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PROFITS, EFFICIENCY AND IRISH BANKS

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Abstract

This paper looks at the interaction between profits and efficiency in a sample of 17 Irish banks, for the years 1988 - 1991 inclusive. By contrast with previous techniques used for assessing economic models of efficiency, the method employed allows for a finer decomposition of profit loss. This loss can be attributed to allocative or technical inefficiency, and these can be derived both for inputs and outputs.

Relying on the use of shadow prices, as it does, this technique allows us to make some interesting observations about the relative availability of firm-specific data in different research regimes.

The results of the modelling process indicate that there is a substantial degree of loss arising in the Irish banking system. This is estimated as being an amount equal to approximately 20 per cent of the total realised profit. Most of the loss arises from input technical inefficiency i.e. poor planning on the input side of the production process. A by-product of the process is a new test for economies of scope; there is no evidence from the data that there are economies of scope for Irish banks. This is in line with previous findings.

1. WHAT IS PROFIT ?

It is the contention of this paper that there is a profit function decomposition such that there is evidence of substantial deviations from efficiency by Irish banks. In order to approach this analysis and decomposition. I consider it useful first of all to look at what profit is seen to be in economic theory. A fuller exposition of this area can be found in Howard (1983).

We may distinguish between three main theories or schools of thought regarding profit. The first of these is the Surplus school, the second the Neo-classical school, and the final school that of the Schumpeterian analysis.

Surplus Theories

These can easily be dismissed as fanciful, but were the first theories that looked in detail at the determination of the return to capital. The main figures in the act are in historical order Ricardo, Marx and Sraffa. Basically, the surplus is the excess of production over the replacement needs of the economy. A great deal of differentiation can be done on the basis of specification of the production process, the exact definition of the replacement needs and crucially on the role of capital. In these analyses, what we call profit is in fact rent extracted from the other sectors of the economy. In the Marxian analysis, it is exploitation that extracts profit, in the Ricardian school, amongst which may be placed Sraffa, it is the interaction of the system. This approach need not detain us except to note that there is an elimination of the role for pure profit.

Neo-classical Theories

These are the theories of profit as developed by the predominant, if not always pre-eminent, theories of economic development and progress developed since the marginalist revolution of Jevons and Marshall. They are basically posited on three assumptions: that there is an attainable equilibrium, that there is a competitive force in action in the economy such that there is a tendency to move to the equilibrium, and that there is absence of uncertainty. This defines profit = interest, and relegates, in theory if not in fact, pure profits to the interplay of market imperfections.

The marginal product of capital, which itself is never well defined, is declared to be profit. As capital is somewhat metaphysical, being the productive part of the economy whose components are capital goods, profit is necessarily ill-defined. Accounting, or measured profit is more easily defined, being the excess of income over expenditure.

Theories of Pure Profit

These are theories that are theories of profit as such, rather than interest, or rent profit. We have seen above that the profits derived from the surplus and from the neo-classical profit theories are primarily theories that see what we call profit as being rent extracted from the other sectors of the economy, as a payment to capital, or as interest to the capital invested. By contrast, this section looks at Knightian and Schumpeterian analyses of profit *as such*. The main issue is that Knight and Schumpeter envisaged profits as coming mainly from the market power that arises from innovation and entrepreneurship. If these conditions of informational monopoly can continue, then profits above the competitive rate can continue indefinitely. Where the schools of thought differ one from another is the degree of persistence that actually exists.

Another difference is that in the neo-classical approach, pure profits are in some sense a reflection of a market imperfection. Where the Schumpeterian and Knightian analysis differs to some extent is in the realisation that the profits are to a great degree dependent on the uncertainties and imperfections that are present in the system. Thus, there is no social evil associated with pure profits. Indeed, it is the incentives that are present from the existence of such profits that are the driving force of capitalism. Unlike in neo-classical theory, markets are not imperfect in the sense of being flawed, but are so by their nature.

This means that there are forces in the system such that there is the likelihood of imperfections in the operating of the firm. We have an economy driven by uncertainty and informational asymmetries. Thus, of necessity any study that looks at the long or medium run and seeks to explain inefficiencies is a theory that is related to pure profit theory. In a neo-classical world, there would be forces that pushed out the inefficient firms but here they may thrive due to the prevalence of imperfections.

Other Imperfections

It should be noted in passing that there are many other issues in reality that prohibit firms from attaining the desired level of efficiency. One of these is the regulatory environment. We have in the financial system a most regulated system indeed, one that prohibits the firms from acting as they would. This may well be the most pressing matter that a firm faces when attempting to deal with a perceived inefficiency - the action may be prohibited by labour or banking regulations. In addition, over the period under analysis, we witnessed a differential liquidity regime as between associated and non-associated banks.

2. THE THEORETICAL FRAMEWORK

The objective of this section is to outline the theoretical reasoning behind using the methodology used for analysis. I shall first of all discuss the traditional production function methodologies, concentrating on the Jondrow-Knox Lovell-Materov-Schmidt (1982) (henceforth JKMS) decomposition, and only then outline the profit function approach.

Concepts of Technical Inefficiency

Why might different production units exhibit different transformations of inputs into outputs and products? We can, in principle, identify four reasons:

1. Companies might be using different technologies;
2. Companies might have distinctly different activities, i.e. their product mix may vary widely;
3. Companies might be operating at different scales of production;
4. Allowing for all these, the companies may actually differ in their efficiency.

Technology in Irish banking is unlikely, I am assuming, to vary widely. Unfortunately, there is little evidence on this area. We must be careful to distinguish between technical and technological.

Technical issues are very variable, but are unlikely to be of prime importance. All banks will, at this stage, have broadly similar computing and information technology. The main technological distinguishing factors of banks arise in the production process itself. These are likely to be manifestations of human capital, banking being an information good. Consequently, we will subsume the technology issues into the analyses of the profit relationship. This imposes a particular structure, product mix and scale, both from the function used and from the sample selected.

Product mix is an interesting area which leads to the concept of scope economies. Unfortunately, these, and their close ally of cost sub-additivity/cost complementarity are dependent on there being made available attributable cost data. There are not enough banking institutions making available such data to enable these to be analysed here. Some succour can be derived form the profit function itself, however, as we shall see that there is a concept of "Optimal Scope Economies". These will be explained later.

Scale economies are again a concept that is somewhat dependent on the function under analysis. There are wildly differing scales under analysis here, ranging from small to extremely large.

This JKMS methodology looks at the technical, as opposed to the allocative efficiency of banking institutions. Allocative efficiency is a price concept, the ability to achieve optimal input combination at a given price ratio, whereas technical efficiency is a production concept, the ability to achieve optimal output from a given set of inputs.

An assumption of this analysis, and one of the main weaknesses, is that the two types of inefficiency are independent within each unit under analysis. This may well be a false assumption, as poor cost management and poor production management may well derive from similar firm specific management dynamics. Consider the situation where there is a misperception of the price of an important output, such as consumer loans. In that case, there will be allocative inefficiency on the output side as plans will be formulated on the basis of misperceived prices.

Possibly also there will be technical inefficiency in that it is also possible for there to be a misperception of input prices, such as deposits, resulting in poor production. Unfortunately, the methodology to be outlined below will only pick up the technical side of the situation. We will see later how the Berger-Hanweck-Humphery model allows the explicit estimation of allocative and technical efficiencies on both the input and output sides of an equation.

Towards a functional specification

The method of decomposition of residuals

The idea of the stochastic frontier is that the production of any output is expressible in the form

$$Q = f(K, L, E) + e$$

where K and L are capital and labour measures, E is a set of other factors that are involved, and e is a random error term.

Crucially, there is the assumption that the error term can be decomposed into two separate components. This allows the decomposition to take place. The first element of the error term is a pure error term, a symmetric random component, reflecting the slings and arrows that jar the production process from its optimal path. It will also include any measurement errors. It is common to assume that this term is normally distributed, with mean zero and with an unknown but estimable standard deviation.

The second component is assumed to be non-symmetric, and to reflect inefficiencies, as defined here to be factors that, at least in principle, are under the control of the unit. This measure is assumed to be bounded at the upper limit by zero, reflecting the idea that after allowing for the influence of bad luck, each unit under examination must lie on or below the frontier. We are thus assuming that there will be, in the frontier units, management practices that are such as to compensate for the random 'bad luck' element. This approach has as its genesis the methods of Aigner et al (1977).

We can fit a number of functional forms to the theoretical production process, but for the sake of simplicity, and for the sake of having a very general measure, the

Translog form is usually estimated.. This takes the form of a second order approximation to the frontier, all data being expressed in log form.

In general, this has the form

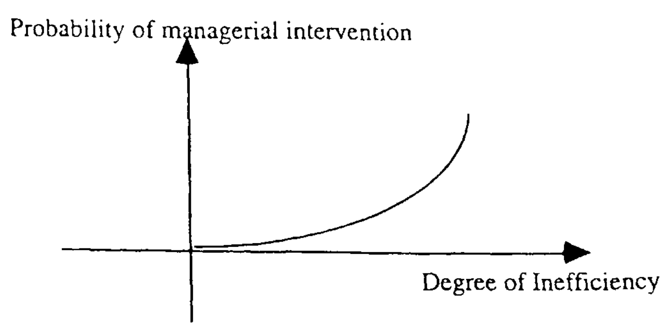
$$\ln Q = a_0 + a_1 \ln L + a_2 \ln K + a_3(\ln L^2) + a_4(\ln K^2) + a_5 (\ln L \ln K) + \sum_i^n a_{i+5} E_i + e.$$

$$e = u + i$$

In order to make assumptions about the degree of inefficiency, we need to ascertain the distribution of u, the random effect, and i the inefficiency effect. As stated previously, standard assumptions (zero mean, symmetrical distribution) are made about u. In the case of i there are a number of options. Some papers have assumed that the distribution is distributed in a gamma form e.g. Richmond (1974), Greene (1990) or in an exponential distribution Aigner, Lovell & Schmidt (1977). A review of the statistical implications of choosing various distributional assumptions is provided in Frain (1990).

Caves & Barton (1990) provide a rationale for the assumption of a half normal distribution. The idea is that there is a progressively higher probability of management intervention as inefficiency rises, assuming that the degree of inefficiency in the absence of such intervention rises at a constant rate per unit of time. The management intervention acts to force the inefficiency, resulting from bad practice, to zero. Thus, truncation at the mode can be allowed.

Graph 1



Olsen, Schmidt & Waldman (1980), quoted in Greene & Mayes (1991)) show that from the moments of the residuals of the OLS estimated frontier, the standard deviations of the component residuals are computable. This holds as stated only if the measure is assumed to be truncated at the mode. This paper also shows that a simple OLS model can provide more robust estimation of the function where there is a small sample size than can a Maximum Likelihood or systems approach.

Once we have estimated the standard deviation of the components we can then, using the JKMS procedure, decompose the (OLS) residuals into the symmetric (bad luck) component and the truncated normal (bad management) component. This procedure derives the mean and standard deviation for the non-symmetric component, and thus allows inferences to be drawn and confidence intervals given for the individual units' inefficiencies[1]. We call these measures managerial inefficiencies.

In addition to the estimates for the individual units, we can always derive estimates of the population as a whole. Some of these are:

1. Population Managerial Inefficiency: This is given as the ratio of the standard deviations of the two components or $\lambda = \sigma_i / \sigma_u$. This looks at the degree of (variation in) inefficiency under the unit's management control to that which results from external factors.

2. Average Technical Inefficiency is defined as the expected value of i as a whole and is measured by $(\sigma_i\sqrt{(2/\pi)})$.

Other measures can be found discussed in Chapter 4 of Caves & Barton (op cit.).

Recall throughout that we are examining a set of units of production, and that efficiency is measured relative to each other. The measures are not relative to some 'star' or reference technology. The hull is taken as best practice, and deviations therefrom as evidence of inefficiency.

The method of average residuals

The average residuals method derives from Berger (1992) and was conceived as a method for estimating efficiencies involving time as an identifying variable. This method is distribution free, in his terminology, but is not so in fact. In essence, it is simplicity itself, merely identifying the deviation of a unit from the frontier as the measure of inefficiency.

The average efficiency ratio is calculated for each firm as shown below. First, a total cost, or in this case total production, function is estimated for each of the T periods in your sample. The Translog specification is assumed in what follows. Secondly, an average residual for each firm is calculated, by summing the residuals for firm f for each year. This gives

$$\ln \overline{U} = \frac{\sum_{i=1}^{T} \ln U_f}{T}$$

Thirdly, the total sample of firms is searched, to find the minimum residual, denoted U_f^{min} and finally, the distance between the individual averages and the minimum deviations is estimated. This yields the efficiency measure

$$EFF = e^{(\ln \overline{U}_f^{min} - \ln U_f)}$$

In general, this is a simple method, but its simplicity is an advantage where, as here, the underlying population is small and the quality of the data not extremely reliable.

The method of the profit function

As the profit function is the method that I intend to place most reliability on, or at least the method that generates the richest data on efficiencies, I intend to discuss it in some more detail than was the case with the two previous methods.

The main advantage claimed for the use of the profit function is that it allows the decomposition of any inefficiencies into a number of types. These are summarised in Table 1.

Table 1 Taxonomy of Inefficiencies

Type of Inefficiency	Reason
Input Allocative	Bad Input Plans, based on mispriced inputs
Output Allocative	Bad production plans, based on misperceptions of final product prices
Input-Output Allocative	A combination of above
Input Technical	Incorrect input mix
Output Technical	Incorrect output mix

Another advantage accruing from the profit function is that the errors that derive from specification error and mismeasurement are minimised. There is an unresolved controversy in banking regarding the correct treatment of inputs and outputs, broadly defined as the struggle between the "production" school, as typified by the work of Benson, Hanweck & Humphery (1982) and the "intermediation" approach as typified by studies such as this one or Mester (1987). The Production school see the primary function of banks as the accretion of physically greater amounts of assets and liabilities, while the intermediation approach sees the monetary value of the same assets and liabilities as more important. The intermediation approach has its origins in the work of Sealey & Lindsay (1977). Taking this into account, we can see that there are a number of problems.

First of all, misspecification of an output as an input or vice versa may well be expected to result in substantial distortion of the estimated efficiencies. We shall see that the method to be used indicates to us whether or not the data reflect any such misperception. Secondly, there is no clear way to treat the differential quality that may be expected to be exhibited in a multiproduct form such as a banking firm. More inputs are usually required to create a higher quality product, and as such a firm with higher quality than the average across its product range will be seen to be more inefficient, in terms of having a higher ratio of inputs to outputs.

Use of the profit function may realistically be expected to assist the researcher in avoiding or mitigating the effect of these traps. Higher quality usually implies, but not always is realised as, higher revenue. Also, in a profit function, as we shall see, the specification of inputs and outputs proceeds in a symmetric manner. So, there are a priori reasons to suspect that the use of the profit function is inherently to be preferred.

There have been a number of previous studies using the profit function approach, but these have tended to be couched in the Industrial Organisation, Structure-Conduct-Performance and Industrial Economics literature. Very recent work has begun to integrate the efficiency measures and the SCP approach. A detailed list of previous work on the profit function can be seen in Berger-Hancock-Humphery (1982), itself the source material for much of the work that will be presented here.

Towards a formulation

We can define Allocative Inefficiency as the loss of profits that arises when the unit under consideration intentionally makes poor choices regarding the optimal mix of inputs and of outputs. Thus, we have seen that there is input and output allocative inefficiency. We might more correctly define these as input and output allocative *price* inefficiency.

This arises from the definition of intentional as a rational decision based on the prices perceived by the firm. These prices, on which the plans are based, are in fact not necessarily the actual prices, and the inefficiency arises from the price misperception. We can now define technical inefficiency as loss of profit arising from the firms inability to carry out this set of plans, regardless of the quality of the plans themselves.

Traditionally, technical inefficiency is seen as a proportional increase in all inputs, with the resulting or concomitant deviations from the input optimal mix being allocative inefficiency. Thus, this present measure is considerably more general. Estimation of the profit function is best dealt with by a panel data system. The main exogenous factors that affect profits are generally held to be much more time dependent than dependent on the individual firm. This is not quite the case in the present analysis. Table 2 shows the analysis of variance of the transformed profit data (details of the transformation, which is linear, are provided later in the paper).

Table 2 Analysis of Variance of the Profit Data

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Marginal Significance Level
Individual	175.3265	13	13.48666	30.433	0.00
Time	2.353891	3	0.78463	1.771	0.17
Joint	177.6804	16	11.10503	25.059	0.00

We can see that there is a significant degree more explanatory power in the individual effects than in the time effects, but that the joint effect is also significant in explanation of the variance. Thus, we may proceed to an analysis of the time effects, in the knowledge that they are not totally insignificant. These are the input and output prices, the loan rates charged to borrowers, the deposit rates offered to customers, the wages paid to staff, and the cost of the capital base. By and large, these are determined by some base interest rate, such as the Central Bank Overnight Rate, DIBOR or some other reference rate.

Naturally, individual decision making units (DMUs) will offer a range of prices to its inputs and outputs. These will affect the profits made, but it is assumed in the model used here that the DMUs are facing exogenously determined prices beyond their control. Thus, they are in the position of having to vary the variable inputs and outputs to maximise profits. Banks and other companies may treat the prices as exogenous if they either are actually so small as to affect prices, as may be a realistic assumption for many of the DMUs under analysis, or if the prices are set at a fixed rate so as to deter entry or to maintain a cartel, or to comply with regulation. Regardless, it is not possible in this formulation to have firm specific prices which differ from other prices charged in other firms.

Define y and x as the sets of variable outputs and inputs.
Define the vector of variable 'netputs' as q = (y, -x): there are n of these in total.
Variable profits are then defined as p = p*q where p is defined as the set of prices.
Let z stand for the set of k fixed netputs. Jointness or cost complementarities will affect the variable profits by the interaction of the fixed and variable netputs. The profit function in the absence of all inefficiencies is then defined as follows:

$$\pi(p,z)/p_n = \sum_{i=1}^{n} a_i\left(p_i/p_n\right) + \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j/p_n^2\right)$$
$$+ \sum_{r=1}^{k}\beta_r z_r + \tfrac{1}{2}\phi_{ij}\sum_{r=1}^{k}\sum_{s=1}^{k}\phi_{rs}z_rz_s + \sum_{i=1}^{n-1}\sum_{r=1}^{k}\gamma_{ir}\left(p_i/p_n\right)z_r$$
$$Q_i = a_i + \sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j/p_n^2\right) + \sum_{r=1}^{k}\gamma_{ir}z_r$$
$$Qn = a_n - \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j/p_n^2\right) + \sum_{r=1}^{k}\beta_r z_r + \tfrac{1}{2}\phi_{ij}\sum_{r=1}^{k}\sum_{s=1}^{k}\phi_{rs}z_rz_s$$
and $\phi_{ij} = \phi_{ji}$ and $\phi_{rs} = \phi_{sr}$

We normalise by the final netput price for two reasons. First of all, there is imposed linear homogeneity in prices. An increase of x per cent in all input and output prices will result in an increase in variable profits of x per cent also. Secondly, the derivation of the inefficiencies requires that at least one of the variable netput prices be correctly perceived.

Allocative inefficiency is derived by assuming the actions of the firm are as a result of its acting as if it were facing the shadow relative price ratios rather than the actual relative prices. We assume that the firm in fact bases its desired inputs on the shadow price ratio

where the tau factor determines the degree of misperception of the firm at the time of making the decision. It is possible for there to be negative tau factors - the particular characteristics of the banking firm make this possible. In addition, the question of the input or output nature of the netput comes into the matter. A negative tau indicates that the firm has misclassified an input as an output, or vice versa. As was noted earlier, this allows for a check on the specification of the system analysed. If the cost of the funds is less than the return generated by an asset, then it is an output, contributing to profitability. Definitionally therefore, the ratio P_j/P_n will be positive. If we encounter a negative tau, then we have evidence that the DMU is acting as if $P_i < 0$. As we have defined this to be the case only where the price refers to an input, the sign of the tau factor is a check on the empirical dynamics of the DMU. See Hancock (1985) for further details.

Technical inefficiencies are those that arise from the deviation of the actual production from the optimal production. We may define these as below, where the * technology is the desired level. In that case, the technical inefficiencies are given as:

The *desired* production level is the level that the firm would achieve were the shadow price vector $\tau\Theta p$, where Θ is the Hadamard product such that each element of p is multiplied by the corresponding element of the tau vector. The *optimal* level of production and profit would be where there were neither technical nor allocative inefficiencies.

The interpretation of these technical inefficiencies differs across inputs and outputs. In outputs it refers to an underproduction of that output relative to the desired level, and in inputs it refers to an overuse of the input relative to the desired level of use. These measures of inefficiency are derived by reference to their effect on the profit function, in practice. The function is the profit that arises from the multiplication of the actual netputs by the actual prices. The types of inefficiency are then derived as the following.

<u>Total Allocative Inefficiency</u>

$$\sum_{i=1}^{n-1}\sum_{j=1}^{n-1}\phi_{ij}\left[\frac{1}{2}-\left(1-\frac{1}{2}\tau_i\right)\right]\tau_j\left(\frac{p_i p_j}{p_n}\right)$$

This equals the reduction in profits arising from a misperception of all the netputs, where the tau factors are the misperceptions. In both sides of the equation are present the technical inefficiencies. Thus, we accept that the firm may carry out plans badly, but we are here isolating the effect of only having the wrong plans, not the poor implementation of same.

<u>Input Price Allocative Inefficiency</u>

$$\sum_{i=m+1}^{n-1}\sum_{j=m+1}^{n-1}\phi_{ij}\left[\frac{1}{2}-\left(1-\frac{1}{2}\tau_i\right)\right]\tau_j\left(\frac{p_i p_j}{p_n}\right)$$

We may define these as the reduction in profits that arises from the input prices only being misperceived. That is to say, we correctly perceive the output prices but not the input prices. Traditionally estimated cost functions will miss some of the effects here, as the perception of inputs as relatively cheap will probably be associated with the overproduction of those outputs which are intensive in the use of these misperceived factors.

Output Price Allocative Inefficiency

$$\sum_{i=1}^{m}\sum_{j=1}^{m}\phi_{ij}\left[\frac{1}{2}-\left(1-\frac{1}{2}\tau_i\right)\right]\tau_j\left(\frac{p_i p_j}{p_n}\right)$$

Similar to the input measure, this looks at the reduction in profits arising from a misperception of the output prices only.

Input-Output Price Allocative Inefficiency

$$\sum_{i=1}^{m}\sum_{j=m+1}^{n-1}\phi_{ij}\left[\frac{1}{2}-\left(1-\frac{1}{2}\tau_i\right)\right]\tau_j\left(\frac{p_i p_j}{p_n}\right)+$$
$$\sum_{i=m+1}^{n-1}\sum_{j=1}^{m}\phi_{ij}\left[\frac{1}{2}-\left(1-\frac{1}{2}\tau_i\right)\right]\tau_j\left(\frac{p_i p_j}{p_n}\right)$$

The measure here looks at the total interaction effect of the misperceived inputs and output prices.

Total Technical inefficiency

$$\sum_{i=1}^{n}\xi_i p_i$$

The measure of total technical inefficiency is the effect on the profit function of only having carried out the actual as opposed to the desired plans, albeit based perhaps on the misperceived prices for inputs and outputs. Again, this measure can be broken down into input and output measures.

Input Price Technical Inefficiencies are given as $\sum_{i=m+1}^{n}\xi_i p_i$

while

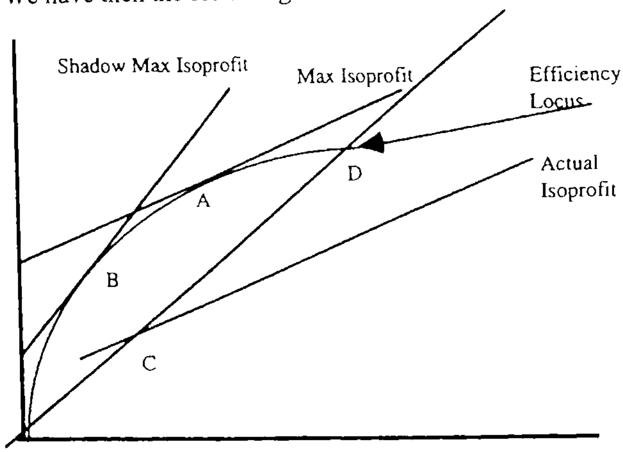
Output Price Technical Inefficiencies are given as $\sum_{i=1}^{m}\xi_i p_i$

These measure, respectively, the effect on the profit function of having only technical inefficiencies on the input or output side only. In the case of output Technical Inefficiency, there is an overproduction of outputs relative to the desired level, in the input case an overutilisation of inputs.

Intuition and Algebra

In this section I intend to discuss the concepts outlined above from a geometric viewpoint. As we shall see, using the method of shadow prices allows us to escape from the radial straight jacket. The advantage is that we are no longer required to assume that the desired product or input mix is equal to the actual product or input mix.

Start with the assumption that there is one variable output and also that there is one variable input. We have then the following situation.



The efficiency locus is the locus of production that an efficient firm would choose. It shows the transformation of the variable input into the variable output. Profits are maximised at point A, where the locus is tangential to the maximum isoprofit line. The slopes of these are equal to 1/((Input price)/(Output price)) at this point. In actual fact, production takes place at point C, in the interior of the set. This is clearly not efficient. The total inefficiency is determined, from the profit function approach, as the loss in profits arising from this mismatch. We can define this as being $P(\zeta^*_A - \zeta^*_C)$ where P is the vector of prices and ζ^* is a point on the efficiency locus.

The firm would desire to produce at point B, where the shadow isoprofit line is tangential to the efficiency locus. Here, the slopes are equal to 1/((Input price)/(Output price)) i.e. as adapted by the tau factor referred to above.

We now can decompose the inefficiency into allocative and technical terms. The allocative efficiency measure is the difference between being at point A, the maximum profit level, and point B, the desired level. This is measured as $P(\zeta^*_A - \zeta^*_B)$ while the technical efficiency measure is the measure of being at point C in fact when the desired production takes place at B, or $P(\zeta^*_B - \zeta^*_C)$.

In the real world, the analogy to this model will be where there is a number of (potentially variable) outputs and inputs, and the dimensionality of the model will be greater than two. Thus, there will be a hyperplane corresponding to each of the lines above and real analytic techniques will be required.

3. ESTIMATION OF THE MODEL

The model in full, with the t factors included for the derivation of the allocative inefficiencies and the x factors included for the technical inefficiencies, plus the error terms, is as follows[2].

$$\pi(p,z)\Big/p_n = \sum_{i=1}^{n} a_i\left(p_i\big/p_n\right) + \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j\big/p_n^2\right)$$

$$+\sum_{r=1}^{k}\beta_r z_r + \tfrac{1}{2}\phi_{ij}\sum_{r=1}^{k}\sum_{s=1}^{k}\phi_{rs}z_r z_s + \sum_{i=1}^{n-1}\sum_{r=1}^{k}\gamma_{ir}\left(p_i\big/p_n\right)z_r$$

$$Q_i = a_i + \sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j\big/p_n^2\right) + \sum_{r=1}^{k}\gamma_{ir}z_r$$

$$Qn = a_n - \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1}\phi_{ij}\left(p_ip_j\big/p_n^2\right) + \sum_{r=1}^{k}\beta_r z_r + \tfrac{1}{2}\phi_{ij}\sum_{r=1}^{k}\sum_{s=1}^{k}\phi_{rs}z_r z_s$$

and $\phi_{ij} = \phi_{ji}$ and $\phi_{rs} = \phi_{sr}$

This is very similar to the traditional cost studies, with share equations. Again, one of the output share equations is dropped, in this case the n'th equation. Also, it is obvious that this is a system and as such has to be estimated by system means. This poses a problem, one of under-identification.

There are, in the profit equation, a total of (n-1) (n-2) different ϕ elements. plus (n-1) τ coefficients. This has to be estimated from a linear relationship in the variables. It is only by reference to the (n-1) share equations each of which has (n-1)$\phi\tau$ terms each that we can determine the actual factors under analysis. Otherwise the under-identification of the profit equation, with (n-1) too many parameters to be estimated from it alone, would be insurmountable. In addition, as the problem is essentially one of degrees of freedom, a typical or average set of tau factors is identified, with the interpretation being that these are the industry average tau factors. The individual banks under analysis will face different allocative inefficiencies according to the degree to which they face different market determined prices for the inputs. Thus, only (n-1)τ factors are determined here from the cross equation restrictions. We may however, estimate firm specific technical inefficiencies.

We can determine the average technical inefficiency of an individual bank over time. If we make the assumption that the technical inefficiencies over time are the long-run inefficiencies and that they are uncorrelated with the exogenous factors, then over time the residuals of the equations are expected to converge to zero The procedure then is to measure the inefficiencies in a manner similar to that of the method of average residuals. For the n'th netput, technical inefficiency is measured as the difference between the maximum average error over all banks of the profit equation and the actual average error of the bank under question. For the other (n-1) netputs, the measure is given as the difference between the maximum average netput equation error over all banks and the actual average netput error of the bank. This measure ensures that the bank having the highest profit above the predicted level or the bank with the highest netput above the predicted level is measured as being fully technically efficient for that netput.

The dataset

One of the other main advantages in the Irish situation of using the profit function is the availability of data. While profit as such is not always identifiable from the balance sheets of the company, additions to reserves are. We may define these as (profits less tax plus depreciation). This, instead of actual profits, is the measured variable here. Why is it necessary to use this measure?

There are two main reasons, both of which fall into the regulatory scheme of life. In the first place, the banks that operate in this country are regulated in terms of their operations, capital adequacy, and liquidity by the Central Bank of Ireland. In terms of their annual accounts and reports to the public, they are regulated by the provisions of the companies acts. These have as a side effect the fact that companies that are incorporated as branches of foreign banks are not required to furnish the same degree of information to the public as are domestically incorporated plc banks. All banks must however make a summary balance sheet available to the public, and this is the only source of publicly available data comparable across banks. The second reason is the inability of the Central Bank to make available the information collected by it in the course of its regulatory duties. Indeed, the bank and its officers are prohibited by law from so releasing information.

An enormous and detailed amount of information is submitted to the Central Bank by banks and building societies on a monthly basis. These data form the basis of the banks regulatory and statistical monitoring function. Yet, unlike the USA where the data derived from the Call Reports and the Functional Cost Analysis Report (for larger banks) are made available to researchers, these data are not so made available in Ireland. No legal mechanism exists for making such data as are collected in Ireland available to the public.

It is clear that there is a major difference between the two countries' approaches to banking data, legally speaking. These data are valuable only so long as there is secrecy - were they to be made publicly available for all reportage then there would be the same level playing field as is there at the present, save the fact that the public would have that much more information on which to base its analyses and its opinions. At the least, bank specific data on the major elements should be considered for publication - the NYSE requires a placement document to be published with information on the company placing shares or ADR's, which in the case of Allied Irish Banks involved the publication of data that were previously unavailable.

The banks chosen for analysis were dictated by two issues - firstly, the availability of data in the manner described above, and secondly the desire to achieve a spread of types of banks. Those eventually chosen were Allied Irish, Bank of Ireland, Banque Nationale de Paris, Industrial Credit Corporation, Agricultural Credit Corporation, Anglo Irish Bank, Irish Intercontinental Bank, National Irish Bank, Woodchester Investments, Cork & Limerick Savings Bank, Hill Samuel Bankers, Ansbacher & Co, Lombard & Ulster Bank, and Westdeutsche Landesbank. Data for 1988-1991 were used, except in the case of Westdeutsche where data for 1990 & 1991, and Lombard & Ulster where data for 1988 & 1989, were used.

An additional restriction is provided by the relatively small dataset and the explosive nature of the parameters of the model. An additional one variable netput will cause there to be n+k+2 more parameters (one a parameter, one more t parameter, k more g parameters and n more f parameters) to be estimated. In order to meet the requirements of parsimony, of realism, and of assisting in the use of the profit function the variables as shown below were chosen. At least two variable inputs and two variable outputs have to be chosen, to allow for demonstration of the intersection terms. The data are not all of the same time period, as banks have differing end-of-years. Accordingly, although the data are marked "1988" etc., in some cases this could be March 1988 and in others September 1988. This is not so much of a problem as it may seem, as the focus of this paper is to look at the applicability and testability of the approach, and to investigate some of the determinants of the results.

Loans in total and investments were chosen as the outputs, while the variable inputs were chosen to be other funds and staff numbers. As stated, the data restrictions are so severe that, unless one decides to go for the main public banks (Allied, Bank, Anglo, Woodchester, ICC, ACC) aggregated data are used of necessity. Investments in stocks, bonds, and other securities are chosen as an output also, reflecting the perception that Irish banks are relatively advanced towards the integrated bank with treasury functions as an integral profit centre rather than the traditional hedging role. See for example the comments inter alia in Dixon (1991).

The fixed netputs, to use the terminology of the paper, were decided to be fixed assets, a proxy, albeit very poor, for physical capital, and deposits. The choice of deposits as an input is somewhat controversial, but can be justified by a number of rationales. Firstly, it is consistent with the intermediation approach of banking analyses. In addition, the work of Flannery indicates an approach which banks may take - deposits are essentially determined by events outside the determination of the unit, and can be added to substantially only by changing the size and scale of operation. These are called Core Deposits however, that is to say small deposits. This is less applicable here as the data on deposit are inclusive of the small savings of the widows and orphans as well as the large corporate savings. Again, the research is severely hampered by the lack of adequate data, in marked contrast to the situation that pertains in the USA.

Choice of the prices of the netputs is crucial, as the derivation of the inefficiencies and the efficiencies arises from the shadow or misperceived prices. Thus, if the prices chosen for parameterisation are incorrect, the measures also derived from these will of necessity be incorrect. The work of Berger-Hancock-Humphery uses as the prices the flows of net income or net outflows by the average balance. This is as a result of the data used there being averages of three reporting dates within each year.

While this seems intuitively appealing, there are problems with it. In the first place, the approach assumes that the average balances and the average flows are of the same duration and magnitude. No account of leads and lags is taken, and this causes some noise in the process. Secondly, no account is taken of the potential differing yield spectrums of banks. Finally, interest accrued but not credited is not taken into account.

In the Irish case, we face some of these problems also. In the first place, there are no data available on the income flows of the banks, certainly not the sort of useful product line specific data that the US researchers are in possession of. In the second place, there is no account taken of the accruals and of the maturity spectrum differences. The data on accruals are available in aggregate, but there is no detail of the bank specific nature of these, nor of the specificity of the product lines to which the data relate. Contrast again with the US situation.

Taking all of these factors into account, what are the prices chosen? They were as set out in Table 3.

Table 3 Netputs and Prices Chosen for Analysis

Netput	Price Assumed
Loans	AA Overdraft Rate
Investments	E-Bill Rate
Other Funds	Central Bank Overnight Rate
Staff Numbers	CSO Wage Index for Banking Industry

As may be seen, these are not so much prices as opportunity costs. Only for staff numbers are the data relatively clean. In this case, however, the costs are attributed to all staff as being the same - this is clearly not the case. Executives, Officers and Managers are paid multiples of the standard bank official's wage. The CSO index is an average of wages from a census survey.

The result of this is that there are certain to be divergences from these "assumed" prices compared to the actual prices faced by firms. We may make the following broad assumptions. Staff costs are probably closest to the actual prices faced by firms, and this provides a rationale for the normalisation of all prices by the wage index, as will be seen later. The revenue derived from loans is assumed to be charged at the overdraft rate for AA customers. These are customers in the medium sized category - but Table 4 shows the changing distribution of credit as measured by the central bank. The majority of the rises were in the sectors that include mortgage finance, which is generally at a lower rate than the overdraft rate, and the falls were in the manufacturing and construction areas.

Accordingly, it is probable that the AA overdraft rate is a reasonable proxy for the overall return on loans, but may be so only by dint of severe aggregation and aggregation luck.

Table 4 Summary Changes in Credit by Period, Bank and Sector

	Primary & Construct.	Manufacts.	Finance	Services	Other
1980-87					
All Banks	35 % Fall	28 % Fall	110 % Rise	45 % Rise	2 % Fall
Associated	24 % Fall	2 % Fall	135 % Rise	25 % Rise	1 % Rise
Non-Associated	41 % Fall	53 % Fall	51 % Rise	52 % Rise	98 % Rise
1987-1991					
All Banks	15 % Fall	18 % Fall	38 % Rise	27 % Fall	47 % Rise
Associated	14 % Fall	31 % Fall	127 % Rise	3 % Fall	9 % Rise
Non-Associated	34 % Fall	3 % Fall	18 % Rise	43 % Fall	150 % Rise

The use of the Central Bank Overnight Rate reflects the idea that this is the ultimate source of liquid funds for the financial sector. In reality, many of these other funds are floating or fixed rate bonds and debentures, issued at rates that are generally greater than the LIBOR/DIBOR rates - any estimates using these data are thus possibly understating the true cost of such funds. The use of the E-Bill rate is another limit case - the E-Bill rate is as close to the perfect riskfree asset rate as is possible to get in Ireland. As a result of the banks holding their asset investments in government gilts, which are not riskless and are subject to both speculative and fundamental based revaluation, and in equity investments which are inherently risky, it is almost certain that the rate of return on the investment function is too low, as proxied here. Thus, the actual rate may well be higher. Accordingly, the calculated ratios of these prices to wages are probably too low. Assistance on this area, regarding the appropriateness of the proxies, and alternatives available, would be appreciated.

Estimation

Table 5 shows the parameter estimates for the model. The model was estimated over the period 1988-1991 inclusive, using the RATS 4.0 statistical modelling system. The estimates were achieved by non linear numerical approximation, using the system of multivariate non-linear least squares. The data were firstly divided by their mean.

Table 5 Parameter Estimates of the System Unadjusted for Heteroscedasticity

Variable	Coefficient	Standard Error	T Statistic	Marginal Significance
a1	-0.7273017	1.28577851	-0.56565	0.57163112
a2	0.51043805	1.38457895	0.36866	0.71238161
a3	2.98311088	1.80001727	1.65727	0.09746531
a4	-1.7069648	1.0619843	-1.60734	0.10798081
f11	2.18795933	2.69075317	0.81314	0.41613772
f12	1.42758211	2.17146981	0.65743	0.51090662
f13	-4.8727045	6.0807598	-0.80133	0.42293973
f22	-6.2025829	29.7381426	-0.20857	0.83478134
f23	0.67907104	11.9300122	0.05692	0.95460794
f33	-15.109090	55.0711767	-0.27436	0.7838113
b1	4.07661482	3.24208508	1.25741	0.20860691
b2	-4.6344203	3.61431707	-1.28224	0.19975861
q11	-4.1694900	3.13693346	-1.32916	0.1837948
q12	4.5976522	3.28901528	1.39788	0.16214877
q22	-5.2200377	3.47829684	-1.50075	0.13342143
g11	-0.4269897	0.19811496	-2.15526	0.03114131
g12	0.79980613	0.21904516	3.65133	0.00026089
g21	0.57735608	5.35444749	0.10783	0.91413262
g22	1.52087427	6.03251221	0.25211	0.80095378
g31	-3.5236028	4.32312721	-0.81506	0.41503865
g32	2.15348314	4.83397228	0.44549	0.65596615
t1	0.6876639	0.7651403	0.89874	0.36878997
t2	0.09424971	0.45836812	0.20562	0.83708765
t3	0.05354209	0.17215346	0.31101	0.75579016

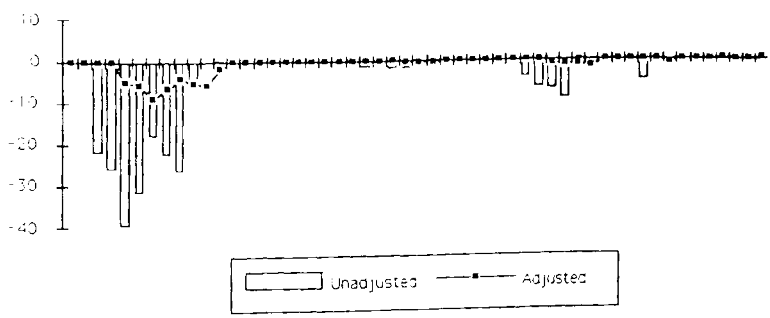
R^2 = [illegible]9

We see first of all that the tau factors are all positive. This implies that the banks are not misperceiving, or are modelled as not perceiving inputs as outputs and vice versa. The classification of netputs adopted above therefore agrees with the data - loans and investments are seen, according to the model, as outputs, and staff costs and other funds as inputs.

We note however that all of the tau factors are less than 1, but are not significantly different from zero. This means that in the case of the inputs, or in this case the input, the banks wish on average to employ more of it than would be warranted by the relative price to labour. In the case of outputs, they wish to produce less than the profitable levels. Thus, in the case of inputs, banks in Ireland are modelled as wishing to use less labour relative to other forms of inputs, proxied here by other funds. The banks also seem to wish to produce less of the investment and loan outputs. As we note, the tau factor on the loans variable is considerably closer to one than the factor on the investment output. This indicates that there is less mispricing on the traditional output of banks than on the relatively new investment profit centre.

Heteroscedasticity is however present in the residuals, especially those of the profit function. See Chart 1 for the evidence - the AIB and Bank of Ireland Data tend to clump together, as might be expected. The two banks are by far the largest of the banks in the sample, and might well be expected to exhibit different characteristics from the remainder of the banks and institutions. However, to exclude them from the analysis would be wholly unsatisfactory, as they do represent the largest forces and should be examined. As they cannot realistically be examined over a long term, of which more later, the only alternative if we wish to examine them at all is to include the data in the dataset. The graph below shows the residuals of the profit function prior to and after adjusting for heteroscedasticity. It is clear that after the adjustment process, while there is still clumping, it is much less pronounced than prior to the adjustment.

Chart 1: Residuals of the Profit Function



Accordingly, the data were re-examined with a heteroscedastic consistent procedure (i.e. White (1980)) being utilised. The results are as shown in Table 6.

Table 6 Parameter Results - Adjusted for Heteroscedasticity

Variable	Coefficient	Standard Error	T Statistic	Marginal Significance
a1	-0.2963512	0.24201665	-1.22451	0.22076075
a2	0.33150611	0.15813542	2.09634	0.03605177
a3	0.01691915	0.11838170	0.14292	0.88635311
a4	-0.0107609	0.12939038	-0.08317	0.93371907
f11	0.48719511	0.22691214	2.14706	0.03178811
f12	0.42062472	0.14304564	2.94049	0.00327690
f13	-0.8677947	0.26758646	-3.24304	0.00118260
f22	-0.1667651	0.10330101	-1.61436	0.10644917
f23	-0.2877197	0.20451182	-1.40686	0.15946859
f33	0.22382568	0.11620965	1.92605	0.05409805
b1	-0.0579106	0.04928325	-1.17506	0.23997197
b2	-0.3289574	0.05885302	-5.58947	0.00000002
q11	0.30887847	0.04998705	6.17917	0.00000000
q12	-0.3245395	0.05181118	-6.26389	0.00000000
q22	0.34169191	0.05403522	6.32350	0.00000000
g11	-0.0303575	0.07513670	-0.40403	0.68619018
g12	0.58811584	0.08416198	6.98790	0.00000000
g21	0.10514390	0.06987458	1.50475	0.13238789
g22	-0.1392532	0.08277390	-1.68233	0.09250435
g31	-0.0835765	0.07092993	-1.17830	0.23867799
g32	-0.1156538	0.07991180	-1.44727	0.14782155
t1	1.59220831	0.24962885	6.37830	0.00000000
t2	1.23127064	0.15831597	7.77730	0.00000000
t3	0.64655955	0.45877066	1.40933	0.15873741

R^2 = [illegible]

By contrast with the previous, unadjusted model, this model rapidly achieved convergence. Consequently, there is a substantial difference between the estimated parameters. This arises due to the nature of the estimation process, which is dependent on the covariance matrix, such matrix being adjusted by the White process.

The most important elements are the tau factors, which have altered from their previously low levels to levels indicating a different degree of mispricing, but one that is closer to the true shadow prices. Note that we have many more significant coefficients in this case than was the case prior to adjusting for heteroscedasticity.

In the case of Loans, the tau factor had previously indicated that the perceived shadow price, relative to labour was 68 per cent of the actual price. The implication then was that banks wished to create less of the output than was optimal. Now, the situation is reversed - the level of tau at 1.59 is greater than 1, indicating that the banks would like to produce more of the output than the actual relative price indicated as profitable.

In the case of Investments, the previous price relative was of the order of 10 per cent, and the incentive would be to produce less than was profitable. Now the relative price vector is 1.23, indicating that the banks misperceive investments less than the traditional loan products. However, again the model indicates that the banking sector wishes to produce a level of investments which is greater than the relative process would really indicate.

Finally, we see that the input tau factor is still less than 1, indicating as before that the banks wish to overuse the input, relative to the labour input. Thus, banks still relatively undervalue labour relative to other inputs. The degree of misperception is reduced considerably, the relative shadow price vector going from 5 per cent to 64 per cent of the actual price vector. We should recall however our impression that the ratio for the input netputs is probably lower than the real ratios faced by banks. If this is the case, then the tau factors estimated here are lower than the real tau factors.

It should be realised that these are estimates based on relative prices. We cannot a priori say where the deviation of price relatives comes from - we have assumed that labour is correctly measured, but this may not be the case in reality. As the measures here suggest, there is no evidence of a need to substantially cut back on the labour component of the banks inputs - there is evidence indeed that there may be a need to more efficiently use the inputs. This is seen clearly in the next table.

Table 7 Analysis of Inefficiency - Heteroscedasticity Adjusted

		% of Average Profits	% Of Total Inefficiency
Total Inefficiency	3.55	20.76 %	100.00 %
Allocative Inefficiency	0.62	3.63 %	17.46 %
Input Allocative Inefficiency	0.03	0.18 %	0.85 %
Output Allocative Inefficiency	0.59	3.45 %	16.62 %
Technical Inefficiency	2.93	17.13 %	82.54 %
Input Technical Inefficiency	0.71	4.15 %	20.00 %
Output Technical Inefficiency	2.22	12.98 %	62.54 %

The significant changes in the model's parameters when adjusted for the heteroscedasticity-inducing extreme differences in size of banks has had a marked effect on the estimates of profit lost. Previously, the estimate was that total losses due to inefficiencies amounted to over 100 per cent of the average realised profit. Now, this is reduced to a level of just over 20 per cent. In the Berger-Hancock-Humphery article we see that the losses ranged form 70 per cent to 42 per cent, depending on the regulatory regime. Again, the preponderant part of the loss is due to technical inefficiency, rather than to allocative inefficiency. As noted above, this implies that the banks are not formulating poor plans, necessarily, but are poor at implementing them. In the context of the recent debates about the need to cut the cost base of the banking sector, we see that the main problem arises on the output side rather than on the input side. The banks would seem from this model to have a problem regarding the mix of outputs as opposed to the mix of inputs. It should be borne in mind that this is a very sparse model of reality. As such, the results should be taken cautiously. However, even if there were overestimation by a large factor, that would still imply a major problem.

We note that there is an absence of the Input-Output allocative inefficiency. This arises due to the fact that there are negative factors in all derivations of the inefficiency types. These are set to zero. If one examines the parameters, and the definition of the input-output price allocative efficiency measure, it is clear that in this case there are no measurable effects. This is a weakness of the model, and should not be taken as a reflection of no actual interaction effects.

We also see that there are interesting differences regarding the input/output mix of inefficiencies. As adjusted above, the output or revenue generating side, resulted in 78 per cent of the inefficiencies. Of this, Output technical inefficiency, accounting for 63 per cent of all inefficiencies, is the most relevant. Thus, by not producing outputs in the appropriate manner, Irish banks are losing the equivalent of 13 per cent of the realised profits.

As analysed by Gorton & Rosen (1992), this issue of technical inefficiency is a common problem. One possible explanation of this may be the encroachment of non-banks in to the traditional output areas. This has certainly occurred in Ireland, but by and large after the period of analysis. Over-capacity, which has been discussed previously in this forum, is another potential problem which can lead to this difficulty.

As an attempt to analyse this, in the appendices are shown rank correlation analyses of the inefficiency measures with total assets and numbers of branches. It is interesting to note that there is a significant negative trend in the relationship between branches and the inefficiencies, but a positive trend, and more strongly so, between total assets and the inefficiency measures. This is surprising, in light of the issues discussed above and in light of the fact that asset size and branch numbers tend to be highly correlated.

We also note that the total technical and allocative inefficiencies tend to rank strongly together - a bank with a very high ranking in one will more than likely have a high ranking in another.

4. COMPARISONS WITH OTHER STUDIES IN IRELAND

This section looks at the recent studies by researchers involving data for the two main Irish banks. The first is McKillop & Glass (1991); the second Glass & McKillop (1992).

The 1991 paper looks at the internal workings of Allied Irish Banks; the 1992 paper at Bank of Ireland. The 1991 paper examined the Allied Irish Bank from 1972 to 1988. This in itself is interesting, as over the time period under examination, one might well expect enormous variation in the efficiency and technological characteristics of any institution, let alone one characterised by as rapid an advance in technology, in the broadest sense, as banking. In addition, the number of data points for analyses is so small, relative even to this paper, as to make on wonder about curve fitting.

A traditional (2 output 3 input) cost function was analysed. Outputs were advances (loans) and investments, as was the case here, and the inputs staff costs, capital costs and deposit costs. Again, the inputs are similar to the non-cost versions used here. AIB was analysed as suffering from diseconomies of scale. There was no evidence of cost complementarity nor of economies of scope. Efficiencies as such were not examined.

In the 1992 paper, the authors examined Bank of Ireland. The inputs and outputs, the estimation procedure, and the period of analysis (1972-1990) were broadly comparable to the AIB situation. Also, there was no evidence of economies of scale: slight but significant diseconomies being found. Again, neither cost complementarity nor economies of scope were found.

The overall impression from these two papers is one of a set of banks that are not terribly efficient and beginning to suffer from oversizing. The appendices show the bank specific measures of inefficiency and it is obvious that there are significant levels of inefficiency in the system

For AIB and Bank of Ireland, however, these levels are not noticeably greater than for other banks. We must therefore conclude that the data analysis does not show AIB/BOI in a bad light.

5. OPTIMAL SCOPE ECONOMIES

One issue that has not been addressed in this paper as of yet is the issue of the optimal scope of Irish banks. Traditionally, scope economies are said to exist if the cost of joint production of the bundles of outputs is less than the sum of the costs of producing the bundles independently.

It does not ask the question of whether joint or specialised production is optimal. Cost subadditivity studies ask a more general question than scope economies: whether across all firms in the sample there is a firm that, with the same output bundle, could produce them more cheaply. A yet more general concept, that of competitive viability, asks if the cost, adjusted for scale effects, could be lower at any output scale in the sample. But, they all are asking the question of observed mixes, and are also asking the question of firms off the technically and allocatively efficient frontier. If we can ascertain that for the optimally producing form it is worthwhile specialising or not, then there is sense in investigating the more specific measures discussed above. Otherwise, the search is for an unattainable ideal.

The test for optimal scope economies here is to look at the optimal outputs (defined as the outputs predicted with no technical or allocative inefficiencies) and ask whether or not the outputs are always positive. There are two approaches to this. The first is to look at the calculated optimal outputs and test the minimum such level for difference to zero. If the minimum is negative, or significantly different and positive, then we conclude that there are optimal scope economies throughout the data. An alternative is to look at the universe of prices and parameters and test if the minimum of this universe is statistically different from zero. If it is, then again we conclude that the joint production is optimal. Also, if the predicted level for all banks in all time periods is never negative, that is to say, all banks are predicted to have a positive optimal level of production in all time periods, then we conclude that there is so called global optimal scope economies. This is not the case here, as there is always at least one bank for which, in one time period there is a predicted optimal negative level. Table 8 gives the results.

Table 8 Testing for Optimal Scope Economies

	Loans	Investments
Calculated Minimum	-2.457450833	-0.49278757

The result of the test is that in all cases we can conclude that the minimum level is significantly different from zero. Thus, there appears to be evidence that Irish banks should not specialise in general. We cannot rule out the possibility that individual banks should so do. This is in marked contrast to the 1991 and 1992 studies carried out by McKillop & Glass. It should be realised that the two sets of work are considerably different.

6. WHAT DOES IT ALL MEAN ?

What we have seen in this paper is fourfold. There is a necessary distinction to be drawn between rent and profit. Rent (profit) is that return to capital required to remunerate. Pure profit on the other hand is a much more Schumpeterian concept, with its origins in areas that are correlated with potential for inefficiency, such as market power, or differential property rights.

Secondly, the traditional cost/production models, as extensively used in the literature, are seriously flawed, or if that is too strong a word, possessed of a degree of dimensionality less than that required to accurately mirror the real world. The Berger-Hancock-Humphery model of inefficiencies as derived from the profit function does address these issues, at least in principle.

Thirdly, this model is applicable in the Irish circumstance. It is severely hampered by the relative dearth of information on individual banks. Regardless, it does have applicability.

The results of the analyses are such as to indicate a severe degree of inefficiency in the industry. A degree of inefficiency equal to a substantial portion of the realised profits of the industry is consumed by various inefficiencies. Of these, technical inefficiency on the output side is by far the most predominant. That is to say that an amount equal to 40 per cent of actual realised profit is lost due to banks carrying out their revenue raising plans badly. The real question, and one whose surface is barely scratched here, is why that should be so?

Fourthly, there is evidence of optimal economies of scope. This implies that, in contrast to previous studies of Irish institutions, it is not possible to say that Irish banks should not continue in the direction of joint provision of services such as Loans and Investments.

Towards a possible solution

What we are seeing exhibited is a persistent and widespread managerial failing - the failure to act up to the optimal level. In this paradigm, the proximate cause is the misperception of shadow process. In the search for the ultimate cause, we will have to examine a number of different areas of managerial thought. Organisational theory, issues of corporate culture, different human resource strategies, the role of agent theoretic issues in the setting of goals; all of these are possible, and probable, interacting causes of managerial inefficiency. Research under way in the School of Business Studies attempts to integrate these issues.

Work in the USA has begun to address the determinants of the persistent inefficiencies exhibited there. Much of this addresses two issues of concern arising from recent experience. This is the issue of organisational form (branch vs. unit site, cross state vs. within state) and agent theoretic (evidence of expense preference, CEO-Chairman affiliation, outside vs. inside directors). A useful set of references is to be found in the paper by Berger, Hunter & Timme (1993).

In Ireland, a number of possible issues are applicable. The first is the issue of Irish vs. Branch banks. This is possibly an analogy to the branching-unitisation argument in the USA. Another issue is that of market share. There is a discussion regarding the applicability of the dominant firm hypothesis, wherein firms that are dominant are so due to inherent efficiency and the general agency model, where larger more dominant firms are likely to exhibit more inefficiencies. This would arise from the increasing degree of market imperfections that a large firm is likely to show. Care must be taken in the Irish context when analysing the market share data so as not to so define it as being equal to Bank of Ireland and Allied Irish Banks. Accordingly, I have defined it as a bank in any period having a large market share if the share of loans is greater than the median share of all banks over the sample period. Detailed analyses are available. These are summarised in Table 9.

Table 9 Direction and Significance of Variables in Explaining Inefficiencies

Dependent Variable	Constant	Year	Irish Owned	Associat-ed Bank	Number of Branches	Big Share
Total Inefficiency	1 %	1 %	10 %		10 %	
	-	+	-		+	
Total Allocative		10 %	5 %	5 %	5 %	10 %
		+	-	-	+	+
Total Technical	1 %	1 %				
	-	+				
Input Allocative	1 %	1 %				
	-	+				
Input Technical	5 %	1 %	5 %			10 %
	-	+	-			+
Output Allocative	10 %	5 %	5 %	5 %	1 %	10 %
	-	+	-	-	+	+
Output Technical	1 %	1 %				
	-	+				

It should also be noted that in the analysis of variance presented in the appendix, in all cases the time dimension was important, the individual dimension not important.

We can thus see a number of issues arising.

The role of Time:

While the earlier work indicated that there was no great explanatory power in the time variable, although it was by no means negligible, we now see that for the most important of the calculated inefficiencies, there is indeed some significant explanatory power in the time dimension. There appears to be an increasing tendency for inefficiency to rise over time. This is confirmed if we do an analysis of variance examination of the inefficiencies, as shown in Appendix 2.

Market Share

We cannot comment with certainty on the influence of market share, and therefore are not in a position to discuss in detail the applicability of either the general agency model or the dominant form hypothesis. What we can say however is that there is a positive, albeit relatively insignificant relationship between the degree of inefficiency and the possession of a market share greater than the median market share. If anything, this tends to support the general agency model, although this will require a great deal more analysis.

Associated vs. Non-Associated Status

There is some explanatory power in the associated banks variable. Interestingly, this is opposite in sign but greater in significance than the big share variable. There are two possible explanations: the indication of a dominant firm in action, as the associated banks in the sample are amongst the very largest, or the ability of these to operate closer to the efficient frontier for some other reason. Obviously some greater work on the size-efficiency relationship is required.

Ownership

Again, there is a set of negative, significant relationships evident for the Irish banks. This may reflect greater knowledge of the local conditions, or it may reflect the somewhat more general nature of the Irish owned banks as opposed to the specialising nature of the non-Irish owned banks.

Thus, in conclusion, we can express some satisfaction with the applicability of the model. Where it falls down is in the detailed data being unavailable. Such data as are available indicates that there are significant technical and allocative inefficiencies, with the technical dominating. We also have the issue of economies of scope - if the banks were to be in a position to eliminate the inefficiencies, then there would be scope economies, of some uncalculated measure, to be found. The potential losses are large, but even were they to be overestimated ten-fold, then this would still represent a substantial dead-weight loss to the economy. A more efficient financial sector implies a more efficient economy in toto, with greater profits in the banks being available for redistribution throughout the system. The evidence here is weak, but does point in the direction of inefficiency rather than efficiency being the norm. This in turn has significant implications for the management of the banks, for the regulators of the banks, and for the customers and staff of the banks.

Footnotes

1. Define $\sigma^2 = \sigma_i^2 + \sigma_u^2$

   where i is the managerial one sided inefficiency term, and u the random error term

   Define $\mu_* = {-\sigma_i^2 e}/{\sigma^2}$ and $\sigma_*^2 = \sigma_i^2 \sigma_u^2 / \sigma^2$

   Then

   $$E(i \mid e) = \mu_* + \sigma_* \frac{f\{-\mu_*/\sigma_*\}}{1 - F\{-\mu_*/\sigma_*\}}$$

   Noting that if we set $\lambda = \sigma_i / \sigma_u$ then $-\mu_*/\sigma_* = {e\lambda}/{\sigma}$ we can rewrite this as

   $$E(i \mid e) = \sigma_* \left[\frac{f\left(e\lambda/\sigma\right)}{1 - F\left(e\lambda/\sigma\right)} - \left(e\lambda/\sigma\right) \right]$$

   where f is the cumulative normal density and Fthe standard normal density function.

2. A full derivation is available on request.

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Spearmans Rank Correlation Coefficient Table

	Total	Total Allocative	Total Technical	Branches	Input Allocative	Output Allocative	Input Technical	Output Technical	Total Assets
Total	1.000								
Total Allocative	0.752	1.000							
Total Technical	0.993	0.738	1.000						
Branches	-0.163	-0.040	-0.134	1.000					
Input Allocative	0.958	0.745	0.957	-0.105	1.000				
Output Allocative	0.841	0.976	0.830	-0.043	0.832	1.000			
Input Technical	0.950	0.731	0.955	-0.151	0.930	0.794	1.000		
Output Technical	0.983	0.756	0.986	-0.113	0.962	0.845	0.915	1.000	
Total Assets	0.243	0.219	0.231	0.428	0.205	0.247	0.207	0.247	1.000

These data are estimates - They are derived from a model and do not purport to be, nor should they be interpreted as so being, accurate or true descriptions of the behavior of individual banks activities. They are provided merely for illustrative purposes.

Bank By Bank Analysis of Inefficiencies

Bank	Total	Total Allocative	Total Technical	Input Allocative	Output Allocative	Input Technical	Output Technical	Number of Branches	Total Assets
Anglo	2.61	0.33	2.28	0.01	0.35	0.57	1.71	10.00	215.10
Anglo	3.18	0.27	2.91	0.02	0.32	0.71	2.20	9.00	385.00
Anglo	3.76	0.53	3.23	0.03	0.59	0.80	2.44	8.00	574.10
Anglo	3.31	0.31	2.99	0.02	0.36	0.70	2.29	8.00	764.60
Allied	3.04	0.41	2.64	0.02	0.44	0.64	2.00	331.00	9100.00
Allied	2.67	0.34	2.33	0.01	0.36	0.61	1.72	327.00	14702.50
Allied	4.23	0.64	3.59	0.04	0.71	0.92	2.67	500.00	15940.80
Allied	3.72	0.50	3.22	0.03	0.56	0.76	2.45	500.00	17857.50
Bank	3.04	0.41	2.64	0.02	0.44	0.64	2.00	366.00	8837.90
Bank	2.67	0.34	2.33	0.01	0.36	0.61	1.72	366.00	11079.10
Bank	4.23	0.64	3.59	0.04	0.71	0.92	2.67	352.00	13424.80
Bank	3.72	0.50	3.22	0.03	0.56	0.76	2.45	378.00	17818.30
BNP	2.67	0.35	2.32	0.01	0.37	0.61	1.71	1.00	570.80
BNP	4.02	0.53	3.49	0.04	0.60	0.82	2.67	1.00	606.40
BNP	3.78	0.48	3.30	0.03	0.54	0.79	2.51	1.00	724.90
BNP	3.64	0.47	3.17	0.03	0.53	0.76	2.41	1.00	909.09
ICC	2.61	0.33	2.28	0.01	0.35	0.57	1.71	2.00	660.00
ICC	3.17	0.29	2.88	0.02	0.33	0.71	2.18	2.00	660.00
ICC	3.76	0.52	3.25	0.03	0.57	0.80	2.45	2.00	1012.80
ICC	3.31	0.31	2.99	0.02	0.36	0.70	2.29	2.00	1054.90
ACC	2.61	0.33	2.28	0.01	0.35	0.57	1.71	10.00	533.30
ACC	3.18	0.27	2.91	0.02	0.32	0.71	2.20	10.00	590.16
ACC	3.76	0.52	3.25	0.03	0.57	0.80	2.45	10.00	626.51
ACC	3.31	0.31	2.99	0.02	0.36	0.70	2.29	10.00	677.08
Intercon	2.61	0.33	2.28	0.01	0.35	0.57	1.71	1.00	562.40
Intercon	4.02	0.53	3.49	0.04	0.60	0.82	2.67	1.00	621.70
Intercon	3.78	0.48	3.30	0.03	0.54	0.79	2.51	1.00	818.70
Intercon	3.64	0.47	3.17	0.03	0.53	0.76	2.41	1.00	869.70
NIB	2.67	0.35	2.32	0.01	0.37	0.61	1.71	50.00	556.70
NIB	3.18	0.27	2.91	0.02	0.32	0.71	2.20	46.00	651.60
NIB	3.76	0.53	3.23	0.03	0.59	0.80	2.44	47.00	768.70
NIB	3.30	0.32	2.99	0.02	0.36	0.70	2.29	51.00	849.10

These data are estimates - They are derived from a model and do not purport to be, nor should they be interpreted as so being, accurate or true descriptions of the behavior of individual banks activities. They are provided merely for illustrative purposes.

Appendix 1 (cont)

Bank	Total	Total Allocative	Total Technical	Input Allocative	Output Allocative	Input Technical	Output Technical	Number of Branches	Total Assets
TSB	2.64	0.34	2.30	0.01	0.36	0.59	1.71	25.00	381.80
TSB	3.61	0.39	3.23	0.03	0.45	0.79	2.43	35.00	400.90
TSB	3.41	0.34	3.07	0.03	0.39	0.73	2.33	35.00	445.00
TSB	3.16	0.35	2.82	0.02	0.39	0.52	2.29	36.00	478.20
WoodInv	2.67	0.35	2.32	0.01	0.37	0.61	1.71	9.00	348.60
WoodInv	4.02	0.53	3.49	0.04	0.60	0.82	2.67	9.00	632.90
WoodInv	3.78	0.48	3.30	0.03	0.54	0.79	2.51	10.00	1079.60
WoodInv	3.64	0.47	3.17	0.03	0.53	0.76	2.41	10.00	1120.40
C&L	2.64	0.34	2.30	0.01	0.36	0.59	1.71	28.00	400.00
C&L	3.61	0.39	3.23	0.03	0.45	0.79	2.43	28.00	419.00
C&L	3.41	0.34	3.07	0.03	0.39	0.73	2.33	31.00	459.10
C&L	3.16	0.35	2.82	0.02	0.39	0.52	2.29	32.00	497.50
Hill Sam	2.61	0.33	2.28	0.01	0.35	0.57	1.71	1.00	281.70
Hill Sam	3.18	0.27	2.91	0.02	0.32	0.71	2.20	1.00	457.40
Hill Sam	3.76	0.53	3.23	0.03	0.59	0.80	2.44	1.00	528.20
Hill Sam	3.31	0.31	2.99	0.02	0.36	0.70	2.29	1.00	512.80
Ansbacher	2.67	0.35	2.32	0.01	0.37	0.61	1.71	1.00	106.60
Ansbacher	4.02	0.53	3.49	0.04	0.60	0.82	2.67	1.00	127.70
Ansbacher	3.78	0.48	3.30	0.03	0.54	0.79	2.51	1.00	144.00
Ansbacher	3.64	0.47	3.17	0.03	0.53	0.76	2.41	1.00	160.10
WestDeuts	3.78	0.48	3.30	0.03	0.54	0.79	2.51	1.00	119.20
WestDeuts	3.64	0.47	3.17	0.03	0.53	0.76	2.41	1.00	145.90
L&U	2.61	0.33	2.28	0.01	0.35	0.57	1.71	12.00	378.20
L&U	3.18	0.27	2.91	0.02	0.32	0.71	2.20	12.00	428.50

These data are estimates - They are derived from a model and do not purport to be, nor should they be interpreted as so being, accurate or true descriptions of the behavior of individual banks activities. They are provided merely for illustrative purposes.

Appendix 2

```
Statistics on Series TOTINEF
Panel(4) of Undated Data From     1//1 To    14//4
Observations  56
Sample Mean     3.3378156998        Variance              0.243972
Standard Error  0.4939350259        SE of Sample Mean     0.066005
t-Statistic     50.56925          Signif Level (Mean=0) 0.00000000
Skewness        -0.16574           Signif Level (Sk=0)  0.62218040
Kurtosis        -1.15148          Signif Level (Ku=0)   0.09882480
```

```
Statistics on Series TOTALL
Panel(4) of Undated Data From     1//1 To    14//4
Observations  56
Sample Mean     0.40514335968       Variance              0.009667
Standard Error  0.09831991461       SE of Sample Mean     0.013139
t-Statistic     30.83623          Signif Level (Mean=0) 0.00000000
Skewness        0.49073            Signif Level (Sk=0)  0.14456741
Kurtosis        -0.80713          Signif Level (Ku=0)   0.24728320
```

```
Statistics on Series TOTTECH
Panel(4) of Undated Data From     1//1 To    14//4
Observations  56
Sample Mean     2.9326723401        Variance              0.175705
Standard Error  0.4191721142        SE of Sample Mean     0.056014
t-Statistic     52.35585          Signif Level (Mean=0) 0.00000000
Skewness        -0.44096           Signif Level (Sk=0)  0.18985341
Kurtosis        -1.09646          Signif Level (Ku=0)   0.11601761
```

Appendix 2 (cont)

```
Statistics on Series INPUTALL
Panel(4) of Undated Data From      1//1 To    14//4
Observations   56
Sample Mean          0.025101        Variance          7.920207e-05
Standard Error       0.008900        SE of Sample Mean      0.001189
t-Statistic      21.10640          Signif Level (Mean=0) 0.00000000
Skewness           -0.13588          Signif Level (Sk=0)   0.68621906
Kurtosis          -0.90089          Signif Level (Ku=0)   0.19657653
```

```
Statistics on Series OUTPUTALL
Panel(4) of Undated Data From      1//1 To    14//4
Observations   56
Sample Mean          0.451061        Variance              0.012296
Standard Error       0.110885        SE of Sample Mean      0.014818
t-Statistic      30.44075          Signif Level (Mean=0) 0.00000000
Skewness            0.53512          Signif Level (Sk=0)   0.11161658
Kurtosis          -0.91261          Signif Level (Ku=0)   0.19081343
```

```
Statistics on Series TECHIN
Panel(4) of Undated Data From      1//1 To    14//4
Observations   56
Sample Mean     0.7098468706         Variance              0.009588
Standard Error  0.0979163262         SE of Sample Mean      0.013085
t-Statistic      54.25048          Signif Level (Mean=0) 0.00000000
Skewness           -0.14079          Signif Level (Sk=0)   0.67552491
Kurtosis          -0.73760          Signif Level (Ku=0)   0.29037539
```

```
Statistics on Series TECHOUT
Panel(4) of Undated Data From      1//1 To    14//4
Observations   56
Sample Mean          2.22283         Variance              0.109361
Standard Error       0.33070         SE of Sample Mean      0.044191
t-Statistic      50.29991          Signif Level (Mean=0) 0.00000000
Skewness           -0.57213          Signif Level (Sk=0)   0.08894582
Kurtosis          -1.05440          Signif Level (Ku=0)   0.13068148
```

Appendix 2 (cont)

Analysis of Variance for Series TOTINEF

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	1.0361237	13	0.0797018	0.530	0.89151652
TIME	6.5161724	3	2.1720575	14.441	0.00000177
JOINT	7.5522960	16	0.4720185	3.138	0.00179672
ERROR	5.8661535	39	0.1504142		
TOTAL	13.4184495	55			

Analysis of Variance for Series TOTALL

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.1381556	13	0.0106274	1.600	0.12708291
TIME	0.1345106	3	0.0448369	6.751	0.00089026
JOINT	0.2726662	16	0.0170416	2.566	0.00830360
ERROR	0.2590082	39	0.0066412		
TOTAL	0.5316743	55			

Analysis of Variance for Series TOTTECH

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.4651499	13	0.0357808	0.345	0.97881819
TIME	5.1580299	3	1.7193433	16.595	0.00000042
JOINT	5.6231797	16	0.3514487	3.392	0.00092949
ERROR	4.0406096	39	0.1036054		
TOTAL	9.6637894	55			

Analysis of Variance for Series INPUTALL

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.0002720	13	0.0000209	0.410	0.95717573
TIME	0.0020949	3	0.0006983	13.690	0.00000301
JOINT	0.0023669	16	0.0001479	2.900	0.00337194
ERROR	0.0019893	39	0.0000510		
TOTAL	0.0043561	55			

Appendix 2 (cont)

Analysis of Variance for Series OUTPUTALL

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.1583569	13	0.0121813	1.436	0.18685030
TIME	0.1871667	3	0.0623889	7.357	0.00050623
JOINT	0.3455236	16	0.0215952	2.547	0.00875690
ERROR	0.3307319	39	0.0084803		
TOTAL	0.6762555	55			

Analysis of Variance for Series TECHIN

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.0489448	13	0.0037650	0.606	0.83405692
TIME	0.2361117	3	0.0787039	12.670	0.00000632
JOINT	0.2850565	16	0.0178160	2.868	0.00367394
ERROR	0.2422619	39	0.0062118		
TOTAL	0.5273184	55			

Analysis of Variance for Series TECHOUT

Source	Sum of Squares	Degrees	Mean Square	F-Statistic	Signif Level
INDIV	0.249302666068	13	0.019177128159	0.302	0.98817743
TIME	3.292004884511	3	1.097334961504	17.301	0.00000027
JOINT	3.541307550579	16	0.221331721911	3.490	0.00072456
ERROR	2.473572940303	39	0.063424947187		
TOTAL	6.014880490882	55			

Appendix 2 (cont)

Dependent Variable TOTINEF - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.440165 R Bar **2 0.384181
Uncentered R**2 0.988213 T x R**2 55.340
Mean of Dependent Variable 3.3378
Std Error of Dependent Variable 0.4939
Standard Error of Estimate 0.3876
Sum of Squared Residuals 7.5121232766
Regression F(5,50) 7.8624
Significance Level of F 0.00001597
Durbin-Watson Statistic 2.280116

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-18.02637386	4.37918447	-4.11638	0.00014390
2. YEAR	0.23919749	0.04898193	4.88338	0.00001111
3. IRISH	-0.25588359	0.13049677	-1.96084	0.05547969
4. ASSOC	-0.41252723	0.24853041	-1.65987	0.10320130
5. BRANCHES	0.00134367	0.00075792	1.77283	0.08234807
6. BIGSHARE	0.20241263	0.13042094	1.55199	0.12697076

Dependent Variable TOTALL - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.306784 R Bar **2 0.237463
Uncentered R**2 0.962096 T x R**2 53.877
Mean of Dependent Variable 0.405143360
Std Error of Dependent Variable 0.098319915
Standard Error of Estimate 0.085856279
Sum of Squared Residuals 0.3685650316
Regression F(5,50) 4.4255
Significance Level of F 0.00205212
Durbin-Watson Statistic 2.507068

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-1.493262772	0.969993783	-1.53946	0.12999828
2. YEAR	0.021290957	0.010849547	1.96238	0.05529511
3. IRISH	-0.073822558	0.028905167	-2.55396	0.01374511
4. ASSOC	-0.111960455	0.055049737	-2.03381	0.04729455
5. BRANCHES	0.000510199	0.000167880	3.03906	0.00376852
6. BIGSHARE	0.050171553	0.028888371	1.73674	0.08859125

Appendix 2 (cont)

Dependent Variable TOTTECH - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.457450 R Bar **2 0.403195
Uncentered R**2 0.989328 T x R**2 55.402
Mean of Dependent Variable 2.932672340
Std Error of Dependent Variable 0.419172114
Standard Error of Estimate 0.323823745
Sum of Squared Residuals 5.2430909003
Regression F(5,50) 8.4315
Significance Level of F 0.00000769
Durbin-Watson Statistic 2.284242

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-16.53311109	3.65852123	-4.51907	0.00003820
2. YEAR	0.21790653	0.04092119	5.32503	0.00000240
3. IRISH	-0.18206103	0.10902149	-1.66996	0.10117785
4. ASSOC	-0.30056677	0.20763085	-1.44760	0.15396991
5. BRANCHES	0.00083347	0.00063319	1.31629	0.19407765
6. BIGSHARE	0.15224108	0.10895814	1.39724	0.16851030

Dependent Variable INPUTALL - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.354862 R Bar **2 0.290349
Uncentered R**2 0.929103 T x R**2 52.030
Mean of Dependent Variable 0.0251
Std Error of Dependent Variable 8.8996e-03
Standard Error of Estimate 7.4971e-03
Sum of Squared Residuals 0.0028102928
Regression F(5,50) 5.5006
Significance Level of F 0.00041311
Durbin-Watson Statistic 2.300901

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-0.322735100	0.084700831	-3.81029	0.00038119
2. YEAR	0.003895878	0.000947393	4.11221	0.00014585
3. IRISH	-0.004024860	0.002524028	-1.59462	0.11710013
4. ASSOC	-0.007260313	0.004806998	-1.51036	0.13724518
5. BRANCHES	0.000020925	0.000014659	1.42744	0.15967031
6. BIGSHARE	0.003235775	0.002522562	1.28273	0.20549995

Appendix 2 (cont)

Dependent Variable OUTPUTALL - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.318795 R Bar **2 0.250674
Uncentered R**2 0.961833 T x R**2 53.863
Mean of Dependent Variable 0.4511
Std Error of Dependent Variable 0.1109
Standard Error of Estimate 0.0960
Sum of Squared Residuals 0.4606686989
Regression F(5,50) 4.6799
Significance Level of F 0.00139485
Durbin-Watson Statistic 2.454797

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-2.083652080	1.084441774	-1.92141	0.06039024
2. YEAR	0.028417808	0.012129667	2.34283	0.02315802
3. IRISH	-0.081185359	0.032315640	-2.51226	0.01526862
4. ASSOC	-0.125241970	0.061544966	-2.03497	0.04717320
5. BRANCHES	0.000548478	0.000187688	2.92228	0.00520517
6. BIGSHARE	0.056090857	0.032296862	1.73673	0.08859322

Dependent Variable TECHIN - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.294988 R Bar **2 0.224487
Uncentered R**2 0.987067 T x R**2 55.276
Mean of Dependent Variable 0.709846871
Std Error of Dependent Variable 0.097916326
Standard Error of Estimate 0.086228279
Sum of Squared Residuals 0.3717658081
Regression F(5,50) 4.1842
Significance Level of F 0.00297139
Durbin-Watson Statistic 2.134649

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-2.096815448	0.974196598	-2.15235	0.03622124
2. YEAR	0.031428336	0.010896556	2.88424	0.00577386
3. IRISH	-0.061003265	0.029030408	-2.10136	0.04067064
4. ASSOC	-0.076766994	0.055288258	-1.38849	0.17114399
5. BRANCHES	0.000270446	0.000168608	1.60399	0.11501446
6. BIGSHARE	0.054272364	0.029013539	1.87059	0.06726099

Appendix 2 (cont)

Dependent Variable TECHOUT - Estimation by Least Squares
Panel(4) of Undated Data From 1//1 To 14//4
Usable Observations 56 Degrees of Freedom 50
Centered R**2 0.499107 R Bar **2 0.449017
Uncentered R**2 0.989343 T x R**2 55.403
Mean of Dependent Variable 2.2228
Std Error of Dependent Variable 0.3307
Standard Error of Estimate 0.2455
Sum of Squared Residuals 3.0128143773
Regression F(5,50) 9.9643
Significance Level of F 0.00000118
Durbin-Watson Statistic 2.344915

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-14.43629564	2.77330781	-5.20544	0.00000364
2. YEAR	0.18647820	0.03101992	6.01156	0.00000021
3. IRISH	-0.12105777	0.08264272	-1.46483	0.14922651
4. ASSOC	-0.22379978	0.15739262	-1.42192	0.16125758
5. BRANCHES	0.00056302	0.00047999	1.17300	0.24635416
6. BIGSHARE	0.09796872	0.08259470	1.18614	0.24117373

DISCUSSION

John Hogan: Firstly I would like to congratulate Brian Lucey on a very interesting paper, with some provocative conclusions. The central conclusion that due to poor planning on the funding side 40 per cent of actual realised profit is lost to banks undoubtedly raises serious concerns but also hopefully opportunities for bankers.

The model used is somewhat different to the models used by the management of the banks. Whereas in the study labour constitutes an input, in operational models the inputs are interest bearing deposits, other funds and free capital. Labour and other costs are quasi fixed expenses to be minimised. Real world models do not envisage a dynamic relationship between labour and outputs which is clearly wrong and may well lead to under utilisation of labour. Deposits are treated as semi fixed in the model with 'other funds' being a variable input; this distinction may be somewhat tenuous particularly for the smaller banks in the sample.

I haven't seen the raw data on which the analysis is based so the following comments are based on inferences from the paper. Firstly, there appears to be two definitions of the proxy for profits - "additions to reserves" and "profits less tax plus depreciation". These are both quite different concepts. Additions to reserves can be affected by capital injections and asset revaluations. Dividend distribution policy also affects changes in the reserves. It would be helpful to know precisely how these issues were handled. More importantly, however, any profit figure or proxy therefor is very dubious in the case of the foreign controlled banks where the returns for their Irish subsidiaries in any one year are very much a policy decision. The time period chosen 1988-91 has some significance for the two quoted banks relative to the rest of the sample. The final year of the period witnessed a major setback in these two banks in respect of their non-Irish operations; this is something which would not be true for the rest of the banks in the sample.

I am not sure to what extent if any the output mix is relevant to the conclusion of the paper. However bank owners are not neutral between profits derived from securities and from loans; the latter have a much lower value because a high proportion need to be retained to maintain regulatory capital and this requirement would differ across the banks studied.

Finally, I note the plea for greater segmented data. Of course, the two major banks, particularly AIB, have been producing substantial amounts of such data for some time. I have to say that my own experience of much of this data and the data produced by US banks generally is seriously misleading. Whatever about the limitations of audited group profit figures, segmented profit figures are highly vulnerable to transfer pricing via changes in internal funding costs and changes in the allocation of free capital. There are also serious definition problems; for instance in the US Call Reports, lending is classified by security which greatly overstates lending to the property sector. All conclusions based on this type of data should come with a strong health warning.

Patrick Massey: I would like to begin by saying that it gives me great pleasure to second the vote of thanks to Mr. Lucey for his paper entitled "Profits, Efficiency & Irish Banks". The paper deals with some important issues at a time when concern has been expressed about a lack of competition in banking. In a small open economy, such as Ireland, the cost of inefficiencies elsewhere in the economy is borne by the traded sector, whose ability to compete with overseas producers is undermined by such costs and this is reflected in job losses in the traded goods sector. The level of inefficiency identified in the Irish banks in the present study is therefore a cause for some concern.

Data Problems

Like many papers which focus on specific industries the paper suffers from the problem of inadequate data. Essentially this is the main difficulty that I found with the paper and its conclusions. The estimates are based on data for a number of institutions for a limited number of years. Various proxies are used as indicators of the various input and output prices and of profits. (In the case of profits, additions to reserves are used. Has any allowance been made for the fact that a significant proportion of bank profits may be generated abroad?) Given all of these limitations one therefore wonders about the reliability of the results.

The Results

Essentially the paper tells us that Irish banks suffer from inefficiencies to a significant degree. (On this point there is some confusion as to the extent of such inefficiencies. Table 7 if I read it correctly indicates that inefficiencies amounted to almost 21 per cent of average profits and that output technical efficiency accounted for the largest component amounting to 13 per cent of average profits. (In the section headed "What does it all mean?" there is a reference to technical inefficiency on the output side equal to 40% of actual realised profits). As the paper notes: "The real question, and one whose surface is barely scratched here, is why that should be so?" I think it is somewhat unfortunate that the paper has not given some consideration to this issue and I would be interested to hear if the author had any views to offer on this question this evening.

The Irish banking system has changed dramatically during the past decade. Up to the mid 1980s the associated banks and the major building societies each operated an interest rate cartel. The Irish financial system was composed of a variety of different types of institution each confined primarily by regulation to a particular range of activities. In addition differences in the tax treatment of deposits with various institutions gave rise to further distortions in the system. We have seen significant changes in these areas in the past few years. The old cartels are gone and many of the distinctions between the different institutions have been removed. The effect has been to greatly increase competition in the financial services sector.

Economic theory would suggest three possible types of efficiency gain to result from increased competition within the financial services industry:

1. Firms will be forced to operate closer to the minimum point on their Long Run Average Cost Curve (LRACC) - an operational or cost efficiency gain;
2. Firms will be forced to price their services explicitly and in closer relation to the cost of providing such services, eliminating cross subsidisation, and allowing prices to provide accurate signals for resource allocation - an allocative efficiency gain;
3. Competition should enhance the capacity of the system to adapt to changing circumstances and generate innovations - a dynamic efficiency gain.

This raises the question as to the extent to which the results in the paper are attributable to a lack of competition in the past or indeed whether such inefficiencies remain in spite of greater competition. If it is the latter then we must ask why this should be so. It may be worth investigating whether the level of efficiency in banks has risen in recent years.

Cost Efficiency

One way of assessing movements in cost efficiency is to examine trends in the ratio of operating expenses to total assets. Information for the two largest banking groups can be derived from their annual reports and is given in Table A1. These do not, however, give disaggregated data for the groups' associated banks and non-associated bank operations. The other drawback with the data is that it includes overseas subsidiaries. It shows that the ratio of operating expenses to total assets has remained fairly stable since 1987, a sharp fall in 1989 being quickly reversed.

Table A2 measures bank efficiency by measuring the ratio of operating profit to operating expenses - a measure developed by Hogan (1990). The justification for this approach is that "[the] ratio tests the returns gained by owners in terms of the expenses (or outlays) required to generate such profits". Ackland and Harper (1990) point out that the index also "has the virtue that it avoids the use of balance-sheet aggregates like deposits, assets and shareholders' funds, measures of the size of a banks business which fail to incorporate off-balance-sheet activity." Again it is difficult to discern any clear trend from the figures.

Another way to measure operating efficiency is to examine trends in output per employee or unit labour costs. Table A3 illustrates trends in real deposits per employee and real unit labour costs for all credit institutions (other than building societies) for the period since March 1988. There is no indication of any clear trend in real deposits per employee over the 1988-92 period. The performance of real unit labour costs is perhaps more interesting. Real unit labour costs declined after 1988 but this fall was reversed in 1992.

There are indications that the banks have been seeking to increase efficiency in recent years - moves to extend branch opening hours being a good example.

Allocative Efficiency

Increased competition should force financial institutions to unbundle their products and introduce explicit charges for identifiably separate services. In particular it should eliminate cross-subsidisation of certain services e.g. money transmission from net interest margins. The Central Bank (1985, p.64) noted that the associated banks lost money on their money transmission services. In a more competitive environment, as Ackland and Harper (op. cit.) point out, institutions have an incentive to cut their net interest margins and introduce fees and charges as this would enable them to expand their borrowing and lending activities, eliminating profit haemorrhage through overuse of underpriced ancillary services.

Table A4 shows that net interest income as a proportion of total income of the big two banking groups has fallen by over 10 per cent since 1987. Increases in bank charges along with the introduction of new charges for what were regarded as free services has inevitably met with some consumer resistance. Bank charges remain subject to Central Bank control. Following the dismantling of the associated bank cartel, banks must now apply individually to the Central Bank for permission to alter their charges. Presumably the rationale for such controls is that competition is not sufficiently strong to prevent the banks from earning monopoly profits at the expense of consumers. The danger is that controls will lead to charges being too low to cover the full costs of such services, so cross-subsidisation continues reducing allocative efficiency and net interest margins are higher than would otherwise be the case, a situation which is not in the interests of the banks or the economy as a whole. Milbourne and Cumberworth (1990) argue that banks themselves may be somewhat reluctant to introduce fees and charges on a comprehensive basis due to the odium likely to be borne by the first bank to make a substantial move in this direction. As a result the banks (and society) may be locked into a sub-optimal Nash equilibrium, with inappropriately priced financial services and net interest margins which are too wide.

Competition in Banking

The changes which have taken place in the Irish financial system in recent years have certainly increased the degree of competition in banking. Banking is, however, a multiproduct business and increased competition may not have been uniform across all lines of business. There appears to be little problem in the market for lending to major commercial borrowers. Margins appear fairly tight indicating that competition is strong. In the UK increased competition in the early 1980s was concentrated in the personal sector due to competition from building societies providing banking services and in the larger corporate sector where firms borrowed on the wholesale markets. (Financial Times, 1993). Competition in the small business sector was less intense. It may be that a similar situation has arisen in Ireland. In the UK complaints that this lack of competition in the small business sector had led to banks overcharging small firms were not, however, borne out by a Government inquiry initiated in response to such complaints (ibid.). Ackland and Harper (op. cit.) reported that following financial deregulation in Australia margins narrowed on lending on larger commercial loans but widened on smaller loans.

The completion of the single market on 1 January 1993 opened the way for overseas financial institutions to enter the Irish market. Thus the likelihood is that competition will become even more intense. The removal of restrictions on foreign bank entry was a major element in increasing competition in the financial sector in countries such as Australia and New Zealand. Hall (1985) for example argued that the entry of foreign banks was the most significant change to occur in Australia.

Irish financial institutions are already exposed to direct competition from foreign banks in some markets. Nevertheless it may be that the a lack of competition in certain markets may reduce the incentive for banks to maximise efficiency by allowing them to pass on the cost of inefficiencies to customers in less competitive markets.

The single market is, however, likely to significantly increase competition in Ireland in other ways. Indeed to some extent this has already occurred as the advent of the single market has been partly responsible for the reduction of distortionary controls on financial institutions. The reduction in the primary liquidity ratio in preparation for the single market was designed to improve the capacity of Irish financial institutions to compete against institutions from other member states. Other regulatory distortions which place Irish financial institutions at a disadvantage relative to other EC institutions will also have to be removed in the single market. As Walsh (1987) noted, the single market will mean that location will, over time, gravitate to wherever the costs of operating are cheapest. "This cost factor will also include the costs imposed by the regulators." Thus inefficiencies arising from regulatory distortions should be reduced.

Economies of Scope

The paper finds no evidence to support the existence of economies of scope in Irish banking. These findings are in contrast with those of the banking industry in other countries. (See, for example, Gilligan and Smirlock (1984), Gilligan, Smirlock and Marshall (1984), and Murray and White (1983)).

Conclusion

The paper indicates that Irish banks exhibit a significant level of inefficiencies. It does not offer any explanation of this, nor does it tell us whether the position has improved over time. Recent years have seen a significant increase in the degree of competition in the market. It might be expected that this would increase the pressure on banks to operate more efficiently. If it has not done so, then we need to ask why. In conclusion I would like to congratulate Mr. Lucey on a most interesting and thought provoking paper, which, in my view, seeks to shed some light on an important topic. It has certainly provided some considerable food for thought and scope for further analysis.

TABLES

Table A1 Operating Expenses as a percentage of Total Assets (AIB and Bank of Ireland)

Year	Percentage
1987	3.5
1988	3.7
1989	3.0
1990	3.6
1991	3.4
1992	3.6

Note: The figures relate to the year ending March 31.
Source: Bank of Ireland and Allied Irish Banks, Annual Reports, various issues.

Table A2 Hogan's Bank Efficiency Index (Ratio of operating profit to operating expenses)

Year	Index
1987	0.45
1988	0.47
1989	0.48
1990	0.49
1991	0.52
1992	0.48

Note: The ratio is based on operating profit before bad debts.
Source: As for Table A1.

Table A3 Productivity and Labour Costs in Banks

Year	Real deposits per employee	Real unit labour costs
1988	100.0	100.0
1989	99.3	100.3
1990	99.8	99.0
1991	100.2	99.2
1992	99.5	104.1

Source: Derived from Central Bank figures on non-government deposits in financial institutions and the CSO Index on Employment and Earnings in Banking, Insurance and Building Societies.

Table 4 Net Interest Income as a percentage of Banks' Total Income

Year	Percentage
1987	80.5
1988	80.0
1989	77.1
1990	73.2
1991	72.8
1992	71.9

Source: As for Table A1.

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John Frain: I enjoyed Brian Lucey's excellent non-technical presentation on the measurement of efficiency in Irish banks. He presented the essence of some very abstract theory very clearly and made it appear to be far simpler than it is. I would like to join with the other speakers in congratulating him on his presentation. My comments refer to the paper itself rather than the material in the presentation. These comments are of a technical nature and are regrettably less clear than his presentation.

Estimation of Profit Function

The coefficient estimates in Tables 5 and 6 should be identical. Standard linear or non-linear least squares require that the variances of the error terms be equal. When these are not equal the coefficient estimates are consistent but not optimal. The estimates of the standard errors of these estimates are biased even in large samples and are, thus inconsistent. The methodology[1] of White (1980) accepts the sub-optimal coefficient estimates and provides a way to adjust the standard errors so that they become consistent. The gain in precision (reduced standard errors) reported in Table 6 is much greater than I would have expected. White's consistent standard errors are often, but not always, greater than their unadjusted counterparts.

What has gone wrong? I suspect that the non-linear estimation procedure has run into some problems and may not have converged. Many non-linear problems are not easy to solve and the routine application of a computer algorithm may give misleading results. With 24 coefficients and so small a sample two problems may have arisen. The objective function may be very flat in the neighbourhood of the true turning point and the convergence criteria may need refining. RATS uses the iterative procedure outlined in Berndt, Hall, Hall and Hausman (1974) to estimate the coefficients. Each iteration involves two steps. The first step determines the direction to take at the next iteration. The second step determines how far to move in that direction. The sub-iterations parameter determines how many coefficient vectors are examined in the second step and, in RATS, defaults to 10 after the first two iterations. When the sub-iterations parameter is exceeded the algorithm may appear to have converged and will report the latest values of the coefficients if it had converged. The sub-iterations parameter may be reset but this may increase computation time. It is possible that the information content of the data set is too small to support the analysis and that a solution to the non-linear problem will be very difficult.

The parameter estimates in Table 6 also deserve some comments. The profit function, as estimated, is not convex and thus is not a valid profit function. Technically it cannot be the dual of a valid multiproduct technology. The negative β 's need some explanation. The τ values have very large standard errors and the resulting estimate of allocative inefficiency must also be subject to similar statistical errors. Looking at the results, I would presume that, statistically, full allocative efficiency cannot be rejected (i.e. joint hypothesis that $\tau_1 = \tau_2 = \tau_3 = 1$). Similar comments apply to Table 5.

Clearly there are problems outstanding in the estimation of the profit function. Given the small sample size it is not certain that these problems can be solved. Thus the profit function approach is not any easier to implement than alternative methods.

Profit Function

The profit function approach leads to a different, and not necessarily a better decomposition of inefficiency. In the actual implementation allocative efficiency is measured by reference to average price proxies rather than firm specific prices. This surely causes more problems with interpretation. The profit function approach requires exogenous prices. I am not fully convinced that this is so in all cases.

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[1] Cragg (1983) has proposed a method of adjusting parameter values but this may not be appropriate in small samples and is not implemented in RATS.