School of Finance & Law

Working Paper Series

Total factor productivity growth and technical change in UK building societies: 1990-95

By

John Ashton

No. 6

1997

Bournemouth University, School of Finance & Law

(Department of Accounting & Finance), Talbot Campus,
Fern Barrow, Poole, Dorset BH12 5BB

Published 1996 by the School of Finance and Law, Bournemouth University, Talbot Campus,

Fern Barrow, Poole, Dorset, BH12 5BB.

For further details contact:

John Ashton

School of Finance & Law
Bournemouth University
Fern Barrow
Poole, BH12 5BB
United Kingdom

Tel: (00)-1202-595245
Fax: (00)-1202-595261
Email: jashton@bournemouth.ac.uk

ISBN 1-85899-044-0.

A catalogue record for this publication is available from the British Library.

For further information of the series, contact K Howell.

Total factor productivity growth and technical change in UK building societies: 1990-95

by

John Ashton

School of Finance and Law

Bournemouth University

Abstract

The total factor productivity and technical change within the UK building society sector are examined in this paper. Total factor productivity growth is measured using a cost function shift approach. An intermediation model of bank production with a translog specification of productive technology is employed. Static total factor productivity growth is observed over the sample period. Very Low levels of technical change are found.

This paper investigates characteristics of productivity and technical change within the UK building society sector. The sector has undergone substantial re-structuring and change following the influential re-regulation of the Building Societies Act (1986) and its subsequent amendments. Productivity measures are used to quantify the change over time in the 'efficiency' of production. Measures of productivity may incorporate aspects of technical change, scale efficiency, technical efficiency and allocative efficiency. Technical change denotes the change in the productive technology of the sample considered. Scale efficiency relates to the potential for differing efficiencies across a range of output levels. Under-utilisation of resources is captured within technical efficiency. Allocative efficiency considers the allocation of resources in terms of input prices for a cost minimisation objective. Productivity studies are therefore related to studies of economies of scale and efficiency. A large number of such studies have been performed both on UK building societies and other financial institutions, particularly US banks. Hardwick and Ashton (1996) and Berger *et al* (1993) have undertaken surveys of work in this field. Total factor productivity growth is examined using cross-sectional shifts within a cost function (Humphrey, 1993). This work is part of a wider survey of productivity, efficiency and technical change within UK deposit taking institutions.

Previous studies of productivity change in building societies have been limited. Esho and Sharpe (1995) considered total factor productivity and technical change for Australian permanent building societies. A consistent decline in total factor productivity of 2 per cent p.a. was observed for the sample period 1974-90. Similar results were recorded for technical change. A number of US studies have considered technical change in the banking sector. Hunter and Timme (1986) and Humphrey (1993) both found static or declining levels of technical change. Lang and Welzel (1996) examined technical progress for German co-operative banks between 1989 and 1992 and found a small yet significant negative trend. Berg *et al* (1996), in a study of 159 Norwegian banks between 1980-89, discovered a fall in productivity between 1981–83 and a rise in productivity after 1987. Malmquist indices were used in this study. Similar results for other financial institutions have been reported. Wolff (1991), for example, recorded negative total factor productivity growth for the US insurance industry between 1948 and 1986.

Model specification.

An intermediation (Aldaheff, 1957, Sealey and Lindley 1977) specification of depository institution production is employed. This approach is considered appropriate due to potential substitutability between inputs; e.g. capital and labour may be substituted for each other and possibly for non-retail deposits. Building societies are assumed to produce outputs in the form of mortgages (Y_1) and non-mortgage advances (Y_2) using labour (X_1), capital (X_2) and deposits (X_3). The cost (TC) of production is therefore an amalgam of operational and interest cost. A correspondence of this relation may be represented as:

$$TC(Y_1, Y_2, P_1, P_2, P_3)$$

Output quantities (Y_l) are measured by their value. Input quantities (X_i) are denoted by the total full-time equivalent staff numbers, tangible fixed assets and the value of both retail and non-retail deposits. Input prices are the staff costs divided by staff numbers (P_1), capital costs are divided by total fixed assets (P_2) and the price of deposit interest is obtained by total interest paid divided by the value of total deposits (P_3).

Approaches to measuring productivity

The derivation of technical change from cross-sectional shifts follows the method defined by Humphrey (1993). The cost function shift approach examines the change in average costs for each of the sample years. A translog model specification is employed to represent productive technology. This is written as:

$$LnTC = a_0 + \sum_l b_l LnY_l + \sum_i a_i LnP_i + \sum_l \sum_k 1/2 (g_{lk} LnY_l LnY_k) + 1/2 (\sum_i \sum_j (w_{ij} LnP_i LnP_j)) + \sum_l \sum_i (d_{li} LnY_l LnP_i) + e$$

For l, k = 1, 2 and i, j = 1, 2, 3.

Cost shares are derived from Shephard’s Lemma and the system of equations may be written as:

$$S_i = \partial LnTC / \partial LnP_i = a_i + w_{ij} LnP_j + d_{li} LnY_l + u_i$$

Following established cost and production theory, the following restrictions are imposed:

$$\sum b_i = 1, \sum g_{lk} = 0, \sum w_{ij} = 0, \sum d_{i1} = 0$$

Estimation of total factor productivity may be derived from estimates of technical change and scale elasticity. Economies of scale are proxied by elasticity of scale, which may be estimated as the sum of the first derivatives of *LnTC* with respect to LnY_1 and LnY_2. Following Humphrey, (1993) technical change may be written as:

$$Tech = -\left(AC_{t+1} - AC_t\right) \Big/ AC_t$$

where AC_t represents average costs of time period t and AC_{t+1} represents average costs in time period $t+1$. Average costs are total costs divided by total assets of the building societies. For each year total costs are calculated by substituting the parameter estimates and building society input and output values within the translog system.

Total factor productivity growth may be viewed as measuring change in cost efficiency over time. Following Baltagi and Griffin (1988) total factor productivity growth may be represented as:

$$\dot{TFP} = -Tech + (1 - e_{scale})\dot{Y}$$

$$\begin{aligned} Where \quad \dot{TFP} &= change \;\; in \;\; total \;\; factor \;\; productivity, \\ Tech &= technical \;\; change \\ e_{scale} &= elasticity \;\; of \;\; scale \\ and \quad \dot{Y} &= scale \;\; deflated \;\; change \;\; in \;\; output. \end{aligned}$$

Scale deflated change in output, $\dot{Y}$, is constructed following the procedure outlined in Esho and Sharpe (1995).

Data and results

A sample of 55 UK building societies for the period 1990-95 was used. Data on cost, prices and quantities was taken from Annual Reports and Accounts. Societies with assets below £100m in 1993 are excluded from the sample to reduce the dispersion of quantities and prices and reduce the possibility of mis-specification due to distinct productive technologies within the sector. Positive levels of prices and quantities were recorded for all societies in all years. The data is deflated by the RPI, where appropriate. Summary statistics may be observed in Table 1.

Table 1: Overall summary: 1990-1995 for the building society sectors (55 societies).

Overall	mean	standard deviation		mean	standard deviation
Interest receivable £m's	390.79	999.46	Mortgages £m's	3,287.72	8,674.74
Interest payable	301.62	781.58	Other Advances £m's	123.37	257.26
Interest payable on retail deposits	234.72	623.61	Fixed assets £m's	49.45	112.98
Interest payable on non-retail deposits	62.31	153.07	Total assets £m's	4,307.77	11,060.18
Administrative expenses £m's	56.85	144.95	Retail funds and deposits £m's	3,163.74	8351.01
Staff costs £m's	24.42	61.95	Non-retail funds £m's	779.09	1,881.76
Depreciation £m's	5.25	13.26	Full time staff	1,245	3,152
Other expenses £m's	27.174	73.01	Part Time Staff	338	914
Provisions £m's	125.70	46.40	Total Staff	1,585	4,040
Profit £m's	28.23	81.02	Labour price £'s	16,436	3,362
Liquid assets £m's	74.79	1901.45	Capital price £'s	665	392
Commercial assets £m's	3,452	8,989.38	Deposit price £'s	8	3

Table 2: Parameter estimates * indicates 10% significance.

	1990		1991		1992		1993		1994		1995	
α_o	0.92	(0.05)*	0.97	(0.06)*	1.20	(0.06)*	1.03	(0.06)*	1.18	(0.08)*	1.19	(0.06)*
α_1	0.28	(0.02)*	0.20	(0.04)*	0.29	(0.04)*	0.30	(0.03)*	0.16	(0.04)*	0.21	(0.03)*
α_2	0.20	(0.02)*	0.25	(0.02)*	0.30	(0.04)*	0.23	(0.03)*	0.40	(0.05)*	0.35	(0.04)*
α_3	0.52	(0.03)*	0.54	(0.04)*	0.40	(0.04)*	0.47	(0.04)*	0.44	(0.05)*	0.44	(0.04)*
β_1	0.03	(0.01)*	-0.01	(0.01)	-0.03	(0.01)*	0.00	(0.01)	-0.04	(0.02)*	-0.05	(0.01)*
β_2	-0.03	(0.01)*	-0.01	(0.01)	0.01	(0.01)	-0.01	(0.01)	0.02	(0.02)	0.03	(0.01)*
γ_{11}	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)*	0.00	(0.00)
γ_{22}	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)*	0.00	(0.00)
γ_{21}	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)*	0.00	(0.00)
δ_{11}	0.15	(0.01)*	0.10	(0.02)*	0.22	(0.01)*	0.20	(0.01)*	0.20	(0.01)*	0.22	(0.01)*
δ_{12}	0.14	(0.01)*	0.15	(0.01)*	0.21	(0.01)*	0.19	(0.01)*	0.24	(0.01)*	0.23	(0.01)*
δ_{13}	0.14	(0.01)*	0.11	(0.01)*	0.14	(0.02)*	0.14	(0.01)*	0.12	(0.02)*	0.10	(0.02)*
δ_{22}	-0.08	(0.01)*	-0.07	(0.01)*	-0.15	(0.01)*	-0.12	(0.01)*	-0.16	(0.01)*	-0.17	(0.01)*
δ_{23}	-0.08	(0.01)*	-0.03	(0.01)*	-0.07	(0.01)*	-0.08	(0.01)*	-0.04	(0.01)*	-0.04	(0.01)*
δ_{33}	-0.06	(0.01)*	-0.08	(0.01)*	-0.07	(0.01)*	-0.06	(0.01)*	-0.08	(0.01)*	-0.06	(0.01)*
ω_{11}	0.00	(0.00)	-0.02	(0.00)*	0.00	(0.01)	-0.01	(0.00)*	0.01	(0.01)*	0.00	(0.00)
ω_{12}	0.01	(0.00)*	0.01	(0.00)*	-0.01	(0.00)*	0.01	(0.00)*	-0.02	(0.01)*	-0.02	(0.00)*
ω_{13}	-0.01	(0.00)*	0.00	(0.00)	0.01	(0.00)*	0.00	(0.00)	0.01	(0.01)*	0.02	(0.00)*
ω_{21}	0.00	(0.00)	0.01	(0.00)*	-0.01	(0.00)*	0.01	(0.00)*	-0.02	(0.01)*	-0.01	(0.00)*
ω_{22}	-0.01	(0.00)*	-0.02	(0.00)*	0.01	(0.01)	-0.02	(0.00)*	0.02	(0.01)*	0.02	(0.01)*
ω_{23}	0.01	(0.00)*	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.01)	-0.01	(0.00)*

A high degree of variance exists for most inputs and outputs due to the considerable variability in the scale of building societies. The growth rates of the variables included within the model display a number of changes over the sample period. Interest costs and deposit prices, mirroring the prevailing interest rate, have suffered a decline. Components of costs have all appreciated fairly high levels of average annual increase. Outputs used within the model have all increased, yet often at a lower rate than cost components. Parameter estimates are presented in table 2. A generalised least squares (GLS), iterative, seemingly unrelated regression (SUR) estimator is used for all estimations, following a procedure elaborated in Greene (1993). Within most estimations the majority of parameters are significant at the 10% significance level. Diagnostic statistics are well behaved and are presented in table 3.

Table 3: Diagnostic statistics * indicates 10% significance.

	1990	1991	1992	1993	1994	1995
Iterations	26	10	16	15	20	16
Adj. R^2	0.999	0.999	0.999	0.999	0.999	0.999
Log Likeihood	217.15	217.54	199.17	208.26	191.14	204.55
Wald test for restrictions	322.9*	268.92*	80.85	161.18*	82.62*	68.41*

Total factor productivity growth and technical change estimates are reported in table 4. Results are presented on average, though incorporating yearly average mean values for input prices and output values. Values for small building societies, defined as having less than £250,000m total assets, are estimated through considering yearly average values for input prices and output values. Similarly, the large building society group, including societies with greater than £250,000m in total assets, are estimated by incorporating appropriate average values. Technical change, both on average and for the size groups, may be viewed as very low, with both slight positive and negative values recorded. The level of technical change after 1992-1993, which displayed a negative technical change for all groupings, enjoyed a slight improvement towards the end of the sample period, particularly for larger building societies. Total factor productivity growth, similarly, is characterised by its low and insignificant levels, across all scale groups. Levels of growth displayed a minor improvement after 1992-1993, particularly for the small society group.

Table 4: Total factor productivity and technical change over time (percentage change).

Total factor productivity growth	Small	Large	Average
1990-1991	0.002	0.010	0.007
1991-1992	0.012	0.014	0.016
1992-1993	-0.007	-0.015	-0.013
1993-1994	0.005	0.015	0.013
1994-1995	0.005	-0.044	0.007
Tech	Small	Large	Average
1990-1991	0.024	-0.266	-0.013
1991-1992	0.219	0.162	0.162
1992-1993	-0.227	-0.059	-0.191
1993-1994	0.199	0.231	0.144
1994-1995	-0.097	0.443	-0.138

A common sense view of the results

The presence of zero or low levels of technical change and negative total factor productivity for the duration of the sample period may have occurred for a number of reasons. The presence of static or low technical change indicates that either no improvement or a slight increase in the level of productive technology is prevalent. This representation of technology accounts for the most efficient average combination of factors of production. Factors include labour, capital and deposits, which are used to produce mortgages and other non-mortgage advances. Such an eventuality may be a function of the observable rise in costs during the sample period.

There are many reasons why total factor productivity growth has been static within the building society sector. Many commentators have mooted the presence of a global or western slowdown in productivity growth. Reasons that have been forwarded to explain this phenomenon have included data problems and imprecise abstract model assumptions (Griliches, 1994), the disruption of dramatic change, the form of service production (Baumol, 1993) and the possibility of exogenous shocks.

Griliches (1994) suggested that during the 1970's and 1980's the sources of growth became confused. The characteristics of the productivity growth decline were suggested to be concentrated particularly in the areas of construction, finance and services sectors, where output measurement is particularly difficult. According to Griliches the agricultural, manufacturing and communication sectors, where output measurement is more clear-cut, have experienced less productivity growth decline. Such shortcomings in methods for output measurement, the diversity of production methods and the mechanisms producing productivity growth may have adversely influenced our findings.

The restructuring within the building society sector has witnessed the introduction of a wide range of new technology. This change has been used to assist production within a diversity of functions, including distribution and information processing in addition to reducing transaction costs. Many upheavals such as retraining of staff and widespread reorganisation of building societies have been incurred. It could be suggested that the present static level of total factor productivity growth is a product of the dis-organisation and adaptation to new techniques. Managers and workers have to learn to work with both new equipment and new operating processes, where the productivity growth after dramatic and radical organisational change may become worse before it gets better. Thus the high levels of investment may have adversely affected building societies within the medium term. Similarly, the static total factor productivity growth we observe may represent productivity growth during a time of change and perhaps underestimate the true long-term total factor productivity growth.

The products of building societies, such as mortgages are composite products. These are ‘manufactured’ using an amalgam of services and transactions. The inclusion of ‘personnel services’ of customer care within products may reduce the potential for total factor productivity rises similarly to the ‘cost disease’ forwarded by Baumol (1991). Within such an environment, however much is spent on new technology will still leave the productive technology underpinning the service unchanged. Within such an environment of rising input costs, low productivity growth and low technical change are to be expected.

The low levels of total factor productivity may have resulted from more intense levels of competition within the sector. Building societies have been competing both with retail banks and independent financial intermediators within mortgage and savings market during the sample period. This competition in conjunction with the lack-lustre performance of the UK economy during the early 1990’s could have contributed to the large losses appreciated by building societies during this period. More recently the economic upturn and the broadening of the interest spreads on core business activities have greatly improved the profits of building societies. The degree to which this may alter productivity growth is yet to be observed.

Conclusions

In the paper total factor productivity growth has been measured using a cost function shift approach. This approach indicates insignificant technical change for all years. Total factor productivity growth is observed to be static over the sample period.

Acknowledgements

I would like to thank P Hardwick and D McKillop for their insightful comments and continued encouragement. The usual disclaimer applies.

References

Aldaheff, D. A. (1954) *Monopoly and Competition in Banking*, University of California Press.

Baltagi, B. H. and Griffin, J. M. (1988) A General Index of Technical Change, *Journal of Political Economy*, vol.96, 20-41.

Baumol, W. (1991) Technological imperatives, productivity and insurance costs, *The Geneva Papers on Risk and Insurance,* vol.16, 154-165.

Berg, S. A. F∅rsund, F. R. and Jansen, E. S. (1992) Malmquist indices of productivity growth during the deregulation of Norwegian banking, 1980-89, *Scandinavian Journal of Economics,* (Supplement), 211-228.

Berger, A. N. Hunter, W. C. and Timme, S. G. (1993) The efficiency of financial institutions: a review and preview of research past present and future, *Journal of Banking and Finance*, vol.17, 221-249.

Drake, L. (1992) Economies of scale and scope in U.K. building societies: an application of the translog multi-product cost function *Applied Financial Economics,* vol.2, 211-219.

Drake, L. and Weyman-Jones, T. G. (1996) Productive and allocative inefficiencies in UK building societies: A comparison of non-parametric and stochastic frontier techniques, *The Manchester School*, vol.64, 22-37.

Esho, N. and Sharpe, I. G. (1995) Long run estimates technological change and scale economies in a dynamic framework: Australian permanent building societies, *Journal of Banking and Finance*, vol.19, 1135-1157.

Griliches, Z. (1994) Productivity, R & D, and the Data Constraint, *The American Economic Review*, vol.84, 1-23.

Greene, W. H. (1993) *Econometric Analysis* 2nd edition, Prentice Hall Englewood Cliffs, New Jersey.

Hardwick, P. (1989) Economies of scale in building societies *Applied Economics*, vol.21, 1291-1304.

Hardwick, P. (1990) Multi-product cost attributes: A study of U.K. building societies *Oxford Economic Papers*, vol.42, 446-461.

Hardwick, P. and Ashton, J. K. (1996) Estimating inefficiencies in depository financial institutions: A survey *Discussion paper series*, vol.19, Financial Services Research Centre, Bournemouth University.

Humphrey, D. B. (1993) Cost and technical change: effects of bank regulation *The Journal of Productivity Analysis*, vol.4, 9-34.

Hunter, W. C. and Timme, S. G. (1986) Technical change, organisational form and the structure of bank production *Journal of Money, Credit and Banking*, vol.18, 152-166.

Lang, G. and Welzel, P. (1996) Efficiency and technical progress in banking Empirical results for a panel of German Co-operative banks *Journal of Banking and Finance*, vol.20, 1003-1023.

Sealey, C. W. and Lindley, J. T. (1977) Inputs, outputs and a theory of production and cost at depository financial institutions *The Journal of Finance*, vol.32, 1252-1253.

Wolff, E. N. (1991) Productivity growth, capital intensity, and skill levels in the U.S. Insurance industry, 1948-86 *The Geneva Papers on Risk and Insurance*, vol.16, no.59, 173-190.