Cost efficiency and UK building societies. An econometric panel-data study employing a flexible Fourier functional form.

By

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For further information on the series, contact K. Howell
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Abstract

The paper empirically quantifies firm specific 'distribution free' cost efficiency, economies of scale and economies of scope in the UK building society sector between 1990-1995. Both a flexible Fourier and a translog functional form are employed with an intermediation representation of depository institution production. Differences in the performance of these two functional forms are found. A broad distribution of cost efficiency over the sample period is observed, with a mean efficiency of 76 per cent estimated using the flexible Fourier form and a mean efficiency of 72.52 per cent estimated employing the translog form. Distinct results for economies of scale are produced with the two models.
Introduction

In this paper, cost efficiency, economies of scale and economies of scope in the British building society industry are empirically quantified. The importance of such a study is primarily the provision of evidence as to whether, one, significant variation in cost efficiency exists within this most important commercial sector and if previous estimates employing the translog functional form have provided an adequate description of this. An intermediation model of depository institution production is applied. A flexible Fourier (Gallant, 1981) functional form and a translog functional form are both used to represent productive technology. A comparison of the efficiencies derived from the superior and relatively under-used flexible Fourier functional form and the widely applied translog functional form is undertaken to identify any mis-specification with the translog form. A one component fixed effects model is employed to incorporate the distinct data characteristics that are present within the data panel over time. Fixed effects models are employed for the estimation of distribution free cost efficiency, economies of scale and scope economies using an average cost function.


Most previous UK studies have considered distinct aspects of overall cost efficiency such as economies of scale and economies of product mix. The studies that have quantified overall cost efficiency for this sector have included both data envelopment analysis (DEA) (see Field, 1990, Drake and Weyman-Jones, 1992 and Piesse and Townsend, 1995) and stochastic frontier techniques (see Drake and Weyman-Jones, 1996). These efficiency studies have all employed cross sectional samples engendering a range of divergent results from different years. Field, employing a sample of 205 building societies in 1981 in a production model, estimated that only 14 per cent of the societies in this year are productively efficient. Drake and Weyman-Jones (1996) using both DEA and translog stochastic frontier approaches to found that only about 4 per cent of the societies were efficient with the DEA approach and observed very little allocative or technical inefficiency with the cost frontier approach. Piesse and Townsend, using a DEA approach (1995) estimated, five separate models with different objective functions producing a broad array of inefficiency estimates.

Cost studies employing flexible Fourier functional forms have been limited within the financial institutions literature. The earliest study to employ this form for analysis of depository institutions was McAllister and McManus (1993). Other studies have considered US commercial banks, including Onvural and Mitchell (1996), Berger and DeYoung (1997) and Berger and Mester (1997). Onvural and Mitchell and McAllister and McManus both compare the performance of the flexible Fourier
functional form with that of the translog functional form. Consistently distinct estimates are found with these differing functional forms. This is the first study to employ the flexible Fourier form in the analysis of UK financial institutions.

Model specification

An intermediation model (see Aldaheff, 1957 and Sealey and Lindley, 1977) of depository institution production is assumed. Building societies are assumed to minimise costs and employ labour, capital and deposits to produce loans. The intermediation approach within the dual cost function would suggest:

\[ C = g(Y_1, Y_2; P_1, P_2, P_3) \]  

(1)

where outputs are quantified by their values; \( Y_1 \) denotes mortgage loans and \( Y_2 \) denotes non-mortgage advances. The price of labour, \( P_1 \), is proxied by the total wage bill divided by the number of full time equivalent employees. The price of capital, \( P_2 \), is proxied by the aggregation of property and equipment rentals and depreciation divided by the quantity of physical capital. The price of deposits, \( P_3 \), is total interest payable divided by the quantity of deposits inclusive of retail and non-retail costs. \( C \) represents the total cost of production for the building society, including administration expenses, depreciation and interest costs.

The sample has been constructed using data from Annual Reports and Accounts for 99 UK building societies from 1990 to 1995. The data are deflated to
1993 prices using the Retail Price Index. The data panel is unbalanced and contiguous.

Table 1  

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets (£m’s)</td>
<td>537.822</td>
<td>1573.855</td>
<td>0.002</td>
<td>18049.801</td>
</tr>
<tr>
<td>Mortgages (£m’s)</td>
<td>2338.885</td>
<td>7111.443</td>
<td>2.728</td>
<td>74683.398</td>
</tr>
<tr>
<td>Non-Mortgage Advances (£m’s)</td>
<td>155.060</td>
<td>442.298</td>
<td>0.000</td>
<td>5108.300</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>636.658</td>
<td>1895.959</td>
<td>4.000</td>
<td>13802</td>
</tr>
<tr>
<td>Management Expenses (£m’s)</td>
<td>28.419</td>
<td>81.682</td>
<td>0.060</td>
<td>689.000</td>
</tr>
<tr>
<td>Deposits (£m’s)</td>
<td>2743.161</td>
<td>8296.709</td>
<td>3.640</td>
<td>70206.398</td>
</tr>
<tr>
<td>Interest Paid (£m’s)</td>
<td>219.655</td>
<td>654.379</td>
<td>0.335</td>
<td>6445.980</td>
</tr>
<tr>
<td>Interest Received (£m’s)</td>
<td>280.561</td>
<td>829.611</td>
<td>0.5163</td>
<td>7476.90</td>
</tr>
<tr>
<td>Profits (£m’s)</td>
<td>29.145</td>
<td>96.893</td>
<td>-42.060</td>
<td>962.400</td>
</tr>
<tr>
<td>Total Fixed Assets (£m’s)</td>
<td>26.843</td>
<td>77.490</td>
<td>0.100</td>
<td>750.500</td>
</tr>
</tbody>
</table>

The variables are characterised by a high level of dispersion within the data. Such a feature is strongly indicated through reference to both the large standard deviations of variables and the substantial range between maximum and minimum values.

To estimate an average cost function over a data panel (including building society observations both over time and across a cross section of institutions) a one component fixed effects model is used. 'Effects' models aggregate both period invariant and individual invariant variables with individual time varying variables. The basic linear relationship, may be defined,
\begin{equation}
y_{it} = u_{i} + \beta^{'}X'_{it} + \nu_{it} \tag{2}
\end{equation}

Where $y_{it}$ are the time and firm estimates dependent on; $\beta^{'}$ the parameters of the K explanatory variables within the model, $X'_{it}$, the $i_{t}^{th}$ observation of the K explanatory variables and $\nu_{it}$, the disturbance term; for all $i = 1, \ldots, N; t = 1, \ldots, T$. $u_{i}$ represents individual specific effects of the building societies and is used to capture non-random disturbance between the building societies. $\nu_{it}$ is employed to capture random error within the model. $X'_{it}$ and $\nu_{it}$ are assumed to be independent for $i$ and $t$ observations of the K variables within the model. The procedure for estimation is set out in detail within Greene (1993), Baltagi (1995) and Intriligator et al (1996).

\textit{Economies of scale, economies of scope and distribution free efficiency}

Economies of scale are proxied by ray scale elasticity, a measure of elasticity of scale relative to cost outlined by Baumol et al (1982). Assumptions of proportional increases or decreases of cost in relation to scale and constant composition of outputs in relation to costs are made. These restrictions limit the measurement of elasticity to a single constant ray emerging from the origin. The measure considers changes in scale in isolation of changes in product mix.

Ray scale elasticity may be represented as ray average costs divided by the marginal change in cost of producing additional bundles of output or as the first derivative of cost with respect to output evaluated for a representative
institution (usually assumed to be a mean value for a set of institutions). For a
firm with \( m \) outputs, scale elasticity may be represented as:

\[
RSE = \sum_j \left( \frac{\delta \ln C}{\delta \ln Y_j} \right)
\]

(3)

\( j = 1, 2. \)

where \( C \) is total cost and \( Y_j \) represents the output of the \( j \)th product. Elasticities greater
than unity imply diseconomies of scale and values less than unity indicate economies of
scale; unity denotes constant returns to scale. Economies of scale are estimated
overall, for individual year means and for asset group means.

Economies of scope, outlined by Baumol et al (1982), measure the cost
 savings from producing quantities of two output groups produced jointly within a
single institution relative to specialised production of the output groups individually by
two institutions. Thus the statistic measures the cost of simultaneous production
relative to specialised production. Economies of scope may be measured by:

\[
\text{Scope} = \left[ C(\bar{P},\bar{Y}_1,0) + C(\bar{P},0,\bar{Y}_2) - C(\bar{P},\bar{Y}_1,\bar{Y}_2) \right] / C(\bar{P},\bar{Y}_1,\bar{Y}_2)
\]

(4)

where \( Y \) is the sample mean of output \( j \), \( C(\bar{P},\bar{Y}_1,0) \) represents the costs of
production with complete specialisation in output one, \( C(\bar{P},0,\bar{Y}_2) \) represents the
costs of production with complete specialisation in output two and \( C(\bar{P},\bar{Y}_1,\bar{Y}_2) \)
represents the cost of production for the multiproduct firm. If the estimated value is
greater than zero then positive economies of scope are present, if the value is less than
zero then diseconomies of scope exist. Estimates of economies of scope are made for
specialised production within mortgages and non-mortgage advances, both overall and
for individual asset groups.

Distribution-free cost efficiency is a relative measure of firm specific efficiency.
The efficiency of sample institutions is derived through reference to the efficiency of
the most cost efficient building society within the sample. The advantage of this
approach is that it removes many of the strong distributional assumptions of efficiency
imposed in alternative techniques such as econometric frontiers (see Drake and
Weyman Jones, 1996 and Ashton and Hardwick 1997, for further discussion of this
issue). Efficiency is derived directly from the individual effects produced by the fixed
effects model, where the individual effects, \( \upsilon_i \), would include the “ … unobservable
entrepreneurial or managerial skills of the firm's executives” (Baltagi, 1995, p.9). This
is a development of the approach initially proposed by Berger (1993) who employed
the average residuals from cross-section regressions for a ten-year period to provide
estimates of relative and distribution free efficiency. The approach assumes that
efficiency is constant over time and random variation in efficiency may be removed
through averaging over time. The individual effects (\( \upsilon_i \)) may be employed as an
indicator of non-negative cost efficiency. Thus distribution free efficiency may
denoted:

\[
Efficiency_i = \exp (\text{min}[\ln \upsilon_i] - \ln \upsilon_i) = \text{Min}\[\upsilon_i]/\upsilon_i
\]  

(5)
for the $i^{th}$ building societies, where $\min(v_i)$ is assumed to be the most efficient building society in the sample. For further discussion of this measure see Allen and Rai (1996, 1997) and DeYoung (1997).

*The choice of functional form*

The firms’ production or transformation process has been represented in empirical studies with the use of generalised functional forms. In selecting a functional form the choice between flexibility and better global behaviour across a spectrum of observations is presented. Simple functional forms such as the Cobb-Douglas form satisfy many conditions or properties of a cost function over a broad range of observations. Their simplicity enables properties within the function to be consistently, if bluntly and robustly, applied. Difficulties with the use of simple forms centre on the limited scope of productive technologies that may be represented with such a simple form. The representation of a more sophisticated productive technology, as envisaged within the UK building society sector, requires a greater degree of flexibility, this in turn enables a wider range of productive characteristics to be represented. This flexibility may be obtained by employing a more complex functional form, such as the translog to model the situation.

The translog function form may be represented

$$\ln C = \sum_i \alpha_i \ln Y_i + \sum_j \beta_j \ln P_j + 1/2 \sum_s \sum_m \chi_{jm} \ln Y_j \ln Y_m +$$
\[
\frac{1}{2} \sum_{r} \sum_{q} \omega_{rq} \ln P_r \ln P_q + \sum_{j} \sum_{r} \partial_{y} \ln Y_j \ln P_r + u_i + v_t \tag{6}
\]

where \( j, s = 1, 2 \) and \( r, q = 1, 2, 3 \). Restrictions are imposed following established cost and production theory including symmetry (which requires that \( \chi_{js} = \chi_{sj} \) and \( \omega_{rq} = \omega_{qr} \)) and linear homogeneity in input prices (where linear homogeneity suggests if all input prices are doubled then costs are exactly doubled).

In previous studies of UK building society sector, the translog functional form has been primarily employed. This Diewert flexible functional form, provides a cost function that could accommodate a second order differential approximation to an arbitrary twice continuously differential cost function. Such a cost function will satisfy linear homogeneity in prices property at any point only within certain parameters or an 'admissible domain' (Diewert, 1971). This representation of productive technology, whilst deemed appropriate for the consideration of the building society sector may only be quantified or estimated consistently within a certain range of observations or 'specified domain', leaving the possibility of specification error in estimation.

White (1980) indicated that while second order approximations of the translog flexible functional form allow the attainment of any arbitrary function at a given point, nothing implies that the true cost function is consistently estimated from this point. There have been a limited number of studies that have considered the workings of the translog functional form in applied work. Wales (1977) and Caves and Christensen (1980) have undertaken investigations into the viability of approximation, as the number and variability of observations is increased. Wales (1977) found the behaviour
of the translog to deteriorate substantially as the true substitution elasticity departs from unity. Caves and Christensen (1980) found the translog to be better behaved over a broader range of observations than the generalised Leontief function. Guilkey (1980), Guilkey et al (1983) and Ivaldi (1996) have undertaken Monte Carlo tests of the performance of different functional forms. These tests examined the ability of the translog functional form and other forms to represent properties or characteristics of productive technology using pre-defined test data. Guilkey (1980, 1983) examined the productive characteristics such as economies of scale and factor substitution of the translog and other Diewert flexible forms. Tests were performed with data representing varying degrees of technology. Guilkey (1980) found that the translog functional form performed well over a broad range of technologies. Guilkey et al (1983) found the translog to broadly display better global behaviour than other Diewert flexible forms such as the generalised Box Cox and the Generalised Leontief functional forms, where “… the translog form provides a dependable approximation to reality provided that reality is not too complex” (p.614). Ivaldi et al (1996) in a comparison of the translog and the flexible Fourier functional forms with a panel data model indicated that, although both functional forms provide equivalent descriptions of the productive technology, the flexible Fourier functional form was able to represent a wider range of cost structures.

Whilst it may be concluded that use of the translog form may be appropriate when substantial dispersion of data is not present, the potential for specification error when considering a diverse data set, as used here, may present difficulties. To amend for such potential mis-specification both the translog and the flexible Fourier functional forms are employed. The flexible Fourier functional form (see Gallant, 1981, 1984) is a
second order polynomial in the explanatory variables together with a combination of sine and cosine functions in the explanatory variables. This form is Sobolev flexible (see Gallant, 1981) and therefore can estimate elasticities consistently and has negative prediction bias, thus removing the potential for specification bias within the representation of productive technology. The flexible Fourier form has the translog form (3) nested within and should provide a similar interpretation of productive technology whilst reducing the potential for specification error. The expansion of the functional form to fit the scale of the data set is performed through the inclusion of additional trigonometric terms. This novel approach of fitting the size of the functional form to the sample size (Eastwood and Gallant, 1991, suggested the total number of parameters should equal the number of observations raised to the two thirds power) differs from the method employed when using Diewert function forms, such as the translog, where the functional form is assumed to provide a priori a representation of the true cost function.

The trigonometric transformations of the variables are functions that re-scale the periodic sine and cosine values so that they fall within a sample specific domain of (0, 2π). Chalfant and Gallant (1985) and Mitchell and Onvural (1996) indicate that the semi non-parametric sample-specific scaling procedure may be simplified through the imposition of a number of a priori assumptions allowing the flexible Fourier series expansion to be used as an effective expansion technique even with small samples (Rossi, 1985). The non-parametric sample specific scaling procedure employed for the flexible Fourier functional form may be denoted:
\( p_{r,\text{min}} \) = sample minimum for the \( r \)th input price

\( p_{r,\text{max}} \) = sample maximum for the \( r \)th input price

\( y_{j,\text{min}} \) = sample minimum for the \( j \)th output quantity

\( y_{j,\text{max}} \) = sample maximum for the \( j \)th output quantity

\[ W_{pr} = 0.00001 - \ln p_{r,\text{min}}, \quad W_{yj} = 0.00001 - \ln y_{j,\text{min}} \]

\[ M = \ln p_{r,\text{max}} + W_{pr}, \quad \lambda = \frac{6}{M}, \quad \mu = \frac{6}{[\ln y_{j,\text{max}} + W_{yj}]} \]

Input price \( l = \lambda[Lnp_{r} + W_{pr}] \).

Output quantity \( Z = \lambda\mu[Lny_{j,\text{max}} + W_{yj}] \)

The flexible Fourier functional form may be represented:

\[ \ln C = \sum_j \alpha_j \ln Y_j + \sum_r \beta_j \ln P_r + \frac{1}{2} \sum_s \sum_j \chi_{js} \ln Y_j \ln Y_s + \]

\[ \frac{1}{2} \sum_r \sum_q \omega_{rq} \ln P_r \ln P_q + \sum_r \sum_j \partial_j \ln Y_j \ln P_r + \]

\[ \sum_j \phi_j \cos Z_j + \sum_j \kappa_j \sin Z_j + \sum_r \gamma_r \cos I_r + \sum_r \delta_r \sin I_r + \]

\[ \sum_{js} \varphi_{js} (\cos Z_j + \cos Z_s) + \sum_{js} \kappa_{js} (\sin Z_j + \sin Z_s) + \]

\[ \sum_{js} \sigma_{js} (\cos Z_j - \cos Z_s) + \sum_{js} \theta_{js} (\sin Z_j - \sin Z_s) + \]

\[ \sum_{rq} \gamma_{rq} (\cos I_r + \cos I_q) + \sum_{rq} \delta_{rq} (\sin I_r + \sin I_q) + \]
\[
\sum_{rq} \psi_{rq} (\cos l_r - \cos l_q) + \sum_{rq} \zeta_{rq} (\sin l_r - \sin l_q) +
\]
\[u_i + v_{it}\]  

(7)

where \(j, s = 1, 2\) and \(r, q = 1, 2, 3\). Where \(\alpha, \beta, \chi, \omega, \delta, \varphi, \kappa, \phi, \theta, \gamma, \vartheta, \psi\) and \(\zeta\) are coefficients to be estimated. \(u_i + v_{it}\) denotes non-random disturbance of the individual building societies and random error respectively.

Symmetry is imposed on the translog portion of the model. The trigonometric vectors within the model are chosen \textit{a priori} as opposed to pre-testing. The vectors include single outputs \(\cos(Z_j)\) and \(\sin(Z_j)\) and single input prices \(\cos(l_r)\) and \(\sin(l_r)\). Pairs of outputs \((\cos Z_j + \cos Z_s), (\sin Z_j + \sin Z_s), (\cos Z_j - \cos Z_s), (\sin Z_j - \sin Z_s)\), and input prices \((\cos l_r + \cos l_q), (\sin l_r + \sin l_q), (\cos l_r - \cos l_q), (\sin l_r - \sin l_q)\) are employed. Linear homogeneity is imposed through the use of opposite signs in the input price vectors and the imposing the restriction that parameters of the input price vector sum to zero (Mitchell and Onvural, 1996). Monotonicity and quasi-concavity in input prices are not imposed due to the semi-non-parametric (non-multiplicative) technique underlying the flexible Fourier functional form. Gallant (1981) stressed this does not hinder the flexible Fourier form from closely approximating the true cost function.

Results

Parameter estimates for the translog and flexible Fourier models are presented in Table 2. Diagnostic statistics are provided with the parameter estimates. The parameter estimates of translog functional form display lower levels of approximation error than the flexible Fourier model due to the larger number of parameters to be
estimated with the latter model. Building society specific estimates of cost efficiency are presented in Table 3. Estimates of economies of scale and scope are given in Table 4.

**Table 2 Parameter estimates**

<table>
<thead>
<tr>
<th>Coeff.</th>
<th>Fourier</th>
<th>Coeff.</th>
<th>Fourier</th>
<th>Coeff.</th>
<th>Translog</th>
<th>Coeff.</th>
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<td>$\beta_1$</td>
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<td>$\kappa_2$</td>
<td>0.01 (0.03)</td>
<td>$\beta_1$</td>
<td>-0.07 (0.02)*</td>
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</tr>
<tr>
<td>$\beta_2$</td>
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<td>$\varphi_{12}$</td>
<td>-0.04 (0.02)*</td>
<td>$\beta_2$</td>
<td>-0.15 (0.05)*</td>
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</tr>
<tr>
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<td>$\varphi_{12}$</td>
<td>-0.04 (0.02)*</td>
<td>$\beta_3$</td>
<td>1.22 (0.05)*</td>
<td></td>
</tr>
<tr>
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<td>$\alpha_2$</td>
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<td>$\chi_{11}$</td>
<td>0.03 (0.03)</td>
<td>$\gamma_1$</td>
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<td>$\chi_{11}$</td>
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<td></td>
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<tr>
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<td>$\gamma_2$</td>
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<td>$\chi_{22}$</td>
<td>-0.01 (0.01)</td>
<td></td>
</tr>
<tr>
<td>$\varphi_{12}$</td>
<td>0.03 (0.02)</td>
<td>$\psi_{12}$</td>
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<td>$\varphi_{12}$</td>
<td>0.01 (0.01)</td>
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</tr>
<tr>
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<td>$\omega_{11}$</td>
<td>0.00 (0.00)</td>
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<td>$\hat{\eta}_2$</td>
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<td>$\omega_{22}$</td>
<td>0.08 (0.00)*</td>
<td></td>
</tr>
<tr>
<td>$\omega_{23}$</td>
<td>0.00 (0.00)*</td>
<td>$\psi_{12}$</td>
<td>-0.12 (0.02)*</td>
<td>$\omega_{23}$</td>
<td>0.00 (0.00)*</td>
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<tr>
<td>$\omega_{12}$</td>
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<td>$\psi_{12}$</td>
<td>-0.04 (0.03)</td>
<td>$\omega_{12}$</td>
<td>0.06 (0.01)*</td>
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<tr>
<td>$\omega_{13}$</td>
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<td>-0.01 (0.00)*</td>
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<td>$\psi_{23}$</td>
<td>-0.12 (0.02)*</td>
<td>$\delta_{12}$</td>
<td>0.02 (0.01)*</td>
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<tr>
<td>$\delta_{13}$</td>
<td>0.01 (0.01)</td>
<td>$\gamma_{23}$</td>
<td>0.08 (0.02)*</td>
<td>$\delta_{13}$</td>
<td>-0.09 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>$\delta_{21}$</td>
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<td>$\hat{\theta}_{12}$</td>
<td>0.07 (0.03)</td>
<td>$\delta_{21}$</td>
<td>-0.01 (0.01)</td>
<td></td>
</tr>
<tr>
<td>$\delta_{22}$</td>
<td>0.00 (0.01)</td>
<td>$\zeta_{12}$</td>
<td>0.02 (0.02)</td>
<td>$\delta_{22}$</td>
<td>-0.02 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>$\delta_{23}$</td>
<td>0.00 (0.01)</td>
<td>$\hat{\theta}_{13}$</td>
<td>0.13 (0.13)</td>
<td>$\delta_{23}$</td>
<td>0.04 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>$\varphi_1$</td>
<td>-0.04 (0.05)</td>
<td>$\zeta_{13}$</td>
<td>-0.43 (0.31)</td>
<td>$\varphi_1$</td>
<td>0.00 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>$\varphi_2$</td>
<td>0.01 (0.02)</td>
<td>$\hat{\theta}_{23}$</td>
<td>-0.05 (0.02)*</td>
<td>$\varphi_2$</td>
<td>0.00 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>$\kappa_1$</td>
<td>0.20 (0.06)*</td>
<td>$\zeta_{23}$</td>
<td>-0.09 (0.02)*</td>
<td>$\kappa_1$</td>
<td>0.00 (0.01)*</td>
<td></td>
</tr>
</tbody>
</table>

* denotes significant at 10 per cent
Diagnostic Statistics

Flexible Fourier Model

Adjusted R-squared = 0.99623
F Test for the model [143, 377] = 962.32, Prob value = 0.00000
Diagnostic: Log-Likelihood = 405.0186
F Test for the restrictions [1, 376] = 9.2232, Prob = 0.0026

Translog model

Adjusted R-squared = 0.99162
F test for model [115, 405] = 536.09, Prob value = 0.00000
Diagnostic: Log-Likelihood = 175.6761
F Test for the restrictions [3, 402] = 31.1525, Prob = 0.0000

Likelihood ratio between the two functional forms 458.685 significant at 1 per cent.

Acceptable levels of model fit are appreciated for both models. The likelihood ratio test indicates significant differences exists in the degree of ‘fit’ between the two models suggesting the translog could be replaced by the flexible Fourier form.

The distribution free cost efficiency estimates indicate substantial variation in the level of efficiency between building societies during the sample period. Average efficiency levels of 76 per cent with the flexible Fourier model and 72.52 per cent with the translog model are observed. The magnitude of efficiency dispersion differs considerably between the models, with the flexible Fourier model reporting a standard deviation of 6.869 with a minimum 68.54 per cent efficiency. The distribution of efficiency of the translog model is far greater with a standard deviation of 16.55 and a minimum value of 28.38 per cent. These cost efficiency estimates display lower efficiency levels are prevalent in the building society sector than was previously observed by Drake and Weyman Jones (1996) who suggested that little allocative or technical inefficiency were present when using data for 1988.
<p>| Alliance &amp; Leicester | 71.16 | 50.13 | Hampshire | 73.70 | 65.03 | North of England | 71.24 | 57.37 |
| Barnsley | 74.09 | 90.41 | Hanley Economic | 74.65 | 82.55 | Northern Rock | 71.95 | 59.14 |
| Bath Investments | 82.26 | 88.57 | Harpenden | 83.33 | 84.09 | Norwich &amp; Peterborough | 71.29 | 68.30 |
| Bedford Crown | 88.14 | 89.55 | Haywards Heath | 73.85 | 76.02 | Nottingham | 72.21 | 82.78 |
| Beverley | 84.25 | 88.83 | Heart of England | 70.00 | 49.84 | Nottingham Imperial | 82.97 | 85.14 |
| Bexhill | 90.38 | 91.21 | Hendon | 82.71 | 78.30 | Penrith | 84.88 | 87.52 |
| Birmingham | 69.00 | 35.35 | Hinckley &amp; Rugby | 72.73 | 81.50 | Portman | 71.08 | 59.88 |
| Bradford &amp; Bingley | 70.99 | 36.59 | Holmesdale | 78.72 | 75.18 | Portsmouth | 68.54 | 42.00 |
| Bristol &amp; West | 70.27 | 37.48 | Ilkeston Permanent | 92.10 | 98.73 | Principality | 72.36 | 74.53 |
| Britannia | 71.00 | 49.94 | Ipswich | 73.31 | 80.55 | Progressive | 72.11 | 78.61 |
| Buckinghamshire | 81.68 | 82.43 | Kent Reliance | 70.68 | 66.61 | Saffron Walden, Herts &amp; Essex | 71.72 | 71.90 |
| Cambridge | 71.26 | 75.57 | Lambeth | 71.53 | 77.17 | Scarborough | 70.74 | 67.94 |
| Catholic | 88.89 | 93.96 | Lancastrian | 70.03 | 65.10 | Scottish | 77.67 | 85.75 |
| Chelsea | 69.94 | 47.45 | Leamington Spa | 68.62 | 28.38 | Shepshed | 85.16 | 81.32 |
| Cheltenham &amp; Gloucester | 72.37 | 46.47 | Leeds | 71.12 | 42.83 | Skipton | 69.26 | 42.52 |
| Chesham | 79.18 | 85.09 | Leeds &amp; Holbeck | 70.57 | 53.17 | Southdown | 71.08 | 63.64 |
| Cheshire | 71.89 | 70.59 | Leek United | 71.81 | 81.32 | St Pancras | 75.78 | 71.49 |
| Cheshunt | 69.86 | 54.86 | Londonderry | 100.00 | 96.36 | Stafford Railway | 84.35 | 84.20 |
| Chorley &amp; District | 82.25 | 83.58 | Loughborough | 76.03 | 79.04 | Staffordshire | 71.23 | 75.64 |
| City &amp; Metropolitan | 76.06 | 72.93 | Manchester | 76.41 | 72.79 | The Standard | 90.83 | 94.53 |
| Clay Cross | 91.48 | 96.67 | Mansfield | 77.53 | 92.05 | Stroud &amp; Swindon | 70.00 | 62.62 |
| Coventry | 72.40 | 70.66 | Market Harborough | 72.66 | 79.16 | Surrey | 75.04 | 54.86 |
| Cumberland | 70.69 | 72.59 | Marsden | 71.73 | 72.59 | Swansea | 85.89 | 91.51 |
| Darlington | 71.90 | 74.92 | Melton Mowbray | 73.14 | 81.20 | Teachers | 76.94 | 88.26 |
| Derbyshire | 72.63 | 82.49 | Mercantile | 74.97 | 81.38 | Tipton &amp; Coseley | 78.66 | 88.26 |
| Dudley | 79.57 | 88.99 | Mid-Sussex | 84.58 | 88.88 | Town &amp; Country | 70.37 | 54.68 |
| Dunfermline | 71.92 | 74.26 | Monmouthshire | 74.65 | 78.61 | Tynemouth | 81.53 | 83.86 |
| Earl Shilton | 81.31 | 78.67 | Mornington | 73.25 | 71.42 | Universal | 74.36 | 87.36 |
| Ecology | 96.84 | 100.00 | National &amp; Provincial | 71.99 | 58.81 | Vernon | 75.64 | 81.20 |
| Furness | 71.49 | 74.06 | National Counties | 72.53 | 70.66 | West Bromwich | 72.04 | 79.53 |
| Gainsborough | 88.15 | 87.95 | Nationwide Anglia | 69.78 | 32.12 | West Cumbria | 85.23 | 88.57 |
| Greenwich | 73.31 | 74.26 | Newbury | 72.40 | 75.44 | Woolwich | 71.48 | 55.30 |
| Halifax | 70.36 | 43.45 | Newcastle | 71.30 | 65.86 | Yorkshire | 71.13 | 60.78 |</p>
<table>
<thead>
<tr>
<th></th>
<th>Translog RSE</th>
<th>Translog SE</th>
<th>Flexible Fourier RSE</th>
<th>Flexible Fourier SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1.0031</td>
<td>(0.0421)</td>
<td>0.7501</td>
<td>(0.043)*</td>
</tr>
<tr>
<td>1990</td>
<td>0.8317</td>
<td>(0.0457)*</td>
<td>0.7330</td>
<td>(0.045)*</td>
</tr>
<tr>
<td>1991</td>
<td>1.0225</td>
<td>(0.0457)</td>
<td>0.7880</td>
<td>(0.054)*</td>
</tr>
<tr>
<td>1992</td>
<td>0.9825</td>
<td>(0.0422)</td>
<td>0.7534</td>
<td>(0.043)*</td>
</tr>
<tr>
<td>1993</td>
<td>1.1252</td>
<td>(0.0408)</td>
<td>0.7540</td>
<td>(0.042)*</td>
</tr>
<tr>
<td>1994</td>
<td>1.1610</td>
<td>(0.0397)*</td>
<td>0.7589</td>
<td>(0.042)*</td>
</tr>
<tr>
<td>1995</td>
<td>1.1779</td>
<td>(0.0393)*</td>
<td>0.7570</td>
<td>(0.042)*</td>
</tr>
</tbody>
</table>

* denotes significant at 10 per cent

The two functional forms provide fairly distinct results for economies of scale. The translog functional form in indicates constant costs are present overall. The distribution of economies of scale over assets size of the building societies indicates sharply decreasing levels of economies of scale as asset size increases. Constant costs are indicated for building societies between £50m and £150m in total assets. Building societies with assets in excess of £150m in total assets display diseconomies of scale.

The distribution of economies of scale over time suggests the level of economies of scale within the sample is decreasing. In 1990, significant economies of scale were recorded, between 1991 and 1993 constant economies where recorded and during 1994 and 1995 significant diseconomies of scale where appreciated, overall suggesting a U shaped cost function.
form indicate far higher levels of economies of scale than the translog functional form, with a value of 0.75 being recorded overall, suggesting substantial economies to be gained by expansion. The distribution of economies of scale over asset groups indicate substantial significant economies exist for growth for societies with total assets up to £150m. Societies with total assets in excess of £150m are assumed to appreciate constant economies of scale. The distribution of economies of scale over time displays significant scale economies for all years.

Dis-economies of scope are indicated for both the translog and flexible Fourier models. This suggest that the separate provision of mortgage loans and advances would be preferable for the societies considered. The degree of dis-economies are more exaggerated within the translog specification. The translog distribution of scope diseconomies over asset size suggests the magnitude of diseconomies of scope decreases as asset size rises.

Overall, it may be inferred that the translog specification overestimates economies of scope, provides some fairly implausible efficiency results and has underestimated the level of economies of scale. Such conclusions indicate that substantial specification bias may be present when employing the translog functional form in this study. The sensitivity of the two functional forms also differs. The translog specification displays a greater degree of responsiveness of economies of scale and scope both over time and across total asset size, perhaps being a result of the lower levels of approximation error appreciated.
Conclusions

The empirical quantification and comparison of cost efficiency using the flexible Fourier and the translog functional form models provides evidence that the two approaches produce divergent estimates. These results indicate that the translog functional form does not estimate consistently over the broad range of building societies during the sample period. Consideration of the behaviour of the translog functional form is thus required through reference to the data to ensure that the results are consistent with the theory underpinning the analysis and are plausible to what should broadly be expected. It may be concluded that the use of this functional form in similar analysis should be undertaken with great care, ensuring that the distribution of the ‘raw data’ is both within limited parameters and the cost structure estimated corresponds to what may be considered credible. Whilst differences in estimation suggest that the translog both underestimates the levels of economies of scale and overestimates the dispersion of efficiency, the underlying cost structure of the building society sector appears to be similar to that produced by the flexible Fourier form (the correlation between the two distribution free efficiency measures was 0.717), supporting the conclusions of Ivaldi et al (1996), that the two forms estimate equivalent cost structures, with the Fourier form estimating more consistently over a wider range of observations.

The efficiency results indicate that many previous studies of economies of scale that have employed the translog functional form may have substantially underestimated the economies of scale within the building society sector. Average levels of 76 per cent cost efficiency are recorded for the 1990 to 1995 period, indicating that
substantial gains may be possible both through growth and improved managerial and entrepreneurial decision-making. It may be indicated that the previous use of Diewert flexible forms for the measurement of economic characteristics, as considered here, may have provided biased results.
References


