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Productivity growth and funding of public service broadcasting

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Abstract In this paper we demonstrate how standard techniques for measuring productivity growth can be applied to the broadcasting sector to provide a benchmark for reasonable efficiency savings which public finance officials might expect public service broadcasting (PSB) to achieve. Using establishment level data from the UK, we produce estimates of productivity growth amongst commercial broadcasters between 1999 and 2003, which provide some evidence that improvements to PSB can reasonably be expected to be funded by efficiency savings rather than solely by increases in public funding.

Keywords Broadcasting · Efficiency · Productivity growth

JEL Classification D24 · J24 · L82

1 Introduction

The role of public service broadcasting (PSB) and how it should be funded has long been a source of controversy amongst policy makers in many countries. Typically PSB is funded at least partially from public money, either by means of a license fee or from general tax revenue. The level of public subsidy is commonly the outcome of a political process involving various stakeholders—public finance officials, public service broadcasters, commercial broadcasters, content providers and viewing organizations.

Typically the public service broadcaster has an incentive to argue that improvements in, for example, programming quality should come from increases in public subsidy whereas

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public finance officials would prefer to see improvements funded from efficiency savings. The negotiating process over this issue is complicated by the difficulty in identifying a level of efficiency savings that it is reasonable to expect the public service broadcaster to achieve.

In this paper, we demonstrate how standard techniques to measure productivity growth in service industries can be applied to provide a benchmark against which PSB can be judged. We illustrate the application of these techniques in the context of the United Kingdom. The UK is a particularly useful case to study for two reasons. First, the United Kingdom is one of the few countries in the world to fund its main public service broadcaster, the BBC, entirely by means of a license fee levied on anyone who owns a television set. Second, the BBC is the largest and most dominant public service broadcaster in the world.

In the next section of the paper we discuss the underlying rationale for PSB and discuss the political process by which the level of subsidy for the PSB in the UK is determined. In Sect. 3 we consider previous work on estimating productivity in broadcasting. In Sect. 4 we discuss our methodology and introduce the data. Results of the productivity analysis are reported in Sect. 5, whilst the final section contains some concluding comments.

2 Public service broadcasting

A rationale for using public funds to subsidize broadcasters can be derived from the classic argument of 'market failure', which may exist for a number of reasons (see, for example, Brown 1996a; Peacock 2000; Cowen and Crampton 2003; Anderson and Coate 2005). Firstly, broadcasting is a public good characterized (in the case of the BBC) by non-exclusivity (the technology exists and is used by other broadcasters to exclude those who do not pay) and non-rivalry (consumption of the good by one person does not reduce its availability to others. This is the 'free rider' problem in which those who do not pay are as able to consume the product as those who do pay, a particular problem as consumer group size increases (e.g., Olson 1965; Chamberlin 1978; Goetze et al. 1993).

There is another principle relevant to public service broadcasting, sometimes known as the 'merit good' principle, i.e., a good whose value to an individual (in terms of information and education, for example) exceeds the value placed upon it by the individual, in part because people are not fully informed. In a more general sense, public service broadcasting may provide more positive externalities (e.g., improvements in attitudes of social responsibility) than would a free market which may pander to the lowest common denominator. Even so, when it comes to merit goods a key question is to establish who the decision-maker is. Without this context, the broadcaster (perhaps the Government itself) becomes the decision-maker. This creates the problem that we may be extending the list of merit goods to a range of services that might actually be better provided by the market. Still, the rationale for a public service broadcaster (PSB) may become even more important as spectrum width and digital technology reduce barriers to entry (see Adda and Ottaviani 2005, for a consideration of issues arising the transition from analogue to digital television), although advantages of scale could mean that a high level of market concentration is maintained (Motta and Polo 1997). Eusepi (1995), however, argues that the public good characteristics of the electromagnetic spectrum may no longer be justified as an argument in support of a monopoly public broadcasting system when considered alongside opportunity costs in terms of lost choice and diversity. Regardless of this, there does exist what Cave refers to as a potential 'citizen-based' ground for public service broadcasting (Cave 2004; see also Cave 1996, for a broader overview of public service broadcasting in the UK) and, in particular, the public interest objective of increasing overall levels of program quality (O'Hagan and Michael 2003), creating what Noam (1987: 26) terms "... a bias towards quality." As the UK Government's Department for Culture, Media and Sport (DCMS) put it, the PSB should "provide a strong and distinctive schedule of benchmark quality programs on all its services" (DCMS 2000: par. 5). Finally, PSB may increase diversity of supply above competitive market levels Van Der Wurff (2005).

PSB in the UK is dominated by the 'British Broadcasting Corporation' (the BBC). The BBC was founded in 1922 by a group of wireless manufacturers and in 1927 received its Royal Charter. Since then it has largely been a self-governing statutory corporation. The BBC began television broadcasts in 1936, and its Charter was last renewed in 2006. Funding for the BBC (including radio and online) is by means of a license fee, paid by every household with a TV, with a concession for the blind and those over 75. This raised income for the BBC of £3.24 billion in 2006–2007 (BBC Executive Report 2007: 83), up £142 million on the previous year and up from £2.94 billion in 2004–2005 (Armstrong and Weeds 2007). The UK devotes a significantly larger share of gross national product to PSB than any other developed economy. In turn, PSB in the UK attracts a much larger audience share than, for example, in the US (Brown 1996b; Aufderheide 1996; Berry and Waldfogel 1999).

The level of funding for the BBC is determined every five years or so by a 'license fee settlement' resulting from negotiations between Government and the BBC. In these negotiations, the UK Government has increasingly been concerned with trying to assess the level of efficiency savings that the BBC might reasonably be expected to achieve over the lifetime of the 'settlement'. Given that the BBC's programming output is free at the point of use, it is difficult to identify levels of output in a form suitable for assessing productivity levels or growth in the BBC. However, a natural alternative is to estimate productivity growth in the commercial broadcasting sector and to use these estimates as a benchmark to judge reasonable efficiency gains which the Government might expect the BBC to be able to achieve. This examination necessarily sets aside, of course, the actual process leading to choice. In particular, the bargaining between the BBC and Government for fund appropriations sets the two in an asymmetric position, with the BBC holding the informational advantage. Estimates of productivity growth viewed in this framework might be regarded as only marginal in their effect on this informational advantage. In that context, it is difficult to quantify the extent to which budget constraints act as an incentive for the BBC to pursue efficiency gains.

This aside, any attempt to measure productivity growth in broadcasting in any case faces the difficulties inherent in measuring productivity growth in service industries more generally. In particular, there is a problem in defining measurable units of output and adjusting for quality changes, as well as in constructing accurate measures of capital input. For this reason, many academics have limited themselves to the analysis of labor productivity, typically measured as real output divided by the number of employees or hours worked. The benefit of labor productivity is that it is likely to be measured with greater precision than 'total factor productivity', i.e., productivity with respect to all relevant inputs. However, relying solely on labor productivity suffers from several disadvantages associated with using the simpler productivity measure. First, to ensure reliability, output and input measures must be consistent, i.e., they must refer to the same production activity. A second problem with labor productivity measures is that the average product of labor might be related to the business cycle. Thus, such measures may be capturing effects that are unrelated to technical progress. The most critical problem in using labor productivity measures alone, however, is that neither labor nor capital is the sole source of productivity improvements. In particular, labor productivity measures the efficiency of only one input and does not control for the possibility that the plant, firm, or industry, can substitute capital, materials, or services for labor. For these reasons, in our empirical work below, we present estimates based on both Labor Productivity and Total Factor Productivity growth measures.

An even more fundamental problem exists in many service industries, since it is sometimes difficult to define and measure real output in the service sector. We have reason to believe, however, that the measurement difficulties cited in this section can be overcome, given the availability of enterprise-level data, which allow us to measure and 'explain' relative productivity growth.

3 Previous work on broadcasting productivity

Although Caves (2000) provides a comprehensive economic analysis of contractual relationships within the creative industries there have been to date very few academic papers providing estimates of productivity growth in broadcasting and, to our knowledge, none at all based in the UK.

Exceptions include Triplett and Bosworth (2003), who calculate labor productivity in a range of US services industries. They use data from the Bureau of Economic Affairs (BEA) to calculate an annual growth rate of labor productivity in Radio and Television Broadcasting of 1.2% per annum between 1995 and 2000. The authors also report a similar growth rate of 1% per annum when Bureau of Labor Statistics (BLS) data are used (Table 4, p. 29). Another exception is Asai (2005), who calculates total factor productivity (TFP) growth of Japanese terrestrial broadcasters, using data derived from 25 broadcasters between 1997 and 2002. While a decrease in output was shown to cause low TFP growth, TFP growth was observed to improve through technical advances. Asai finds, however, that the average rate of technical change was low, although greater among larger-scale than smaller-scale broadcasters.

Sichel's (2001) study of productivity in the US communications sector provides the most exhaustive analysis of broadcasting productivity growth. He reports labor productivity growth estimates using both total output (real gross output) and value added (real GDP) for the broadcasting sector for three periods: 1977–1990, 1990–1995 and 1995–1999. Using total output, annual labor productivity growth was estimated to be 0.6% for 1977–1990, 1.1% for 1990–1995 and 0.7% for 1995–1999. These are broadly comparable with the Triplett and Bosworth estimates. Productivity growth estimates show much greater variance when using value added. The growth rate for 1977–1990 is estimated to be −0.8% per annum rising to 6.3% per annum between 1990 and 1995 and then dropping back to −4.5% per annum in 1995–1999.

Finally, ten Raa and Wolff (2000) discuss the relationship between R&D and total factor productivity (TFP) growth in a range of industries between 1958 and 1987, again in the US. They do not list actual figures, but report that the radio and TV broadcasting sector experienced negative TFP growth over the period.

Thus, the evidence-base to date on productivity growth in the broadcasting sector is weak and it is not clear that it tells us a great deal about the experience of productivity growth in the UK. We have no published estimates of TFP growth in this sector, no estimates for any period beyond the year 2000 and no estimates at all (excepting the single Japanese study) for broadcasting in any country except the US. This latter point is particularly important in the context of this study given the institutional differences in broadcasting between the US and UK. To illustrate this, Sichel (2001) notes that the dynamics of productivity in cable TV (which has traditionally been of relatively more importance in the US) are likely to be very different to traditional TV or radio broadcasting.

Despite the lack of evidence relating specifically to the broadcasting sector, there is a growing literature on the measurement of productivity in services which underpins much of the analysis in this paper. For a discussion of this, we refer readers to Paton et al. (2004).

4 Estimating broadcasting productivity: methodology and data

4.1 Introduction to the annual respondents database (ARD)

The Annual Respondents Database (henceforth, ARD) is a plant-level file based on the Annual Business Inquiry, a survey conducted by the Office for National Statistics. Information is collected on a range of variables covering output, employment, investment and expenditure for samples of enterprises across many industries.

Firms are selected for inclusion in the ABI from the Inter-Departmental Business Register (IDBR) at the ONS. Sampling is based on size by employment on the Register. The probability of being selected for the ABI increases with employment size and the largest firms (currently over 250 employees) are surveyed every year. The ABI is carried out at the level of reporting unit, which is typically at the enterprise level. However, a significant number of enterprises have more than one reporting unit. Selected firms have a statutory duty to provide data to the ABI.

A limited amount of data (on employment and turnover) is held for all reported units on the IDBR. There is some evidence (Haskel and Khawaja 2003) that the employment data on the IDBR are reasonably reliable, whereas the turnover data are not. For this reason, the productivity analysis in this paper is based on the ABI data alone.

4.2 Methodology

Our empirical approach consists of two stages. In the first stage, we calculate a series of labor productivity growth estimates for the broadcasting sector using published ABI data. These are broadly comparable to the Experimental Productivity Measures currently published for some service industries by the ONS and reported in Daffin et al. (2002). In the second stage, we derive estimates of total productivity growth using econometric productivity models. We concentrate on the use of stochastic frontier analysis (SFA) models and use these to decompose productivity growth into technical change or 'frontier shift" and efficiency change or 'catch-up'.

4.2.1 Labor productivity measures

We report annual labor productivity estimates for SIC 92.20: Radio and Television Activities using total turnover and gross value added (basic prices) as published by the ONS. We measure employment as average total employment in each year.

To provide a comparison with more broadly defined sectors, we also present labor productivity growth estimates for SIC O (Other community, social and personal service activities) and 92000 (Recreational, Cultural and Sporting Activities).

There are several possible deflators, including the GDP deflator, Producer Price Index (PPI), and the Retail Price Index (RPI). Here we deflate the output measures by the Consumer Price Index for Recreation & Culture published by the ONS (series CHVS/D7C4) with a base year of 1996. Note that Sichel (2001) uses an advertising price deflator, but this is probably less relevant in the context of the UK.

4.2.2 Stochastic frontier analysis

To arrive at annual productivity growth estimates and decompositions, we focus on the stochastic frontier analysis (henceforth, SFA) method developed independently by Aigner et al. (1977) and Meeusen and Van den Broeck (1977). SFA generates a production (or cost) frontier with a stochastic error term that consists of two components: a conventional random error ('white noise') and a term that represents deviations from the frontier, or relative inefficiency. SFA can be contrasted with data envelopment analysis (DEA), a non-parametric estimation technique that has been used extensively to compute relative productivity in service industries.[1] DEA and SFA each have key strengths and weaknesses. DEA is a mathematical programming approach that does not require the specification of a functional form for the production function. It can also cope more readily with multiple inputs and outputs than parametric methods. However, DEA models are deterministic and highly sensitive to outliers. SFA allows for statistical inference, but requires somewhat restrictive functional form and distributional assumptions.

In SFA, a production function of the following form is estimated:

$$y_i = \mathbf{X}_i \beta + \epsilon_i \tag{1}$$

where the subscript i denotes the ith company, y represents output, $\mathbf{X}$ is a vector of inputs, β is the unknown parameter vector, and $\varepsilon_i = v_i - u_i$ is an error term with two components, $\varepsilon_i = v_i - u_i$, where u_i represents a non-negative error term to account for technical inefficiency, or failure to produce maximal output, given the set of inputs used and v_i is a symmetric error term that accounts for random effects. The standard assumption (see Aigner et al. 1977) is that the u_i and v_i have the following distributions:

$$u_i \sim \text{i.i.d. } N^+(0, \sigma_u^2), \quad u_i \geq 0,$$
$$v_i \sim \text{i.i.d. } N(0, \sigma_v^2).$$

That is, the inefficiency term (u_i) is assumed to have a half-normal distribution; i.e., enterprises are either "on the frontier" or below it. An important parameter in this model is $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$, the ratio of the standard error of technical inefficiency to the standard error of statistical noise, which is bounded between 0 and 1. Note that $\gamma = 0$ under the null hypothesis of an absence of inefficiency, signifying that all of the variance can be attributed to statistical noise.

However, this conventional approach is potentially sensitive to the distributional assumptions requiring fixed σ_u^2 and σ_v^2. The one-sided nature of u_i means that σ_u^2 could potentially vary in relation to systematic differences in technical efficiency across companies (unobserved heterogeneity), and σ_v^2 could vary as a consequence of systematic differences in measurement error (heteroscedasticity). In particular, there is good cause to believe that efficiency and measurement errors will vary depending on company size and across regions, given the differences in commercial and regulatory environments within which broadcasters operate. Caudill et al. (1993) have shown that if heteroscedasticity is ignored there can be significant estimation biases which affect both the shape of the estimated frontier (and therefore estimates of technological change) and the estimated technical efficiency effects.[2]

[1] See Charnes et al. (1994). See also Ackerberg et al. (2006) for a discussion of panel data frontier techniques in the context of the service sector.

[2] For a review of the biases associated with ignored heteroscedasticity in both error terms, see Kumbhakar and Lovell (2000), pp. 115–122.

In order to address estimation problems arising from both unobserved heterogeneity and heteroscedasticity, we adopt a procedure suggested by Kumbhakar and Lovell (2000) and explicitly model the variances of both types of error when fitting the production frontiers:

$$\sigma_{ui}^2 = g_u(z_{it}; \boldsymbol{\theta}_{\mathbf{u}}), \tag{2}$$

$$\sigma_{vi}^2 = g_v(z_{it}; \boldsymbol{\theta}_{\mathbf{v}}) \tag{3}$$

where z_{it} is a vector of covariates including the company's scale of operation (total employment), its region of operation, and its use of technology;[3] $\boldsymbol{\theta}_{\mathbf{u}}$ and $\boldsymbol{\theta}_{\mathbf{v}}$ are vectors of coefficient estimates from the one-sided and two-sided heteroscedasticity models respectively.[4] Kumbhakar and Lovell (2000: 273) point out that this approach offers the possibility of solving two problems at once—correcting for heteroscedasticity and incorporating exogenous influences on technical inefficiency. Joint maximum likelihood estimation of (1), (2), and (3) using our data reveals the structure of the production frontier as well as firm-specific technical efficiency effects.[5]

To implement this model, we estimate the following Cobb-Douglas production function:

$$\log(Q_{it}) = \beta_0 + \beta_1 \log(K_{it}) + \beta_2 \log(L_{it}) + \beta_3 \log(M_{it}) + \beta_4 \,\text{trend} + v_{it} - u_{it} \tag{4}$$

where Q = output (either gross output or gross value added) of firm i in year t; K = capital stock; L = labor (employment); M = materials; trend = linear time trend; v_{it} = a standard, "white-noise" error term; u_{it} = inefficiency of firm i at time t, assumed to follow the truncated normal distribution.

Using maximum likelihood methods, we jointly estimate (4) together with the following variance models:

$$\log(\sigma_{vi}^2) = \gamma_0 + \gamma_1 \log(L_{it}) + e_v, \tag{5}$$

$$\log(\sigma_{ui}^2) = \delta_0 + \delta_1 \log(L_{it}) + \delta_2 T_{it} + \delta_3 R_{it} + e_u \tag{6}$$

where T = technology adoption; R = region.

In this framework, the (constant) estimated annual rate of technical progress is given by the coefficient on the time trend (β_4). The inefficiency terms could then be recovered from the conditional distribution of u_i given the observed combined error term using the method of Jondrow et al. (1982). The change in technical efficiency ('catch-up') can then be calculated from these inefficiency effects over time. Total factor productivity growth (TFP) is the sum of technical progress and efficiency catch-up elements. Heshmati (2003) provides a useful overview of productivity decomposition.

4.3 Broadcasting industry data in the ARD

4.3.1 Scope of data

We summarize here the ARD data from SIC codes 92201 (Radio Broadcasting) and 92202 (TV Broadcasting). For convenience, we refer to these henceforward as Radio and TV respectively. We present labour productivity estimates for both sectors combined. Separate

[3] We assume a loglinear model for these relationships: i.e. $g_v(\cdot) = \exp(\cdot)$ and $g_u(\cdot) = \exp(\cdot)$.

[4] The likelihood function for this model is given in of Kumbhakar and Lovell (2000: 121).

[5] The u_{it} are estimated from the maximum likelihood estimates after substituting into the conditional mode formula given in (3.4.9) of Kumbhakar and Lovell (2000: 121).

TFP estimates are presented for TV and radio combined and then for each of the two sectors.

Data definitions are provided in the Tables 1 and 2. In Table 3, we summaries the ARD data available to us for the broadcasting sector. Over the seven years, we have a total of 930 observations (an average of 133 per year) including 566 from TV and 364 from radio. The sample sizes for the econometric analysis are somewhat smaller due to missing observations for some variables. Looking at the size of firms as measured by number of employees, selected firms in TV tend to be much larger than selected firms in radio. As a result of the stratified sampling strategy used in the ABI, the size of the selected firms in both sectors is considerably larger than that of the non-selected firms. For this reason, in our regression analyses we weight the observations to control for the fact that larger firms have a greater chance of being selected (see, for example, Haskel and Khawaja 2003).

4.3.2 Measurement of variables

We estimate TFP growth using both gross output and gross value added measures. The gross output measure is defined as:

$$\begin{aligned}\text{GO} = {} & \text{turnover} + \text{change in work in progress} + \text{change in stocks brought for resale} \\ & + \text{work of a capital nature by own staff.}\end{aligned}$$

Direct measures of gross value added (GVA) are not presented in the ARD file for services. We compute it as:

$$\begin{aligned}\text{GVA} = {} & \text{Turnover} + \text{Change in Work in Progress at Start and End of Year} \\ & - \text{Total Purchases.}\end{aligned}$$

As with the labour productivity growth estimates, we deflate variables by the Consumer Price Index for Recreation & Culture published by the ONS (series CHVS/D7C4) with a base year of 1996. A further issue is the reporting period for the data which for some firms

Table 1 Variable description and summary statistics

Variable	Description	Mean (£000)	SD
Gross Output (GO)	log(Turnover + change in work in progress + change in stocks brought for resale + work of a capital nature by own staff.)	7.70	2.95
Gross Value Added (GVA)	log(Turnover + Change in Work in Progress at Start and End of Year – Purchases)	6.83	2.90
Capital	Log(capital stock)	7.56	3.26
Labour	Log(total number of employees)	3.06	2.35
Materials	Log(cost of materials used)	4.11	2.96

Source: ONS

Notes

(i) Summary statistics are calculated using the GVA sample, $N = 743$.

(ii) Stats are for radio and TV broadcasting combined.

(ii) Output variables are deflated to 1996 constant prices using the CPI for Recreation & Culture, series—CHVS. Capital stock calculated by ONS and deflated to 1995 prices

Table 2 SFA broadcasting production functions, 1998–2003 dependent variable

Coefficient on:	GO1	GVA
Production frontier		
Labor	0.413***	0.586***
	(0.108)	(0.105)
Capital	0.545***	0.348***
	(0.055)	(0.053)
Materials	0.028	–
	(0.039)	
Constant	2.284***	3.329***
	(0.295)	(0.252)
Time trend	0.010	−0.003
	(0.037)	(0.037)
Two-sided error variance (σ_v^2)		
Labor	0.396***	0.404*
	(0.147)	(0.216)
Constant	−0.749***	−0.844**
	(0.210)	(0.377)
One-sided error variance (σ_u^2)		
Labor	0.601***	−0.034
	(0.200)	(0.134)
Pr(computers)	0.359***	0.050
	(0.118)	(0.052)
Pr(telecom)	−0.066	−0.065***
	(0.050)	(0.023)
Region = North	1.399	0.265
	(0.903)	(0.415)
Region = West	−35.667***	1.229*
	(2.212)	(0.662)
Region = East	1.801*	0.400
	(0.954)	(0.535)
Region = Scot/Wales	−0.498	0.144
	(0.766)	(0.448)
Constant	−3.082***	0.593
	(0.915)	(0.424)
N	549	595
Log Likelihood	−16972.09	−20692.4
Wald χ^2	370.1***	403.8***

Notes
(i) All production function variables are specified in logs
(ii) ***indicates significance at the 1% level; **at the 5% level; *at the 10% level
(iii) The inefficiency term is assumed to follow a truncated normal distribution

Table 3 Numbers & mean employment levels of 'selected' & non-selected broadcasting firms 1997–2003

Year	TV				Radio			
	Selected		Non-selected		Selected		Non-selected	
	N	Emp	N	Emp	N	Emp	N	Emp
1997	89	438.4	578	21.2	69	44.0	1521	5.3
1998	69	486.1	1108	8.4	45	76.1	1440	4.7
1999	69	548.2	1624	6.6	56	61.8	1409	4.9
2000	90	407.6	1991	10.1	43	99.9	1413	4.7
2001	94	522.3	2299	4.6	54	77.4	1366	5.5
2002	73	505.8	2735	8.8	47	114.9	1355	4.7
2003	82	599.6	2992	4.1	50	90.2	1338	5.2

Source: ONS

does not cover the standard 12-month period. To control for this, we multiply each variable by the number of days in the reporting period divided by 365.

Regarding inputs, we firstly use total employment (question q50) which includes part-time work. For capital stock, we use the ONS-calculated data, deflated to 1995 prices. Capital stock data are not available for 2004 and, hence, the TFP growth estimates are limited to 2003. Note that we only include the materials variable in the gross output equations since materials are deleted from the value-added measure.[6] Data on materials are not available for 1997 and that means that TFP growth estimates using gross output are only calculated from 1999.

4.3.3 Limitations

There are well-recognized limitations involved both in the SFA techniques we employ in this paper and in the nature of the data. These include the sampling frame for the ARD which is biased against smaller firms (see Paton et al. 2004). A consequence of this is that we are unable to construct a meaningful panel data set of enterprises. This also limits our use of panel data econometric techniques, such as dynamic GMM estimation that are common in parametric studies of productivity.

A further complicating factor is that some enterprises in our sample may operate in more than one sector of the broadcasting industry. Given that data on the ARD is provided by reporting units our view is that it is unlikely that the analysis of changes within different sectors will be provided under the same reporting unit. However, the level of the reporting units is determined by the enterprise, so it is impossible to be sure of this. For these reasons, we believe it is important that policy analysis is informed by detailed qualitative analysis of changes to different sectors as well as by econometric results of the type presented in this paper.

[6] See Norsworthy and Harper (1993) for a discussion of the relative merits of gross output versus value-added specification of the production function.

Table 4 Annual % labour productivity growth, services, recreation & broadcasting 1999–2004

	Other services		Recreation		Broadcasting	
	GO	GVA	GO	GVA	GO	GVA
1999	2.6	7.9	−1.4	6.5	−10.6	1.4
2000	2.4	0.2	1.6	3.5	8.6	16.3
2001	2.4	3.2	5.2	4.3	12.8	10.7
1999–2001	*2.5*	*3.8*	*1.8*	*4.8*	*3.6*	*9.5*
2002	4.2	0.5	5.7	0.5	2.5	−2.1
2003	11.4	2.6	14.0	1.4	5.0	−8.2
2004	14.6	8.6	13.7	5.4	10.5	18.0
2002–2004	*10.1*	*3.9*	*11.1*	*2.4*	*6.0*	*2.6*
1999–2004	*6.3*	*3.9*	*6.5*	*3.6*	*4.8*	*6.0*

Source: derived by the authors from ONS data
Notes:
(i) Figures are mean annual % growth for the specified periods

5 Broadcasting productivity growth in the UK: results

5.1 Labour productivity growth estimates 1999–2004

In this section, we present the labour productivity growth estimates for all other services, for recreation and for broadcasting. The annual percentage growth rates for each sector using both gross output (GO) and gross value added (GVA) are summarized in Table 4. Consistent employment data are not reported by the ONS for 1998 and so we present estimates of growth for each year from 1999 to 2004, for the periods 1999–2001 and 2002–2004 and for the whole period.

The results in Table 4 suggest significant year-to-year variations in estimated productivity growth. This may be partly due to the relatively small sample size allowing large changes in a very few observations to dominate the estimates. For this reason, our preference is to concentrate on average annual growth estimates over a number of years. Between 1999 and 2004, labor productivity growth in broadcasting is estimated to be 4.8% per annum using GO and 6.0% using GVA.

Of course, these estimates relate only to labour productivity. It may be that ignoring changes in capital inputs will lead to incorrect inferences regarding productivity trends in broadcasting. Thus, in the next section we present TFP growth estimates using more formal econometric analysis.

5.2 TFP growth estimates 1998–2003

In Tables 5–7 we report TFP growth estimates and decompositions for all broadcasting, TV and radio respectively. As explained above, the annual rate of technical change is constrained to be constant across the period, whilst efficiency catch-up varies from year to year. The underlying SFA estimates for all broadcasting are reporting in Table 2. The coefficient estimates for the frontiers suggest that the industry broadly operates under conditions of constant returns to scale. The two-sided error variance model suggests that larger firms are subject to higher levels of heteroscedasticity in the measurement of inputs and outputs. The one-sided variance model indicates that larger firms are more X-inefficient in relation to

Table 5 TFP growth & decomposition, SFA estimates, broadcasting 1998–2003

	1998–2000	2001–2003	1998–2003
GO			
Technical Change	1.02	1.02	1.02
Efficiency Catch up	8.12	−7.52	0.30
Total Productivity Growth	9.14	−6.50	1.32
GVA			
Technical Change	−0.32	−0.32	−0.32
Efficiency Catch up	−2.80	0.76	−1.02
Total Productivity Growth	−3.12	0.44	−1.34

Source: derived by the authors from ONS data
Notes:
(i) Figures are annual % growth for the specified periods

Table 6 TFP growth & decomposition, SFA estimates, TV broadcasting 1998–2003

	1998–2000	2001–2003	1998–2003
GO			
Technical Change	−3.51	−3.51	−3.51
Efficiency Catch up	16.73	−1.40	7.66
Total Productivity Growth	13.22	−4.91	4.15
GVA			
Technical Change	−2.02	−2.02	−2.02
Efficiency Catch up	−0.56	3.71	1.57
Total Productivity Growth	−2.58	1.69	−0.45

Source: derived by the authors from ONS data
Notes:
(i) See Table 5

Table 7 TFP growth & decomposition, SFA estimates, radio broadcasting 1998–2003

	1998–2000	2001–2003	1998–2003
GO			
Technical Change	1.47	1.47	1.47
Efficiency Catch up	1.90	−0.83	0.54
Total Productivity Growth	3.37	0.64	2.01
GVA			
Technical Change	−3.89	−3.89	−3.89
Efficiency Catch up	4.37	2.33	3.35
Total Productivity Growth	0.48	−1.56	−0.54

Source: derived by the authors from ONS data.
Notes:
(i) See Table 5

gross output productivity (although not in relation to gross value-added productivity). Finally, there is some suggestion that gross output inefficiency is actually higher in those firms adopting relatively more computing technology, whereas gross value-added inefficiency is lower for those firms adopting relatively more telecommunications technology. These results may indicate that the relationship between IT investment and broadcasting efficiency is not straightforward; telecommunications investment will inevitably be higher in the cable/satellite sub-sector whereas computing technology may be adopted more intensively in the production sub-sector. The observed differences in efficiency could simply be a reflection of the heterogeneity of firm types within the sector as a whole.

Table 8 SFA TFP growth estimates by employment group, broadcasting

	1998–2000	2001–2003	1998–2003
GO			
50 + employees	−4.65	−1.63	−2.84
20–49 employees	15.27	1.57	7.05
10–19 employees	2.07	−6.29	−2.95
<10 employees	10.99	−11.04	−2.23
GVA			
50 + employees	0.92	2.92	1.92
20–49 employees	1.86	4.79	3.33
10–19 employees	−9.20	2.24	−3.48
<10 employees	−2.73	−5.31	−4.02

Source: derived by the authors from ONS data
Notes:
(i) Figures are mean annual % growth.
(ii) GO estimates are based on 1999–2000, 2001–2003 and 1999–2003 respectively

TFP growth is found to have varied substantially over the period of our analysis, particularly for the GO measure of output. There seems to have been significant growth in GO broadcasting productivity during the first half of our period, mainly due to the television sector, and a partial reversal of this productivity growth in the second half of our period. Over the whole period, the mean annual TFP growth rate for broadcasting is estimated to be 1.32% using GO and −1.34% using GVA. The decompositions suggest that technical change contributes a relatively modest (and sometimes negative) share of productivity growth over the period. Efficiency catch-up is more typically positive across sectors and periods, but relatively volatile in the television sector.

One issue that might be of importance is heterogeneity across firms within the sector. For this reason, we report in Table 8 the TFP growth estimates from the SFA model for different firm sizes. It seems that the high GO productivity growth referred to above in the period 1998–2000, and the subsequent reversal during 2001–2003, is attributable mainly to relatively small broadcasting companies (<49 employees). Using the GVA measure, companies with more than 20 employees experienced positive overall productivity growth over the whole period, with smaller companies experiencing negative growth in most years.

6 Conclusions

In this study, we have used enterprise-level data from the ARD to calculate estimates of labour productivity growth in broadcasting between 1999 and 2004 and TFP growth between 1998 and 2003. We present estimates using both gross output and gross value added. We also present TFP estimates separately for the TV and radio sectors broken down by employment class size and also the decomposition of TFP into technical change and efficiency catch-up.

Our estimates provide at least some evidence that the broadcasting sector has experienced positive productivity growth over recent years, largely driven by efficiency ‘catch-up’. For example, labour productivity growth between 1999 and 2004 is estimated to be 6.0% for gross value added (GVA) and 4.8% for gross output (GO). Using stochastic frontier analysis as a basis, TFP growth in GVA between 1998 and 2003 is estimated to be 1.92% per annum for large firms.

Evidence that capacity exists for efficiency savings through productivity growth would tend to strengthen the argument that improvements in the broadcasting service should be funded (at least in part) in this way, rather than through by direct appeal to the license fee.

Even so, a number of caveats apply to our results that suggest they should be treated with some caution. In the first place, the sample sizes in the ARD for broadcasting are small relative to those for many manufacturing industries. A particular consequence of this is that it is difficult to use sophisticated panel data techniques to eliminate biases due to enterprise heterogeneity.

It should also be noted that our models cannot pick up any systematic differences in efficiency between sub-sectors of the radio and TV broadcasting sectors. For example, some evidence from the US suggests that productivity dynamics for cable/satellite TV are likely to be very different from traditional broadcasting. Insofar as these growing sectors may invest in capacity (capital and labour) with the intention of reaping benefits from long term growth in this sub-sector in the UK, it may be that our results include an under-estimate of productivity growth for this sub-sector.

In summary, although our results are suggestive of general trends and stylized facts in broadcasting, and that these point to efficiency savings over time through productivity growth, with consequent implications for the funding of public sector broadcasting, it is clearly important to complement this analysis with detailed qualitative analyses of the sector.

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