where $d_{ft} = \delta' z_{ft} / (\gamma\sigma^2)^{1/2}$, [A.13]

$$d^*_{ft} = \mu^*_{ft} / [\gamma(1-\gamma)\sigma^2]^{1/2}, \quad [A.14]$$

$$\mu^*_{ft} = (1-\gamma)\delta' z_{ft} + \gamma(vc_{ft} - vc(x_{ft};\beta)), \quad [A.15]$$

$$\sigma_* = [\gamma(1-\gamma)\sigma^2]^{1/2}, \quad [A.16]$$

and $\Theta \equiv (\beta', \delta', \sigma^2, \gamma)'$.

The log-likelihood function in equation [A.12] can be maximized with respect to each element of Θ to obtain maximum likelihood (ML) estimates of all parameters, β, δ, σ^2 and γ.

The computer program, FRONTIER Version 4.1, is used in this study to obtain the ML estimates for the parameters of the stochastic frontier cost model defined by equations [3]-[5] in the text. This program uses a three-step estimation procedure:

1. The first step involves calculation of the OLS estimators of β and σ^2.
2. In the second step, a grid search is conducted across the parameter space of γ, i.e., the log-likelihood function is evaluated for values of γ from 0.1 to 0.9 in increments of size 0.1. In these calculations, the β parameters (excepting β_0) are set to the OLS values, whit β_0 and σ^2 adjusted according to the corrected ordinary least squares formula presented in Coelli (1995). Any other parameters (δ-vector in our case) are set to zero during this grid search.
3. The final step uses the best estimates (that is, those corresponding to the largest log-likelihood value) from the second step as starting values in a Davidon-Fletcher-Powell (DFP) iterative maximization algorithm which obtain the final ML estimates when the likelihood function attains its global maximum.

Approximate standard errors of the ML estimators are then calculated by obtaining the square roots of the diagonal elements of the direction matrix from the final iteration of the DFP routine[82].

Once the ML estimates for the parameters of the stochastic frontier cost model have been obtained, predictions of the cost inefficiency for each producer, *f*, at each observation, *t*, have to be derived. We have estimates of $\psi_{ft} = v_{ft} + u_{ft}$ and we must extract the information that ψ_{ft} contains on the unobservable component u_{ft}. According to the original insight of Jondrow et al. (1982), a solution to the problem is obtained

[82] The direction matrix for the final iteration is usually a good approximation for the inverse of the Hessian of the log-likelihood function, unless the DFP routine terminates after only a few iterations.