y_{t-n} + \mu_{it}$$

(Equation 10.1)

where:

- Q is the log of sales;
- L is a logged measure of labour input into the production process;
- K is a logged measure of capital stock;
- D is a dummy variable for the existence of an employee share scheme, or a slope dummy for the participation rate;
- Y is a vector of logged macroeconomic variables that vary across time only. Examples of macroeconomic variables that are considered for inclusion in the regression are those referred to above: GDP, stock market performance and interest rates.

The monetary measures have been deflated by RPI to convert them to 2003 prices. The model described in Equation 10.1 is linear in parameters, and is the starting point for estimation.

To utilise the nature of panel data fully, fixed and random effects estimation is used to capture firm-specific effects. For more detail on fixed and random effects see Appendix 5.

Company performance with respect to share schemes is likely to have a dynamic nature (ie, it will take a certain period of time before any benefits are felt). Oxera has therefore estimated a dynamic panel that allows for a lag before the effect of introducing a share scheme is observed. In contrast to static panel data models, dynamic panel data models give rise to additional complications of autocorrelation or correlation of the lagged endogenous variable and the disturbance term.

The dynamic panel data approach described above has been applied in other studies to estimate the productivity performance of UK companies (Nickell, Nicolitsas and Drydon 1997), and in the USA to assess the effect of employee share schemes (Kruse 1993b).[56]

The individual steps involved in the analysis are set out below.

10.1.2 Preliminary data examination

To assist the econometric modelling, preliminary data investigation was undertaken to examine:

- summary statistics for each of the potential variables in the modelling;
- cross-sectional and time-series graphs, produced to check for outlying observations and data entry errors;[57]
- correlations of the data, to ensure that economic relationships are intuitive and help inform the modelling process.

For details of the preliminary data examination see Appendix 4.

[56] The use of an alternative approach that takes into account the potential bias in dynamic panel data has also been investigated but the results were not found to be robust. Refer to Appendix 5 for further details (Arellano and Bond estimators).

[57] Observations identified as outliers were investigated to understand why they are significantly different from the majority of the data, and whether this is an error or due to a unique factor that can be controlled for by a firm-specific effect.

10.1.3 General-to-specific methodology

The modelling follows a general-to-specific methodology. The aim of applied work is usually to arrive at a preferred model, which can then be used as a basis for statistical inference. Ideally, the process of arriving at this preferred model should be as systematic as possible. The general-to-specific approach imposes as few restrictions as possible on the data at the outset. The general model includes all the variables that could possibly influence the explanatory variable. The model is suggested by a combination of economic theory and prior research in the area. Sufficient lags should be included to ensure the absence of serial correlation (see Appendix 5 on diagnostic tests). The effect of a particular variable will depend on the general model that is being used.

The general model is first estimated and then progressively simplified by deleting insignificant variables, starting with the least significant. After each is deleted, the general model is re-estimated until all the variables are significant. The final model should be a parsimonious model that cannot be improved upon—ie, the model should explain as much as possible with the fewest parameters as possible.

10.1.4 Diagnostic testing

To ensure that the results are consistent and robust, diagnostic tests are conducted after the modelling has been undertaken. There are some assumptions regarding the behaviour of the error term on which OLS estimation is based. When these assumptions break down, the results of the modelling can be invalidated. Diagnostic testing helps to ascertain whether these assumptions have broken down.

When conducting the regression modelling, statistical outlier analysis is used to identify which observations do not fit the data. These observations are then further examined to assess whether there are individual problems or whether the outliers are systematic, and a different specification is required.

10.1.5 Hausman test for fixed versus random effects

To determine whether fixed or random effects were appropriate, a Hausman specification test was estimated (Hausman 1978), which clearly indicated that the fixed effects estimator was appropriate (as per Kruse 1993b). The modelling described below therefore uses the fixed effects estimator. Most of the differences in industry will be controlled for by the fixed effect itself, and the effect of schemes can still be estimated by industry since the presence of a scheme varies through time. See Appendix 5 for more information.

10.2 Results from static production functions

The results from the static production functions are summarised in Table 10.1.

10.2.1 Testing for the presence of any scheme

Model 1 in Table 10.1 shows the static, fixed effects production function, where output (the log of turnover) is explained by the log of employees, capital, GDP and the REPO rate. The presence of any tax-advantaged share scheme, as tested by the scheme dummy variable, increases output by 8.2% on average for given levels of capital and labour across both listed and non-listed companies.

The remaining explanatory variables are significant and have intuitive signs—for example, output is increased by raising GDP and decreased by rising interest rates.

10.2.2 Testing for the effect of schemes in each industry

Model 2 in Table 10.1 examines the industries where the presence of a scheme has the most effect. The dummy variable for the presence of the scheme was multiplied by the industry

dummy to produce indicator variables for the existence of a scheme in a particular industry (denoted *scheme in industry i* in Table 10.1). Model 2 shows that there is considerable variation in the effect of tax-advantaged share schemes, ranging from no effect to an increase in turnover of over 20% (electricity, gas and water supply, mining and quarrying and education). This supports the hypothesis in section 4.5.3 that the productivity effect is likely to vary significantly across industries.

10.2.3 Testing for the effect of tax-advantaged schemes in listed and unlisted companies

Model 3 estimates the effect of having any tax-advantaged scheme for listed companies and unlisted companies. Due to the limited data available from FAME, the variable identifying listing status does not vary with time, so the listing status is as at 2003 for every year. The results show that companies that are listed in 2003 would have their turnover increased by 13% due to the presence of a tax-advantaged scheme, whereas the equivalent for unlisted companies would be a 7% increase. This supports the hypothesis in section 4.5.3 that the productivity effect of having a tax-advantaged share scheme is greater in listed companies than in unlisted companies. However, since the HM Revenue & Customs dataset does not provide information on the total number of employees with schemes in any one year, it is not possible to distinguish the productivity effects that are due to greater potential incentive effects in listed companies from those arising from greater employee participation in schemes. In other words, listing status may act as a proxy variable for employee participation in schemes and, due to the potentially strong relationship between listing status and participation, the productivity effects are attributed to listing status (ie, there is omitted variable bias, see section 2.2). Given suitable data, an important area of further research would be to establish whether the observed improvement in productivity for listed companies is attributable to the higher degree of employee participation or the greater incentive properties in listed companies.

10.2.4 Testing for the presence of each type of tax-advantaged scheme

Model 4 tests how each of the three types of tax-advantaged scheme has an effect on the output of a company. The presence of a CSOP scheme increases turnover by 7% compared with increases of 5% for both APS and SAYE schemes. This appears to be consistent with the hypothesis (section 4.5.3) that CSOP schemes may have a greater effect on company performance under certain circumstances.

10.2.5 Testing for the presence of tax-advantaged schemes when non-tax-advantaged schemes exist

Schemes that are not tax-advantaged tend to be operated principally to reward senior executives—but also other managers and key groups of employees—over and above what is permissible according to the limits of tax-advantaged schemes. The significant effect of having a tax-advantaged scheme may be due to the presence of non-tax-advantaged schemes which also incentivise employees to increase productivity.

Data was available from HM Revenue & Customs on which companies with a tax-advantaged scheme also operated a non-tax-advantaged scheme at any point in time. As this data is not an exhaustive list of companies and is time-invariant, it is only possible to identify which companies have operated a scheme that is not tax-advantaged at some point during the sample period. Although this definition is potentially subject to bias and measurement error, it does give an indication of whether tax-advantaged schemes offer increased productivity gains over and above non-tax-advantaged schemes.

Model 5 in Table 10.1 shows that, if a firm has had a scheme that is not tax-advantaged at any point in time, as well as a tax-advantaged scheme, output increases by 8.5% compared with 3.1% when only a tax-advantaged scheme is present, relative to companies without

tax-advantaged schemes.[58] This is also consistent with the hypothesis in section 4.5.3 that some of the productivity effect may be due to the existence of non-tax-advantaged schemes.

[58] It is important to recognise that this estimated impact is relative to companies without tax-advantaged schemes (whether they have non-tax-advantaged schemes or no schemes at all). It is not possible to estimate the impact of having only non-tax-advantaged share schemes (or estimating the above effects relative to companies that have no schemes of either type) since there is no information available on whether those companies that do not have tax-advantaged schemes (ie, the control group) have a scheme that is not tax-advantaged.

Table 10.1 Static fixed effects production functions

Model	1	2	3	4	5
	lturnover	lturnover	lturnover	lturnover	lturnover
lemployees	0.765	0.765	0.765	0.764	0.764
	(243.06)**	(241.94)**	(243.06)**	(242.64)**	(242.86)**
lcapital	0.077	0.076	0.076	0.077	0.076
	(34.43)**	(33.88)**	(34.33)**	(34.35)**	(34.33)**
lgdp	0.451	0.454	0.448	0.454	0.448
	(20.02)**	(20.02)**	(19.86)**	(20.11)**	(19.87)**
repo	–0.017	–0.016	–0.017	–0.017	–0.017
	(9.59)**	(9.41)**	(9.57)**	(9.56)**	(9.59)**
scheme (any)	0.082				
	(12.55)**				
scheme in agriculture		–0.18			
		(2.21)*			
scheme in fishing		0			
		(.)			
scheme in mining and quarrying		0.216			
		(4.18)**			
scheme in manufacturing		0.072			
		(6.02)**			
scheme in electricity, gas and water supply		0.224			
		(3.74)**			
scheme in construction		0.02			
		(0.56)			
scheme in wholesale and retail trade		0.037			
		(2.14)*			
scheme in hotels and restaurants		0.115			
		(2.66)**			
scheme in transport, storage and communication		0.154			
		(4.59)**			
scheme in financial intermediation		0.114			
		(4.48)**			
scheme in real estate, renting and business activities		0.069			
		(5.75)**			
scheme in public administration and defence		0			
		(.)			
scheme in education		0.233			
		(2.11)*			
scheme in health and social work		0.107			
		(1.47)			

Model	1	2	3	4	5
scheme in community, social and personal services		0.19			
		(6.35)**			
scheme in private households		0			
		(.)			
scheme in extra-territorial organisations and bodies		0			
		(.)			
scheme listed			0.132		
			(9.56)**		
scheme non-listed			0.068		
			(9.18)**		
APS scheme				0.046	
				(3.04)**	
CSOP scheme				0.069	
				(10.21)**	
SAYE scheme				0.05	
				(4.58)**	
Only tax-advantaged scheme					0.031
					(3.08)**
Also non-tax-advantaged scheme					0.085
					(6.44)**
Constant	–0.063	–0.089	–0.022	–0.091	–0.02
	–0.22	–0.31	–0.08	–0.33	–0.07
Number of observations	103,117	101,479	103,117	103,117	103,117
Number of companies	16,844	16,294	16,844	16,844	16,844

Note: Absolute value of t statistics in parentheses; * significant at 5%; ** significant at 1%. Missing values indicate where a coefficient was unable to be estimated, either due to lack of data points or due to multicollinearity.
Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

The statistical output of the modelling can be found in Appendix 7.

The above models are based on static modelling, assuming that the effect of a share scheme on output is felt instantly. However, there may be a dynamic element to the relationship in that the full effect of a scheme is not felt for several years. It is also possible that the causality between higher output and having a scheme is not clear—for example, as well as tax-advantaged schemes increasing productivity, companies with high levels of productivity may be more likely to have a scheme. As such, the results above may indicate effects that appear greater than they actually are.

10.3 Results from dynamic production functions

To address both these issues, Oxera estimated several dynamic panel data models that include lags of the explanatory variables (which allow for a lagged response to the implementation of a scheme) and lagged dependent variables (which control for the historical performance of an individual company).

Previous studies have argued that the fixed effect (a firm-specific constant that is time-invariant) controls for the potential endogeneity arising from share schemes causing higher levels of productivity and the possibility that higher levels of productivity also result in a higher probability of taking up a share scheme.

However, this is unlikely to be an effective control because it assumes that an average constant level of output is associated with that particular firm, whereas, in reality, the output of that firm's turnover is likely to be following a trend and will vary over time rather than be fixed over time, as the fixed effect suggests. Including the historical values of turnover controls for the most recent observed turnover figures, which are likely to be a better control for the path that the firm's turnover figures are taking. Using this approach the model predicts what the output for a company will be given its past performance, and mitigates the potential bias from the endogeneity described above.

Table 10.2 presents the results from these dynamic models using fixed effects.

Table 10.2 Dynamic fixed effects production functions

Model	1	2	3	4
	lturnover	lturnover	lturnover	lturnover
lturnover_1	0.367	0.369	0.369	0.368
	(116.71)**	(116.98)**	(117.01)**	(118.12)**
lemployees	0.679	0.678	0.678	0.678
	(175.56)**	(174.19)**	(174.29)**	(175.67)**
lemployees_1	–0.228	–0.228	–0.228	–0.224
	(50.98)**	(50.88)**	(50.89)**	(51.63)**
lcapital	0.049	0.048	0.048	0.053
	(20.05)**	(19.68)**	(19.72)**	(25.99)**
lcapital_1	0.006	0.006	0.006	
	(2.56)*	(2.55)*	(2.54)*	
lgdp	1.061	1.063	1.069	
	(7.92)**	(7.90)**	(7.95)**	
lgdp_1	–0.995	–0.996	–1.003	
	(7.51)**	(7.48)**	(7.54)**	
Scheme (any)	0.016			
	(2.81)**			
APS scheme		0.006		
		–0.44		
CSOP scheme		0.01		
		–1.65		
SAYE scheme		0.026		
		(2.82)**		
Scheme listed			0.031	
			(2.61)**	
Scheme non-listed			0.012	
			(1.89)	
Only tax-advantaged scheme				–0.012
				(1.32)
Also non-tax-advantaged scheme				0.033
				(4.39)**
Also non-tax-advantaged scheme_1				0.004
				(0.52)
Constant	2.744	2.727	2.736	3.586
	(12.82)**	(12.70)**	(12.75)**	(153.53)**
Observations	83,602	82,550	82,550	83,602
Number of companies	14,960	14,601	14,601	14,960

Note: Absolute value of t statistics in parentheses; * significant at 5%; ** significant at 1%. Variables followed by an underscore and a number refer to number of lags of the variable; variables without an underscore are not lagged.
Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

From the dynamic specification estimated above, it is possible to estimate a long-run effect from the presence of a variable by summing the coefficients on the variable of interest and dividing by 1 minus the sum of the lags of the dependent variable. In this case, where there is one lag on the dependent variable:

$$\frac{\text{coefficient of scheme}}{1-(\text{coefficent of lturnover}_{t-1})}$$

Each model in Table 10.2 therefore implies the following.

– Model 1 shows that, when past performance is taken into account, there is a small but significant productivity effect from having a tax-advantaged share scheme of around 2.5%. This implies that the results from the static models (8.2%) were higher due to more successful firms choosing to have share schemes, rather than firms gaining a productivity effect from the introduction of a share scheme.

– Model 2 breaks down the result by each of the three tax-advantaged share scheme types and a positive effect of 4.1% in the long run is found for SAYE schemes, but there is no significant effect from CSOP or APS schemes. This refutes the hypothesis in section 4.5.3 that CSOP schemes may have a greater effect on company performance.

– Model 3 examines whether there is a systematic difference in the effect of tax-advantaged share schemes between listed and unlisted companies. Listed companies can expect an average increase of 4.9% in turnover in the long run from the existence of a share scheme, whereas the effect for unlisted companies is borderline significant. This suggests that, where there is an effect, it is significantly smaller than that for listed companies. This confirms the hypothesis in section 4.5.3 that the productivity effect will be stronger in listed companies (due to the degree of participation and/or greater incentive properties of schemes in listed companies).

– Model 4 estimates whether the effect of tax-advantaged share schemes is still found when there has also been a non-tax-advantaged share scheme at some point in time. The model suggests that there is a significant increase in turnover of 5.2% when a tax-advantaged share scheme exists and a non-tax-advantaged scheme has also existed. However, there does not appear to be an increase when only a tax-advantaged share scheme has existed.

Scheme effects by industry

Further modelling of the dynamic effect by industry found three industries where there were significant positive effects from the presence of a share scheme (see Table 10.3).

Table 10.3 Industries where there is a strong productivity effect from tax-advantaged share schemes

Industry	Effect on turnover of tax-advantaged scheme (%)
Manufacturing	4.8
Electricity gas & water	23.7
Financial intermediation	11.1

Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

Scheme effects by firm size

The above analysis was undertaken for each quartile of the turnover distribution to estimate how the effect of tax-advantaged share schemes varies with firm size. Table 10.4 below shows that the effect of a tax-advantaged share scheme is stronger as company size grows,

with only firms in the upper quartile (ie, a turnover greater than £36.3m) having a statistically significant productivity effect.

Table 10.4 Long-run effect of tax-advantaged share schemes by turnover quartile

Turnover band	Effect on turnover of tax-advantaged scheme (%)
Quartile 1 (less than £3.4m)	1.63
Quartile 2 (£3.4m to £11.2m)	1.10
Quartile 3 (£11.2m to £36.3m)	1.39
Quartile 4 (greater than £36.3m)	3.32**

Note: * significant at 5%; ** significant at 1%.
Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

Multiplicative scheme effects

Model 2 in Table 10.2 examined the effect of each individual scheme on firm-level output and found a significant effect only for the SAYE scheme of 5.2% in the long run. One scheme on its own may not provide sufficient incentive to increase productivity, but a combination of multiple schemes may induce a significant increase in productivity.

Table 10.5 shows the effect of having each combination of schemes. The only significant effect is from a combination of CSOP and SAYE schemes, which increases productivity by 4.42%. This is higher than the expected effect of 4.1% from just an SAYE scheme.

Table 10.5 Long-run effect of multiple schemes

Industry	Effect on turnover of multiple tax-advantaged schemes (%)
APS & CSOP	–3.32
APS & SAYE	–0.32
CSOP & SAYE	4.42**

Note: * significant at 5%; ** significant at 1%.
Source: HM Revenue & Customs; FAME; Office for National Statistics Time Series; and Oxera calculations.

10.4 Sensitivity and robustness of modelling

As well as cleaning the data, the models have been subjected to sensitivity testing in the form of removing the two years (1993 and 2003) where the mean turnover and capital values could be considered outliers. Due to the way FAME collects accounting data, there are significantly fewer observations in this year and, as such, they may not be representative of all the industries.

Appendix 6 gives details of the results of the sensitivity testing. The coefficient estimates are very close to those estimated using the full sample, indicating that the small sample sizes in 2003 and 1993 are not significantly biasing the results.

Oxera also split the sample before and after the stock market fall in 2000. When Model 1 (in Table 10.3) was split, no significant productivity effect was found either before or after. This may be due to the very small number of time series observations that are left when such a split is made. This may suggest that data using a longer time series is required to ensure that the result is not biased by large changes in the stock market, which may alter the incentive effects.

10.5 Summary

The results of the static models presented above indicate that the presence of share schemes increases output by around 8% on average. There is a larger statistically significant effect from CSOP (7%) than from the APS (5%) and SAYE schemes (5%).

The strength of the result varies considerably by industry, with some industries exhibiting little or no effect and others showing large gains. As expected, there is a larger effect in listed companies than in unlisted companies. This may be due to listing status representing an approximation for the degree of employee participation in schemes, or to greater incentives properties for listed companies—for example, participants being able to sell their shares more easily and potentially having greater access to information.

The static production functions should be treated with caution since there may be a delay between changing the inputs of production (including the existence of a tax-advantaged share scheme) and the effect on output (turnover). There is also a potential endogeneity between the share scheme and the output. It is not clear that the share scheme causes increased productivity: it may be that relatively productive firms choose to operate tax-advantaged share schemes. The dynamic model addresses these issues by including lags of the dependent variable to control for historical performance and lags of the explanatory variables to account for delayed responses in output to changes in inputs.

When considering a dynamic model that allows for lagged effects from share schemes (and other components of the production function), the average effect of tax-advantaged share schemes is around 2.5% higher turnover if a share scheme exists. However, when the schemes are broken down, the only scheme that gives a significant effect of 4% is SAYE.

This compares to Conyon and Freeman (2004), who estimated a positive impact for APS and CSOP of up to 18.9% and 12.2% respectively, for listed companies, and no impact for SAYE. In contrast, Addison and Belfield (2001) found only a significant effect for SAYE schemes at the 10% significance level.

If a productivity effect is present, it is more likely to occur in a listed company, which has a stronger response to any share scheme (4.9%) than an unlisted company, where no significant effect was found (due to the degree of participation and/or to greater incentive properties of schemes in listed companies). A productivity effect (3.3%) is also most likely to occur in larger firms (with a turnover greater than £36.3m), which are also more likely to be the firms that participate in tax-advantaged share schemes.

The industries for a significantly positive result was found were electricity, gas and water supply (23.7%), manufacturing (4.8%) and financial intermediation (11.1%).

Controlling for the existence of non-tax-advantaged schemes (at any point in time) in the modelling shows that having a tax-advantaged share scheme does increase productivity by around 5% in the long run. However, when only a tax-advantaged scheme exists, there is no significant productivity effect.[59] This implies that tax-advantaged schemes increase productivity only when supported by a non-tax-advantaged scheme. In large companies, which are more likely to take up the scheme and experience the largest response in terms of productivity, it is possible that managers also have profit-related schemes that are not tax-advantaged. If such schemes did not exist, there would be little or no effect from a tax-advantaged scheme.

Due to the limited availability of time series data, it has not been possible to test whether these results are robust to significant changes in the stock market.

[59] The coefficient becomes negative and this may represent the increased administrative costs of running a tax-advantaged scheme. In the sensitivity testing, this result became insignificant when the years 1993 and 2003 were excluded.

The results of this section are summarised in Table 10.6 below.

Table 10.6 Results from dynamic production functions

	Productivity effect (%)	Significance at 5%
Any tax-advantaged scheme	2.5	Yes
SAYE	4.1	Yes
APS	0.9	No
CSOP	1.6	No
Combinations of tax-advantaged schemes		
APS and CSOP	–3.3	No
APS and SAYE	–0.3	No
CSOP and SAYE	4.4	Yes
Listed companies with a scheme	4.9	Yes
Unlisted companies with a scheme	1.9	No
Any tax-advantaged scheme by turnover quartile		
Quartile 1 (less than £3.4m)	1.6	No
Quartile 2 (£3.4m to £11.2m)	1.1	No
Quartile 3 (£11.2m to £36.3m)	1.4	No
Quartile 4 (greater than £36.3m)	3.3	Yes
Companies with tax-advantaged schemes only	–1.9	No
Companies with tax-advantaged and non-tax-advantaged schemes	5.2	Yes
Industries where the effect is greatest		
Electricity, gas and water supply	23.7	Yes
Financial intermediation	11.1	Yes
Manufacturing	4.8	Yes

Source: Oxera analysis.

Table 10.6 suggests that a significant increase in productivity is seen only in large firms operating SAYE schemes and when other non-tax-advantaged schemes also exist. The size of the effect is likely to be an increase in turnover of between 2% and 5%.

11 Data envelopment analysis

11.1 Introduction

The econometric analysis undertaken in section 10 is used to estimate an average production function. The estimated coefficients from the models then provide an estimate of the *average* impact on performance or output of a firm having a tax-advantaged share scheme. This section considers an alternative approach to econometric modelling to assess the impact of tax-advantaged share schemes, namely data envelopment analysis (DEA).[60]

DEA is an analytical technique that is generally used to make efficiency comparisons between units (companies, hospitals, bank branches, etc) while taking into account various inputs, outputs and other explanatory factors.

As such, the approach can be used to estimate a production efficiency frontier and provide estimates of companies' inefficiency relative to this frontier.

However, of more interest for this study is the use of the technique for assessing the impact of tax-advantaged share schemes on company performance.

By extending the usual DEA approach it is possible to estimate a firm's inefficiency due to:

– managerial inefficiency; and
– policy inefficiency (and, in particular, whether a tax-advantaged share scheme has been taken up).

11.2 Approach

DEA was used to construct production frontiers (see Appendix 8, for a more detailed explanation of the basics of the DEA approach and how the technique is implemented to assess the impact of share schemes). In order to assess the impact of tax-advantaged share schemes, DEA was undertaken on 2001/02 data for the manufacturing sector only. DEA was undertaken separately on two sub-samples of the dataset—those companies that have a share scheme and those that do not. This approach results in estimating two production frontiers—a frontier for those companies with share schemes and a frontier for those without. The impact of having a share scheme was then estimated as the distance between the two frontiers.

Thus, the approach can assess the maximum level of output that a firm could achieve given observations on other firms, and thus estimates the production frontier. If, for the sake of explanation, one assumes that having a tax-advantaged share scheme is more efficient than not having a share scheme, this total potential increase in output could be achieved by,

– the firm by improving its managerial efficiency; and
– the firm introducing a tax-advantaged share scheme.

Thus, by estimating the second effect, the DEA results can be used to illustrate the potential for improvements in performance through adopting tax-advantaged share schemes at the efficiency frontier. That is, if a firm is as efficient as it could be (without having adopted a

[60] The main focus of this study is the econometric modelling undertaken in section 10—the DEA in this section is preliminary, and is undertaken to illustrate the use of the approach in assessing the impact of the different schemes on company performance and to complement the econometric analysis.

tax-advantaged share scheme), what is the additional improvement it could achieve were it to adopt a tax-advantaged share scheme?

This potential for improvement can also be measured on a firm-specific basis. For example, the potential for improvements in company performance through adopting tax-advantaged share schemes could be estimated for labour-intensive firms, or for large or small companies, etc. This firm-specific analysis has not been undertaken because the analysis for this report is only intended to be illustrative of the use of the approach.

11.3 Results

The DEA analysis shows that the performance of frontier manufacturing companies with schemes is improved by 6% on average in 2001/02, compared with manufacturing companies without schemes. This result appears to corroborate the findings from the econometric analysis in section 10.

12 Concluding assessment and policy implications

This study has examined the impact of share schemes on company performance and, in particular, tax-advantaged share schemes.

The descriptive analysis has indicated the following points.

– The number of employees who bought shares or were granted options in any one year has been broadly increasing since 1995/96 (SAYE, APS) or 1996/97 (CSOP). However, this measure constitutes a flow rather than a stock in employee participation in schemes, and hence changes in overall participation cannot be inferred.

– Larger companies, as measured by number of employees (but also turnover and amount of capital) are more likely to operate schemes. Large companies are also more likely to operate multiple schemes.

– Analysis of schemes by industry sector reveals that around 80% of all share schemes are concentrated in four sectors (manufacturing; real estate, renting and business activities; wholesale and retail trade; and financial intermediation). When taking into account the total size of each industry, companies belonging to the electricity, gas and water supply, mining and quarrying, financial intermediation, and manufacturing sectors are shown to be most likely to operate a share scheme. Companies in any industry are more likely to operate a discretionary CSOP scheme than either a SAYE or APS all-employee scheme.

– On average, across all industries and years examined, 36% of companies with schemes are listed. The number of companies with a scheme that are listed has increased over time to almost 50% in 2001/2002. Between 38% (mining and quarrying) and 74% (manufacturing) of all listed companies across industries operate a share scheme.

– Companies belonging to the electricity, gas and water supply sector are shown to be most likely to operate any type of share scheme. When focusing the analysis on listed companies, the sector in which companies are most likely to operate a share scheme is manufacturing (74%).

– Listed companies with schemes tend to have the same or higher levels of productivity (capital or labour) and profitability compared with listed companies without schemes.

– Additional modelling shows that companies are more likely to operate schemes the more capital-intensive they are. The analysis also shows that companies are more likely to have share schemes under favourable economic conditions.

When examining the effect of schemes on output, controlling for the inputs of the production process, this study found the following.

– Using static production functions, the existence of a tax-advantaged share scheme increases output by 8%, with a larger effect for CSOP (7%) than APS (5%) and SAYE (5%). However these results should be treated with caution due to the dynamic nature of production functions and the potential endogeneity between tax-advantaged schemes and increased performance.

– When considering a dynamic model which allows for lagged effects from tax-advantaged share schemes (and other components of the production function):

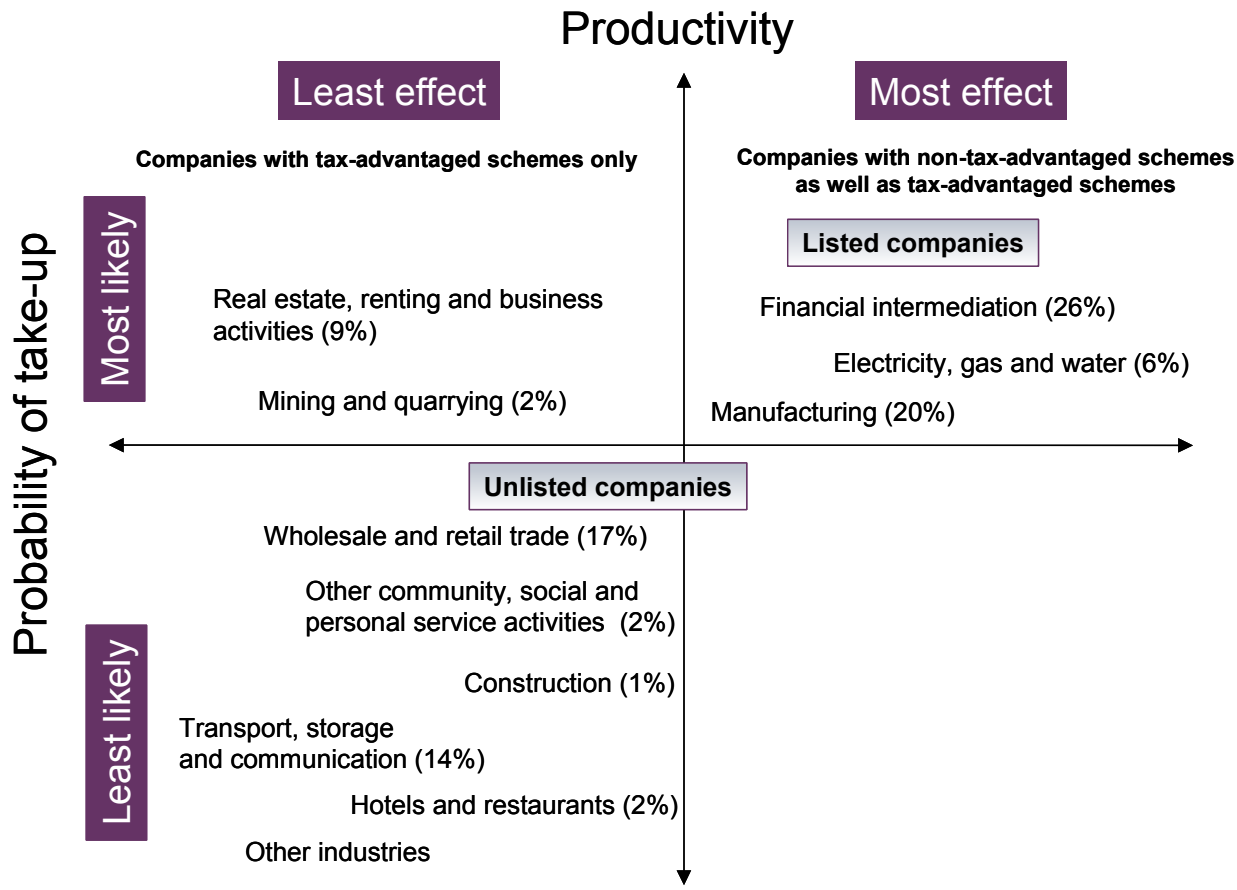
- the effect of tax-advantaged share schemes is, on average and across all industries, significant and increases productivity by 2.5% in the long run;
- when the schemes are broken down, there would appear to be a significant long-run effect from SAYE (increasing productivity by 4.1%), but no significant improvement from CSOP or APS schemes;
- when examining the combined effect of having several types of share scheme, the only significant effect is from a combination of CSOP and SAYE schemes, which increases productivity by 4.4% (ie, greater than the effect of operating only SAYE);
- listed companies show a stronger long-run response (4.9%) to tax-advantaged share schemes than unlisted companies, where no significant productivity effect was found. However, in the absence of information on the degree of employee participation, it is not possible to distinguish the productivity effects of greater potential incentives for listed companies from those arising from greater employee participation in schemes;
- controlling for the existence of schemes that are not tax-advantaged (at any point in time) in the modelling shows that having a share scheme increases productivity by around 5.2% in the long run;
- however, when only a tax-advantaged scheme exists, there is no significant positive productivity effect;
- productivity is significantly increased by 5% for manufacturing companies, by 24% for electricity, gas and water supply companies, and by 11% for financial intermediation companies when these companies have tax-advantaged share schemes;
- the effect of a tax-advantaged share scheme becomes stronger as company size grows, with only those firms in the upper quartile (ie, a turnover greater than £36.3m) having a statistically significant productivity effect.

The results above indicate that the actual tax advantages of tax-advantaged share schemes are not sufficient on their own to increase company productivity. In order for such schemes to be effective in increasing productivity, other factors such as the provision of non-tax-advantaged schemes, particular company size, and being a listed company are required for a significant productivity effect to be found. Contrary to the hypothesis and results from the static modelling, the dynamic models indicate that SAYE schemes have the greatest effect on productivity.

Figure 12.1 summarises the results of the research according to the probability of taking up a tax-advantaged scheme and the likely productivity effect. The figure also shows, for each industry, the approximate value of shares/options held by employees in each industry, expressed as a proportion of the aggregate share/option value across all industries.[61]

[61] The probability of scheme take-up is based on the binary choice modelling in section 9 and Appendix 3. The productivity impact is derived from the econometric analysis in section 10 and Appendix 7. The figures of the value of shares/options held by employees in each industry can be found in section 8.

Figure 12.1 Summary of results



Source: Oxera.

Figure 12.1 indicates that any policy aimed at increasing the productivity of companies through tax-advantaged share schemes could be directed at those companies that show the most productivity effect. Furthermore, the underlying reasons for the observed effect of schemes in industries that are likely to offer schemes but do not display higher than average productivity rates could be investigated further.

The data employed for the analysis in this report does not allow the improved productivity effects observed in listed companies to be attributed to either the higher degree of employee participation in listed companies or the greater incentive properties of such companies. Possible policy options therefore include encouraging take-up in listed companies, encouraging employee participation in all companies (particularly in certain industries), or both. Establishing which factor is most significant would be an important area of further research. However, whether it would be necessary for the government to provide tax incentives to improve performance is not clear since there is some evidence indicating that productivity is enhanced in companies with both tax-advantaged and non-tax-advantaged schemes, and not in those with only the former type of scheme.

The scope of the analysis was limited by a number of issues such as:

– the availability of data on schemes that are not tax-advantaged;
– the length of time series, which limits the ability to control for endogeneity using techniques such as Arellano Bond estimators;
– whether the dynamic panel data specification adequately controls for the issues of causality in short time series;
– availability of data on participation;
– survivorship bias in the dataset.

Further work may be required to confirm some of the results above by comparing the performance of electricity, gas and water companies with the rest of the economy and understanding why manufacturing firms have a lower probability of taking up tax-advantaged share schemes when there are significant productivity gains.

The analysis in this report has attempted to make the best possible use of the available data; however, the shortness of the time series may limit and potentially bias the results. The analysis should be extended when additional time series data is available to investigate further the impact of share schemes on productivity.

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