# Cost Performance of Irish Credit Unions

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There are 424 credit unions in Ireland with assets under their control of €14.3bn and a membership of 2.5m which equates to about 66% of the economically active population, the highest penetration level of any country. That said, the Irish movement sits at a critical development stage, well behind mature markets such as Canada and the US in terms of product provision, technological sophistication, fragmentation of trade bodies and regulatory environment. This study analyses relative cost efficiency or performance of Irish credit unions using the popular frontier approach which measures an entity's efficiency relative to a frontier of best practice. Parametric techniques are utilised, with variation in inefficiency being attributed to credit union-specific factors. The stochastic cost frontier parameters and the credit-union specific parameters are simultaneously estimated to produce valid statistical inferences. The study finds that the majority of Irish credit unions are not operating at optimal levels. It further highlights the factors which drive efficiency variation across credit unions and they include technological sophistication, 'sponsor donated' resources, interest rate differentials and the levels of bad debt written off.

## Introduction

Credit unions are member-owned, voluntary, democratic, co-operative financial institutions that provide financial services to their members. Since it deals exclusively with its members, a credit union can claim to be the purest form of co-operative (Croteau 1963). Credit unions cannot do business with the general public due to a charter limitation which only allows service of a membership which is defined by a common bond. This common bond is enshrined in legislation and is a definitive characteristic of a credit union.

In Ireland, in the late 1950s, a small band of dedicated pioneers lead by the Dublin school teacher Nora Herlihy set about establishing a co-operative community-based system which facilitated mutual self-help financial services provision based on democratic principles. This was the birth of the Irish credit union movement as we know it today. The success of the movement was enshrined in law when President De Valera signed the Credit Union Act, 1966. By 2007, there were 418 credit unions registered in the Republic of Ireland, with assets of approximately €14.3bn and a total membership of 2.5m. The largest credit union had €369m worth of assets under management while the smallest had assets of less than €1m.

The Irish credit union movement has been categorised in recent literature as being in the transitional development stage (Ferguson and McKillop 1997), well behind such mature movements as in the US, Canada and Australia. Classification as a transition movement rests with limited product offerings, trade association fragmentation,[1] a legislative environment which requires further development and a technological environment which has as yet failed to fully capture the benefits which may accrue to members through the sophisticated utilisation of information technology (IT). Where the Irish movement does have a pronounced advantage over the aforementioned mature movements is in the extent to which it embraces the Irish population. At present 66% of the economically active population are credit union members (McKillop et al 2006), which is higher than any other country in the world.[2] Such market penetration creates the potential for credit unions to play a pivotal role in combating the financial distress caused by the banking crisis and economic downturn in Ireland.

In recent times the most disappointing aspect of the credit union movement in Ireland is its failure to implement an integrated technological capability for all credit unions. Worldwide, technological sophistication has increasingly been linked with the advancement and success of financial intermediaries. For example, by enabling customers to access services without having to physically visit premises increases customer flexibility and reduces costs. The recent history of technology in the Irish credit union movement has highlighted the sensitive nature of its adoption. In the late 1990s a work programme was established to take responsibility for ATM projects and to knit the member unions' 33 different IT systems together into one integrated system to support the spread of ATM services, with the ultimate objective being to enable electronic fund transfer. This project became known as ISIS and was financed by a levy on each credit union payable in two tranches. It was anticipated that the new IT system would be in place by 2000. However, in July 2000, the project's anticipated cost had increased dramatically and a number of the largest credit unions withdrew from the initiative with the ISIS project ultimately abandoned in 2001.

It is against this backdrop of a movement in transition, recovering from a failed attempt to launch an integrated IT system, that we now examine the efficiency of Irish credit unions using a stochastic frontier based methodology. Employing newly acquired data this paper estimates relative efficiency scores[3] for individual credit unions and investigates the determinants of these efficiency scores[4]. Berger et al (1993) argues that:

> not only does efficiency have important ramifications for the institution itself – such as profitability, competitiveness and solvency – but also in terms of demands placed on regulatory authorities, and ultimately taxpayers, in the provision of low risk financial intermediation.

While Bauer et al (1998) suggest:

> the main advantage of frontier efficiency over other indicators of performance is that it is an objectively determined quantitative measure that removes the effects of market prices and other exogenous factors that influence observed performance. This allows researchers to focus on the quantitative effects on cost, input use etc which changes in regulatory policy are likely to engender.

Initially the production process of an Irish credit union is modelled using a stochastic cost frontier method.[5] Statistical robustness is achieved by simultaneous estimation of the parameters of stochastic frontier and the model of cost inefficiency using relevant environmental factors. These environmental variables provide a picture of the infrastructure of the Irish credit union movement, capturing many of the key characteristics previously described, including the regulatory framework, trade association affiliation, size, technology usage, and operational ratios.

The remainder of the paper is structured as follows. The methodological framework is described, the dataset is detailed, the empirical results are presented and followed by a summary and concluding remarks.

## Methodology

This study employs a stochastic cost frontier approach to investigate the efficiency of Irish credit unions. The stochastic cost frontier approach allows production technology (the credit union's operating environment) to vary across credit unions and also allows for failure to optimise production technology. The estimated efficiency measure obtained from the cost function can be decomposed into input-oriented technical efficiency and input allocative efficiency parts. Thus inefficiency can be sourced to either the mix of inputs used or the technology of firms or the industry, or a combination of both; a caveat being that decomposition requires additional information on both factor prices and quantities.

A question which arises in such an investigation is the appropriate form of the cost function. The choice of functional form has important implications for any statistical inferences that are made. The classic Cobb-Douglas cost function although simplistic can be restrictive in its a priori assumptions, which has lead most recent academic research, including this study, to the application of a Translog (transcendental logarithmic) cost function[6]. Its generality has several virtues which include allowing both the factor elasticity of substitution and economies of scale to vary across firms (credit unions). However, this increased flexibility may lead to problems with the significance of the estimated parameters. The Translog function is log–quadratic in form and a large number of input prices and output quantities will lead inevitably to multicollinearity among an ever greater number of regressors, leading to an imprecise estimate of many of the parameters in the model, including those characterising the error components containing the efficiency information. In recent literature these problems have been partially solved by using a system of equations in the estimation process, so that additional degrees of freedom are added, resulting in more efficient parameter estimates. A more canonical estimation technique, such as maximum likelihood estimation, to the traditional OLS method also produces more asymptotically efficient estimators[7].

Formally a credit union can be thought as using a set of n variable inputs $x_i = (x_1 \ldots \ldots x_n)$ which have exogenous prices $w_i = (w_1 \ldots \ldots w_n)$ to produce mostly demand driven outputs $y_i = (y_1 \ldots \ldots y_n)$ operating within an environment described by the variables $z_i = (z_1 \ldots \ldots z_n)$. The credit union is assumed to produce its output at a minimum cost given the competitive environment within which it operates, optimisation success being contingent on credit union specific factors, the industry's technological ability and other external random effects. This allows for failure to optimise and various degrees of failure across the industry.

The basic stochastic cost frontier model used in the current study takes the following form

$$TC_i = TL\ (y_i, w_i; \beta_i) + v_i + u_i$$

Where $TC_i$ denotes the total cost of producer i and the deterministic part of the stochastic cost frontier model is represent by *TL(.)* which is a Translog function defined in terms of $y_i$ and $w_i$ with $\beta_i$ being a vector of parameters to be estimated. The stochastic part of the model is the composed error term $\varepsilon_i = v_i + u_i$ where the effects of random shocks to the $i^{th}$ producer are captured via the two-sided random noise component $v_i$ and the non-negative error component $u_i \geq 0$, which reflects cost inefficiency. The $v_i$s are assumed to be independently and identical distributed as $\sim N(0, \sigma_v^2)$, and independently distributed of the $u_i$.

The mathematical formulation of the complete model and the cost efficiency estimator are presented in detail in Appendix one.

## Data Description

The database employed in this investigation is collated from a number of sources. Approximately 96% of the credit unions in the sample are affiliated to the trade association the Irish League of Credit Unions (ILCU) and this trade body provided financial data for its member credit unions. For the remaining credit unions, financial information was obtained from their annual reports. A key variable in this investigation is the extent to which individual credit unions use information technology in the provision of services to members. To obtain the required information the authors undertook a web-based survey of all Irish credit unions. The study also requires information on employee numbers. This data was obtained from a questionnaire based survey again undertaken by the authors.

The year under consideration is 2007 and in that year there were 418 credit unions. Due to inconsistencies in the data and incomplete financial records 12 credit unions were removed reducing the sample to 406.

Specification of input output mix, requires the choice of an appropriate financial institution behavioural concept. There are normally two classic approaches considered. The 'production approach' conceptualises the credit union as a producer of loans and deposit accounts by utilising the labour and capital available. In contrast, the 'asset approach' or 'intermediation approach' (Sealey and Lindley 1977) views a credit union not as producer but an intermediation agent of loans and other assets which resulted from the transformation of previously raised deposits. This approach defines outputs as the value of the loans and investments and any other interest bearing assets on the balance sheet, while the inputs are defined as the labour and capital expenses, with the total costs variable now being operating and interest expense. Deposits can be taken either as inputs or outputs (Colwell and Davis 1992). In this study we employ the

| Variables | Mean | Standard Deviation | Minimum | Maximum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| **Outputs** | | | | | | |
| Loans, $y_1$ | €16.3m | €22.3m | €168,884 | €224m | 4.11 | 29.41 |
| Cash on deposit, $y_2$ | €608,840 | €1.45m | €66 | €19.2m | 7.81 | 82.82 |
| Investments, $y_3$, | €16.6m | €24.2m | €100 | €200m | 3.31 | 17.66 |
| Members' deposits, $y_4$ | €29.6m | €39.0m | €469,953 | €321m | 3.16 | 17.67 |
| **Input Prices** | | | | | | |
| Cost of funds, $w_1$ | 2.02% | 0.95% | 0.05% | 4.64% | -0.39 | 2.36 |
| Cost of labour, $w_2$ | €36,051 | €10,222 | €3,900 | €69,842 | 0.06 | 3.13 |
| Cost of capital, $w_3$ | 1.11% | 0.57% | 0.18% | 4.89% | 1.98 | 10.25 |
| Total costs, TC | €1.32m | €1.77m | €12513 | €16.8m | 3.97 | 27.60 |

**Table 1: Summary Statistics (Year end 2006)**

'intermediation approach'.[8]

A four output and three input model is specified. The outputs are loans $y_1$, cash on deposit $y_2$, investments $y_3$ and members deposits $y_4$. Three input prices are defined as cost of funds $w_1$, cost of labour $w_2$ and price of physical capital $w_3$. Finally total cost is defined as interest expenses plus non-interest expenses (or operating expenses). Deposits have been included as both an input and an output of a financial intermediary. A detailed definition of the variables is set out in Appendix two.

In Table 1 the opportunity is taken to profile the four outputs and three input prices.

From Table 1 we can see that on average the majority of a credit union's output comes from members' deposits. A striking example of the under lent nature of Irish credit unions is that average investments are higher than average loans. The minimum value for cash on deposit highlights that some credit unions may face short term liquidity issues.

### Factors affecting Cost Inefficiency

Irish credit unions operate under different environments. These variations in environment may be either operational or organisational in nature. This analysis endeavours to ascertain their impact on individual credit union cost performance. To date there have been various studies exploring the manner in which operating environments impact upon a credit union's performance in the US, Canada and Australia, but there is only one study on Irish credit unions.[9]

### Operational characteristics

Each credit union has the ability to pay a dividend on members' shares[10]. An assumption of member benefit maximisation would imply that credit unions should aim to pay a dividend to their savers. However, it is also the case that many members are also net borrowers, so the optimal strategy for a credit union might be better described as adding value to members by minimising the spread between average deposit/dividend rates and borrowing rates. The dividend rate and loan rate are calculated using actual paid values, therefore the dividend rate is total dividend paid as a proportion of total members shares while the loan rate is the interest paid on loans as a proportion of the total loans to members. The expectation is that credit unions with higher dividends and lower loan rates are more efficient.

As a primary saving and loans entity, a credit union's chief earning asset should be its loans to members. Guidance from WOCCU suggests that an appropriate value for the loans to assets should be somewhere between 70 and 80%. With an average of 47.9% Irish credit unions are significantly under lent. This has been an ongoing problem for the Irish movement since the late 1990s and reflects the fact that competition in the retail market has intensified over recent years with many non-traditional organisations now competing to on-lend funds. A further factor is that credit unions offer a restricted range of loan products to members and IFSRA has to date been reluctant to provide significant additional product freedoms. We have included a loan to total assets ratio as an explanatory variable in our study. An increase in the loan to asset ratio is expected to see an improvement in cost performance, although it could also be argued that relative to investing funds the making of loans to members is more cost intensive which may mean that credit unions with low loan to asset ratios have superior cost performance.

McKillop et al (2006) have commented that bad debts to gross loans have increased year on year since 2002. In 2007, the average bad debt written off was €112,561.9, which was 0.69% of average gross loans and although relatively low compared to other retail financial institutions it is still a significant burden for credit unions. In terms of the efficiency analysis it is expected that an increase in the delinquency rate causes deterioration in cost efficiency.

A credit union's level of capitalisation is also included as a factor which may impact on performance. A well capitalised credit union, for example, might be expected to be more efficient as the banking literature suggests this is an obvious prevention mechanism for moral hazard. However, there is also a requirement to consider the interaction of risk treatment with capital levels. McAllister and McManus (1993) argue that efficiency improvements arise through asset diversification (proxied by loan book size) reducing the amount of capital that an intermediary is obliged to hold to achieve acceptable risk levels. Mester (1993) argues:

> in the absence of a quantifiable measure of 'protection against risk', credit unions with a low level of assets (and a correspondingly high level of capitalisation) will tend to appear inefficient.

From this discussion it can be inferred that any relationship between capital and cost performance will be clouded by the relative impact of regulation and asset portfolio make-up.

A credit union's liquidity may also prove important. For example, holding cash for liquidity purposes would have an opportunity cost in terms of lost income. Excessive cash levels could therefore prove to negatively impact upon cost performance.

Finally, we include a traditional cost-to-income measure in our model. The establishment of a relationship between the relative efficiency scores and a more traditional static accounting efficiency indicator will help validate our findings.

**Structural and regulatory characteristics**

Credit unions draw their membership from a pre-designated common bond. The credit union is then open to all within the accepted common bond that can make use of its services and are willing to accept the corresponding responsibilities. In Ireland there are two main types, residential/community and associational/occupational. In the sample the majority of credit unions are community based (370 or 91%). A credit union attached to an employer is perceived to have additional cost advantages through such facilities as direct salary deductions. Furthermore, as the membership base is exclusively employed or receiving an employee pension, the economic stability of an occupational credit union's membership may be better. Information gathering costs will also be low in comparison to community based credit unions. A dummy variable is included which takes the value of 1 if the bond is occupational and 0 otherwise. Occupational credit unions are expected to show some improved cost performance relative to community based credit unions.

Size of the organisation is measured using total assets. Berger and Mester (1997) state that "most studies include the size of the institution, but no consistent picture emerges of its relationship with efficiency." Our expectation is, however, that size, in that it should result in scale economies, should lead to improved cost performance.

There are two main trade bodies which an Irish credit union can voluntarily join, the ILCU and CUDA. In 2007 all bar 10 credit unions were ILCU members[11]. A dummy variable is included with a 1 for an ILCU member and a 0 otherwise. There is no a priori expectation as to the influence of the differing trade bodies on credit union efficiency.

The location of a credit union is also considered by including a dummy variable which takes the value 1 for an urban credit union and 0 if the credit union is rurally based. A rural community is a tightly knit area, thus the cost of information gathering for the credit union may be less, so the expectation is that rural credit unions may have superior cost efficiency to their urban counterparts.

To date the literature reports mixed evidence on the net benefits of technological adoptions in financial institutions. De Young et al (2007) and Hernando and Nieto (2007) assess the impact of the internet as a delivery channel on the performance of banks, finding that it significantly improves profitability after a certain period of adoption. In contrast, Furst et al (2002), who assess the factors affecting the adoption of internet banking, find that positive effects on profitability only materialise at an optimal size[12]. Delgado et al (2007) showed in Europe internet banks underperformed new chartered 'bricks and mortar' banks due mainly to higher overhead costs. While Fuentes et al (2006) argues that the intensity of competition encourages the adoption of transactional websites, especially where rivals have already adopted.

Dow (2007) was the first to consider technological adoption in credit unions and found that larger credit unions were more likely to adopt new technologies. Goddard et al (2007) reported evidence of a link between the absence of internet banking capability and the chances of a credit union being acquired. While Dandapani et al (2008) in a study of credit union performance concluded that internet banking adoption resulted in higher operating costs but with retention of profitability and some evidence of potentially higher asset growth rates.

In our study a dummy variable is included to account for whether a credit union has a website or not (1 for website 0 otherwise). We do not distinguish between websites which provide information and those sites through which financial transactions can be undertaken. Also included is a variable to represent the length of time the credit union has had a website. There are 167 credit unions in the sample that have a website. Given the differing viewpoints on the effect and importance of technology, an a priori assumption of its impact on cost efficiency is not possible.

Summary statistics for the previously described variables are presented in Table 2.

From Table 2 we note that the mean dividend payout is 1.42%. This may seem low, but can be explained by the fact that there are a proportion of members' funds held in accounts that do not qualify for a dividend. The loans to assets range widely across the sample, indicative of the varying success with which Irish credit unions on-lend their funds. There are approximately 61 credit unions which have a zero delinquency rate, of which 10 are occupational.

| Variable | Mean | Standard Deviation | Minimum | Maximum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Dividend rate paid | 1.42% | 0.93% | 0% | 4.11% | -0.31 | 2.35 |
| Loan interest rate paid | 9.42% | 1.67% | 5.33% | 19.77% | 0.73 | 5.74 |
| Loans to Assets | 48.73% | 13.51% | 12.61% | 100% | 0.36 | 3.17 |
| Delinquency rate | 0.57% | 0.63% | 0% | 4.33% | 2.00 | 8.45 |
| Liquidity ratio | 2.87% | 5.19% | -0.26% | 43.81% | 4.72 | 29.91 |
| Capital ratio | 13.84% | 3.17% | 1.37% | 31.06% | 0.70 | 6.42 |
| Domain name Age* | 656.20 | 997.54 | -227 | 3,856 | 1.21 | 2.96 |
| Cost to Income ratio | 39.54% | 11.86% | 12.78% | 111% | 1.03 | 6.71 |
| Asset Size | €34.4m | €45m | €524,597 | €369m | 3.12 | 16.29 |

* This is measured in calendar days from 30 September 2007.

**Table 2: Summary Statistics (Year End 2006)**

On average credit unions are well capitalised with a mean value above the WOCCU minimum.[13] Liquidity levels are low on average with a negative minimum value indicative of a credit union being overdrawn. The cost to income ratio varies significantly and this emphasises that there is a large variation in cost performance across credit unions. (Indeed, there is one credit union with a cost to income ratio above 100%). Credit union size also varies significantly and in absolute terms from €524,597 to €369m. Domain name age is approximately two years on average. This taken in conjunction with the fact that less than half the sample have a website illustrates that Irish credit unions are relatively new to technology adoption[14].

## Empirical Results

Table 4 presents parameter estimates for the stochastic cost frontier for two Translog models along with their standard errors, while in Table 5 the estimates of overall cost efficiency from each model are detailed. Maximum likelihood methods are used to obtain parameter estimates for each of the cost frontier models. Translog1 is a basic Translog model which does not include environmental variables, while Translog 2 assumes that the environmental variables affect the cost efficiency of the credit union and are included in the non-negative component of the composed error term as a function of its mean[16] with the coefficients of the environmental variables estimated simultaneously with the cost function parameters. This ensures valid statistical inferences from the technical inefficiency parameter estimates.

To be an adequate representation of the underlying technology the estimated cost function must be concave in input prices and monotonically non-decreasing in input prices and output. The parameter estimates detailed in Table 4 were used to determine whether these regularity conditions were satisfied at the sample mean. In each instance the regularity conditions were satisfied. Table 5 presents gross and net estimates of cost efficiency from each model. Translog1 produces estimates of cost efficiency without accounting for the environmental variables so the reported figure can be viewed as net cost efficiency while for Translog 2 the coefficients of the environmental variables are estimated simultaneously with the cost function parameters and the resultant cost efficiency is a gross figure.

Mean scores in both models indicate that the Irish credit union movement has some scope for efficiency improvements. For example, if we take the mean gross cost efficiency score for the Translog2 model (0.8450) this suggests that on average Irish credit unions could improve cost efficiency by approximately 15.5%. We also note from Table 5 that there is significant variation in cost efficiency across Irish credit unions. For example, for the Translog2 model the minimum gross efficiency value is 0.4615 while the maximum is 0.9895. This suggests that one credit union in the sample could improve its cost

| | Translog1 | Translog2 |
|---|---|---|
| $\beta_0$ | -0.18924 | -0.24275 |
| | [0.01353]*** | [0.01911]*** |
| lny1 | 0.16331 | 0.00351 |
| | [0.04755]*** | [0.05255] |
| lny2 | 0.01546 | -0.00105 |
| | [0.00569]*** | [0.00584] |
| lny3 | 0.04692 | 0.01614 |
| | [0.04009] | [0.03457] |
| lny4 | 0.79989 | 0.98935 |
| | [0.08763]*** | [0.08097]*** |
| lnw1 | 0.45002 | 0.52067 |
| | [0.06511]*** | [0.04961]*** |
| lnw2 | 0.03066 | 0.0587 |
| | [0.09214] | [0.07136] |
| lny1lny1 | 0.17256 | -0.08789 |
| | [0.18322] | [0.12436] |
| lny1lny2 | 0.04722 | 0.05684 |
| | [0.02666]* | [0.02081]*** |
| lny1lny3 | 0.13819 | 0.12011 |
| | [0.09311] | [0.06838]* |
| lny1lny4 | -0.32342 | -0.04685 |
| | [0.27853] | [0.19086] |
| lny1lnw1 | -0.0122 | -0.03311 |
| | [0.04985] | [0.03725] |
| lny1lnw2 | -0.02705 | 0.01981 |
| | [0.06416] | [0.04798] |
| lny2lny2 | 0.00613 | 0.00184 |
| | [0.00228]*** | [0.00183] |
| lny2lny3 | 0.02665 | 0.03065 |
| | [0.01744] | [0.01560]** |
| lny2lny4 | -0.06704 | -0.07829 |
| | [0.04380] | [0.03557]** |
| lny2lnw1 | -0.00204 | 0.00592 |
| | [0.00563] | [0.00458] |
| lny2lnw2 | -0.01465 | -0.01852 |
| | [0.01097] | [0.00815]** |
| lny3lny3 | 0.03366 | 0.02606 |
| | [0.01417]** | [0.01185]** |
| lny3lny4 | -0.14283 | -0.12847 |
| | [0.10781] | [0.07994] |
| lny3lnw1 | 0.04025 | -0.0018 |
| | [0.03601] | [0.02516] |
| lny3lnw2 | -0.04832 | -0.02194 |
| | [0.04942] | [0.03817] |
| lny4lny4 | 0.39798 | 0.12878 |
| | [0.41548] | [0.29396] |
| lnw1lnw1 | 0.16023 | 0.19765 |
| | [0.01720]*** | [0.01383]*** |
| lnw2lnw2 | 0.10135 | 0.15103 |
| | [0.03284]*** | [0.02353]*** |
| lnw1lnw2 | -0.06404 | -0.09649 |
| | [0.01760]*** | [0.01481]*** |
| Observations | 406 | 406 |
| Standard errors in brackets | | |
| * significant at 10%; ** significant at 5%; *** significant at 1% | | |

**Table 4: Parameter Estimate for Stochastic Cost frontier Models**

efficiency by 53.85% while at the other end of the spectrum another credit union could improve by only 1.05%. In Appendix three, Figure 1 we have presented the kernel density estimate of the cost efficiency values. This profiles the cost efficiency values across all 406 credit unions. From Figure 1 we note that almost all cost efficiency values exceed 0.6[16] and in addition that a majority of the cost efficiency estimates are clustered between 0.85 and 0.95.

We also note from Table 5 that there is a difference between the gross and net cost efficiency values. Differences between the gross and net cost efficiency measures for a specific credit union can be viewed as the contribution that the documented environmental variables make to the inefficiency of the credit union in question. We note from Table 5 that the

| | Net Cost Efficiency* (Translog1) | Gross Cost Efficiency* (Translog2 ) |
|---|---|---|
| Mean | 0.8876 | 0.8450 |
| Median | 0.9035 | 0.8620 |
| Standard Deviation | 0.0646 | 0.1071 |
| Minimum | 0.5670 | 0.4615 |
| Maximum | 0.9813 | 0.9895 |
| Skewness | -1.6995 | -0.9018 |

*The stochastic model produces raw inefficiency scores which were converted to efficiency scores.

**Table 5: Cost Efficiency estimates**

magnitude of the difference is approximately 4%.

In Table 6 the opportunity is now taken to present some information on the determinant of cost efficiency. Given the nature of the two models this information is presented for the Translog2 model. These efficiency determinants have characterised in generic terms as either operational variables or structural and regulatory variables. We also report in Table 6 behavioural statistics for the two models.

In terms of the behavioural statistics the null hypothesis of no cost inefficiency (or of *y* = 0, implying that the one-sided error component makes no contribution to the composed error term) can be tested for the respective models. To do this we follow the Coelli (1995) procedure which suggests that the one-sided generalised likelihood ratio test should be performed when maximum likelihood estimation is involved. Critical values for this test are obtained from Table 1 of Kodde and Palm (1986)[17]. For each model the null hypothesis of no cost inefficiency is rejected. For the cost efficiency estimates to be meaningful the residuals from the respective models should be positively skewed. Again this condition is satisfied.

From Table 6 it is also noted that the *y* variance parameter for both Translog models are close to one. This suggests that the majority of residual variation is due to the cost inefficiency effect $u_i$ and that the random noise component $v_i$ is relatively small. A likelihood ratio test is performed on both Translog models to test the null hypothesis that Translog2 is no better a fit of the data than Translog1; the resultant statistic is displayed in the last row of Table 6. The null hypothesis is rejected - Translog2 is a better fit for the data. This confirms that for the sample of Irish credit unions, environmental variables cannot be neglected without introducing bias into the estimation of the cost function and thus inefficiency estimates.

**Factor of influence on Inefficiency**

The model produces scores of cost inefficiency[18] so a negative coefficient estimate can be thought of as an improvement in cost performance, whereas a positive coefficient can be viewed as reduction in cost performance. Our results in Table 6 suggest that operational variables have much more influence over cost inefficiency than structural and regulatory factors.

For example, we note that there is a negative coefficient estimate for the dividend rate and a positive coefficient for the loan rate. This implies that credit unions with superior cost performance are those with lower loan rates and those offering higher dividend payouts. It is perhaps to be expected that those credit unions best placed to offer low loan rates and high dividend rates are those that have superior cost efficiency. Capital levels also seem to significantly impact on cost performance. More specifically, credit unions with lower capital levels are more cost efficient. Berger and DeYoung (1997) argue that credit institutions with poor cost control may suffer from poor credit risk assessment leading to a positive relationship between credit risk and cost inefficiency. From Table 6 we note that the delinquency rate coefficient is positive and significant which implies that credit unions with lower levels of write-offs are more cost efficient. The loan to asset coefficient estimate is also positive and this would suggest that credit unions with lower loan ratios are more efficient. This is a surprising result but may be due to the fact that the alternative to making loans is that of making investments which are less costly to both initiate and service than loans. Finally we note that the coefficient estimate on the cost to income[19] ratio is positive indicating, as expected, that superior performance on this metric translates to superior model generated cost efficiency.

In terms of the structural and regulatory variables we note from that there exists a negative relationship between a credit union

| | Translog1 | Translog2 |
|---|---|---|
| **Operational variables** | | |
| $\beta_0$ | | -0.38723 [0.10777]*** |
| **Dividend rate** | | -10.06249 [1.15132]*** |
| **Loan interest rate paid** | | 0.49147 [0.11219]*** |
| **Capital ratio** | | 0.56001 [0.21935]** |
| **Liquidity ratio** | | 0.35293 [0.25719] |
| **Delinquency ratio** | | 10.59141 [1.17890]*** |
| **Cost to Income ratio** | | 0.48764 [0.07476]*** |
| **Loans to Assets ratio** | | 0.49147 [0.11219]*** |
| **Structural & Regulatory Variables** | | |
| **Size** | | 0.00313 [0.01111] |
| **ILCU** | | -0.03294 [0.05564] |
| **Urban** | | 0.00562 [0.01386] |
| **Occupational** | | -0.10807 [0.02621]*** |
| **Website** | | -0.04118 [0.02104]* |
| **Domain name Age** | | 0.00002 [0.00001] |
| **Gamma** | 0.812182 0.065501 | 0.74032 0.06617 |
| **Sigma squared** | 0.029232 0.003565 | 0.00886 0.00096 |
| **Generalised one-sided likelihood ratio test** ($H_0:u_i = 0$) | 20.72 | 322.10 |
| **Log likelihood function** | 297.46 | 448.16 |
| LR test ($\mathbf{H_0}$ = Translog1 nested in Translog2 ) | | 301.38 |

*** p<0.01, ** p<0.05, * p<0.1
Standard errors in brackets

**Table 6: Parameter estimate for Inefficiency Model**

being occupational in nature and its cost inefficiency. The implication is that 'sponsor donated' resources act to reduce both the credit control costs and the default risk of the membership. The adoption of technology, in the form of a website, also increases the cost efficiency of the credit union. The dummy variable for a website has a negative and significant coefficient, illustrating that adoption of website technology positively impacts cost performance. This 'customer facing' technological change brings with it additional delivery channels for a credit union's product offerings. Thus providing an increased flexibility to existing members coupled with lower per member processing costs.

Finally, we included asset size as one of the structural and regulatory variables and although size is not significant in this study, the heterogeneity within the industry in terms of size merits further analysis. A kernel density estimator of both the lower and upper quartile in terms of assets size is presented in Appendix Three – Figure 2 and this reveals some variation in cost efficiency, with large credit unions having greater concentration in the higher efficiency area (in figure 2 we observe that larger credit unions are more concentrated in the range 0.8 to 1 than their smaller counterparts).

## Concluding Remarks

A credit union can be found in every town and community in Ireland, and their continued existence in an ever more complex market place is a testament to the dedicated pioneers that founded them. The rapid development of the Irish financial services industry has seen a considerable shift in development of individual credit unions and the movement as a whole. That said they sit at a critical stage in their development, well behind mature industries such as the US and Canada.

To date this paper is one of the first attempts to investigate the cost performance of Irish credit unions. The analysis, although important in its own right, should however be viewed as a starting point for more rigorous investigation. The study shows variation in the cost performance levels of Irish credit unions with an average shortfall in cost performance of approximately 15%.

Analysis of how credit union characteristics influence inefficiency highlighted that operational elements have a greater influence than structural and organisational factors. We noted that credit unions with superior cost performance are those with lower loan rates and those offering higher dividend payouts. Furthermore, credit unions with lower capital levels were also more cost efficient. Delinquency was another important driver of cost efficiency with credit unions with lower levels of write-offs more cost efficient. In terms of the structural and regulatory variables we found that occupational credit unions were more cost efficient than their community based counterparts. A final key finding was that adoption of technology, in the form of a website, increased the cost efficiency of credit unions.

In today's uncertain climate the need for better financial services provision is important. Credit unions in Ireland, given their countrywide coverage, have a critical role to play in this process. Having said this they will only be in a position to provide the required products and services if they operate in as efficient a manner as possible. Our study reveals that there is significant scope for efficiency improvements and also highlights the factors that can drive this improved cost performance.

## Appendix One

Heterogeneity in the form of the environmental variables (here, $z_j = (z_1 \ldots \ldots z_m)$ is a vector of environmental effects) will be assumed to affecting the cost efficiency of the production process[20], where the efficiency term $u_i$ is specified as being independently (but not identically) distributed[21] as a non-negative truncation of a general normal distribution of the form[22];

$$\sim N(m_i, \sigma_\mu^2)$$

$$m_i = \delta_0 + \sum_{j=1}^{m} \delta_j z_j$$

Where $\delta_0$ and $\delta_j$ are unknown parameters to be estimated. Again all the unknown parameters are estimated simultaneously via maximum likelihood methods. The likelihood function and its partial derivatives with respect to the parameters of the model are obtained from Battese and Coelli (1993), remembering that for the cost case here $\epsilon_i = v_i + u_i$ (not $\epsilon_i = v_i - u_i$ as in the production case). The likelihood function is expressed in terms of the variance parameters $\sigma_s^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2 / \sigma_s^2$ [23].

Cost efficiency of credit union $i$ is defined as the ratio of the stochastic frontier minimum cost $(u_i = 0)$ to observed cost and is measured by decomposition of the composed error term[24]. Using Glass and McKillop (2006) adaptation of the Battese and Coelli (1993) model for a cost case, a predictor of cost efficiency (the inverse of cost inefficiency) is defined by the conditional expectation of exp ( $-u_i$) given $\epsilon_i = v_i + u_i$. This expression is given by

$$CE_i = E[\exp(-u_i | e_i)]$$

$$= \left[\exp\left\{-u_i + \frac{1}{2}\sigma_*^2\right\}\right] \cdot \left[\frac{\Phi[(u_i/\sigma_*) - \sigma_*]}{\Phi[u_i/\sigma_*]}\right]$$

Where denotes the distribution function of a standard normal variable,

$$u_i = (1-\gamma)\left[\delta_0 + \textstyle\sum_{j=1}^{m} \delta_j z_j\right] - \gamma\epsilon_i$$

and

$$\sigma_*^2 = \gamma(1-\gamma)\sigma_s^2$$ [25]

The unknown parameters in the above can be replaced by the maximum likelihood estimates to obtain estimates of cost efficiency (and inversely cost inefficiency) for individual credit unions. Cost efficiency will take values between zero and one (one being credit unions on the frontier). By simultaneous estimation of both the parameters associated with the stochastic cost frontier and the parameters associated with the firm specific environmental factors directly influence the inefficiency term, there is consistency in the assumptions associated with the non-negative inefficiency error term.

In the empirical analysis, before estimation, Young's symmetry restriction[26] should be imposed (for integrability) as well as homogeneity of degree one in the input prices[27] (by normalising all the cost and input price terms by one of the input prices). The other regularity conditions (concavity in input prices, and the right skewness of residuals) are checked after estimation.

## Appendix Two

$y_i$ = Loans include all interest earning loans made to members in this financial year.
$y_2$ = Cash on deposit includes all commercial deposits held in such a way as to be readily available for use.
$y_3$ = Investments include Irish and EMU state securities, Irish and non-Irish deposit accounts, bonds issued by Irish and non-Irish institutions, Euro denominated securities and collective investment schemes.
$y4$ = Members deposits include all members share and SSIA shares and all members deposits and SSIA deposits.
$w_1$ = Interest Expenses/(Members funds +Borrowings)

Or more specifically:

$$\frac{\text{Dividends paid+Interest Paid+Death Benefit Insurance+Loan and Share Insurance}}{\text{Deposits+Shares+Borrowings}}$$

$w_2$ = Employee expenses/total equivalent full time employees
Where Employee Expenses = Salaries + Pensions + Treasurer's Honorarium. Cost of labour figures were imputed for those credit unions that didn't have employee figures, by averaging out the figures for following groups- total assets= 0-10m, 10-50m, 50-100m and greater than 100m. The missing values in each group where then replaced with the relevant group average.
$w_3$ = Office Occupancy +Office Operating Expenses)/total assets
Where Office Occupancy +Office Operating Expenses= other management expenses less (death benefit Insurance + share and loan insurance + bad debt written off + pensions + treasurers honorarium). Worthington (1998) defines the price of physical capital to include the more theoretically accurate net book value of tangible fixed assets as a denominator. Due to the reported inaccuracy of the 2007 data on tangible fixed assets[28] total assets was used as a more consistent proxy.

$$\begin{aligned} lnTC_i = \beta_0 &+ \sum_m \alpha_m \, lny_{mi} + \sum_n \beta_n \ln w_{ni} \\ &+ \frac{1}{2}\sum_m \sum_j \alpha_{mj} \, lny_{mi} \, lny_{ji} \\ &+ \frac{1}{2}\sum_n \sum_k \beta_{nk} \, lnw_{ni} \, lnw_{ki} + \sum_n \sum_m \gamma_{nm} \, lnw_{ni} \, lny_{mi} + v_i + \mu_i \end{aligned}$$

**The full form of equation (1) model specification**

## Appendix Three

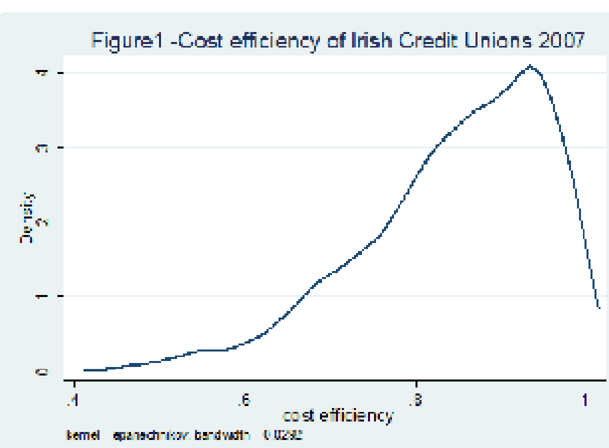

Figure1 -Cost efficiency of Irish Credit Unions 2007

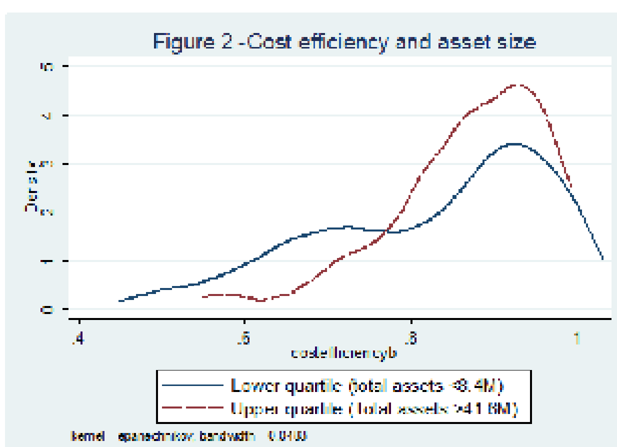

Figure 2 -Cost efficiency and asset size

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## Notes

1 There are two active voluntary trade bodies within the Republic of Ireland each offering different types and levels of service to their members - the Irish League of Credit Union (ILCU) and the Credit Union Development Association (CUDA).

2 In 2006 there were 46,377 credit unions in 97 countries worldwide. They had more than 172 million members and over US$1.2 trillion in total assets (WOCCU, 2007).

3 The concept of efficiency measurement is the calculation of a measure of efficiency of firm production based on a pre-defined behavioural assumption (eg cost minimisation) relative to a given technology, which is generally represented by some form of frontier function. The frontier which is used is generally thought of as that consisting of all the fully efficient firms, which is not known in practice. Its estimation is normally obtained from a sample of firms from the industry.

4 Examples of both parametric and non-parametric frontier analysis in use in the credit union context are as follows; in the US Fried and Lovell (1993), in Australia Worthington (1998) and Brown et al (1997), in Canada Pille and Paradi (2002) and in the UK McKillop et al (2002a).

5 A cross-sectional adaptation of the Battese and Coelli (1995) methodology is used.

6 See also Glass and McKillop (2006), Worthington (1998) and Frame et al (2003).

7 A caveat to this choice of functional form would be that its goodness of fit is critically subordinate to the data's distance from the mean in terms of output mix or size (Berger and Mester, 1997). A badly fitted functional form has been found to increase the inefficiency estimations. Berger and De Young (1997) found that measured inefficiencies were about twice as large when the Translog was specified in place of the Fourier-flexible form.

8 Other credit union studies utilising the intermediation approach include Worthington (1998), Glass and McKillop (2006) and Drake and Weyman-Jones (1996).

9 For the US Fried et al (1993, 1994) used DEA to obtain credit union efficiency measures, explaining variation using various environmental factors while Goddard et al (2002) assess the impact of environmental characteristics on credit union growth. For Canadian credit unions Pille and Paradi (2002) used DEA to detect weakness in credit union performance with a view to predicting failures. For Australian credit unions Worthington (1998) used a two stage process to determine estimates of an econometric cost function and attribute structural and intuitional characteristics of Australian credit unions to their relative cost efficiency scores, Esho (2001) also using similar techniques. Glass et al (2009) consider Irish credit unions using a two-stage approach - the first stage measures efficiency by a DEA estimator, which explicitly incorporates the production of undesirable outputs such as bad loans in the modelling, and the second stage uses truncated regression to infer how various factors influence the estimated efficiency.

10 This is discretionary, but in 2007, 323 (77%) paid a dividend.
11 In 2007 a number of credit unions had dual membership of both trade bodies.
12 They concluded that due to significant start up cost of internet banking smaller institutions which had adopted technology were less efficient than their counterparts who had not, although this differential disappears with banks which have a longer history of internet banking..
13 WOCCU best practice institutional capital/total assets ratio level is >= 10%.
14 A negative minimum reflect the fact that some websites where created after 30/09/2007.
15 Kumbhakar, Ghosh and McGuckin (1991), Reifschneider and Stevenson (1991) and Huang and Liu (1994) were the first to use a single step estimation procedure for technical inefficiency determinants. Battese and Coelli (1995) extends this to the Panel data setting.
16 There are 392 credit unions in the sample that exhibit cost efficiency above this level.
17 From Table 1 the critical value for 7 degrees of freedom (4 outputs, 2 inputs prices and an intercept) 13.401.
18 That is the $u_i$s in the cost frontier represent the shortfall of the individual credit unions from the optimal cost performance level.
19 This measure suggests the less of the operating cost covered by income the more inefficiency a firm is perceived to be.
20 Battese and Coelli (1995) was one of the first studies to model these factors so that they directly influence the inefficiency term, but unlike early work by Reeifschineider and Stevenson (1991), there is no a priori assumption of identical distribution of the random component of the stochastic model of inefficiency across firms or that they are required to be non-negative. The conflicting view is that the environmental variables influence the shape of the production technology, therefore should be included in the cost function as regressors (eg Good et al 1993).
21 The distribution assumption of $u_i$ has taken various forms in the literature including half normal, gamma and exponential.
22 This generalises the normal-half normal model by allowing the $u_i$ to have a non-zero mean. It was first introduced by Stevenson (1980).
23 Aigner, Lovell and Schmidt (1977) used two-variance parameters ($\sigma_s^2 \equiv \sigma_u^2 + \sigma_v^2$ and $\lambda \equiv \sigma_u / \sigma_v$). The $\gamma$ –parameterisation (first suggested by Battesse and Corra (1977)) proves more useful in ML estimation as the parameter space of $\gamma$ can be searched for a suitable starting point for the iterative maximisation algorithm used. This is because it takes only values between zero and one whereas the $\lambda$ –parameter can take any non-negative value.
24 Jondrow et al (1982) first proposed a conditional distribution approach for this decomposition.
25 Again there is adjustment of the formulas to account for the fact that our data is cross-sectional not panel.
26 That is $\alpha_{nk} = \alpha_{kn}$ and $\beta_{jm}$ is imposed.
27 This requires the additional imposition of $\Sigma_n \beta_n = 1, \Sigma_{n'} \beta_{nk} = 0 \forall k$ and $\Sigma_n \gamma_{nm} = 0 \forall m$.
28 Consequently cost of capital figures ranging from 3% to over 1,000%.