arise in testing hypotheses where γ is equal to 0 because $\gamma = 0$ lies on the boundary of the parameter space for γ, given that it cannot take negative values. In all these cases, if H_0 is true, the generalized LR statistic, Λ, has asymptotic distribution which is a mixture of chi-square distributions whose critical values are obtained from Table 1 in Kodde and Palm (1986)[54].

Table 2. Likelihood-ratio tests of hypotheses for parameters of the stochastic frontier cost function [3] and the cost inefficiency model [5]

Null hypothesis	Log-likelihood	χ^2-statistic	Decision
H_0: $\gamma = \delta_0 = \delta_R = \delta_{SP} = \delta_\tau = \delta_{RSP} = \delta_{R\tau} = 0$	179.258	64.655*	Reject H_0
H_0: $\gamma = \delta_0 = \delta_{SP} = \delta_\tau = 0$	182.847	57.478*	Reject H_0
H_0: $\delta_{R\tau} = 0$	211.513	0.147	Accept H_0
H_0: $\delta_{R\tau} = \beta_{MSy} = \beta_{MSk} = \beta_{yy} = \beta_{LMS} = \beta_{ySP} = \beta_{SPSP} = 0$	205.643	11.885	Accept H_0
Restriction: $\delta_{R\tau} = \beta_{MSy} = \beta_{MSk} = \beta_{yy} = \beta_{LMS} = \beta_{ySP} = \beta_{SPSP} = 0$			
H_0: $\gamma = \delta_0 = \delta_R = \delta_{SP} = \delta_\tau = \delta_{RSP} = 0$	171.718	67.849*	Reject H_0
H_0: $\gamma = \delta_0 = \delta_{SP} = \delta_\tau = 0$	176.310	58.665*	Reject H_0
H_0: $\delta_0 = \delta_R = \delta_{SP} = \delta_\tau = \delta_{RSP} = 0$	185.240	40.806	Reject H_0
H_0: $\delta_R = \delta_{SP} = \delta_\tau = \delta_{RSP} = 0$	192.671	25.943	Reject H_0
H_0: $\delta_0 = 0$	201.899	7.488	Reject H_0

* In this case the LR test statistic is asymptotically distributed as a mixture of chi-square distributions with degrees of freedom equal to the number of parameters assumed to be equal to zero in the null hypothesis H_0, provided H_0 is true. The critical values for this mixed χ^2-distribution are obtained from Table 1 in Kodde and Palm (1986).

It can be seen from Table 2 that the null hypothesis of absence of x-inefficiency effects from the model (i.e., H_0: $\gamma = \delta_0 = \delta_R = \delta_{SP} = \delta_\tau = \delta_{RSP} = \delta_{R\tau} = 0$) is strongly rejected at 1 per cent level of significance[55]. The second null hypothesis we consider, H_0: $\gamma = \delta_0 = \delta_{SP} = \delta_\tau = 0$, specifies that the inefficiency effects are not stochastic. If the parameter γ is zero, then the variance of the $u_{ft}s$ is zero and so the model reduces to a traditional mean response function in which the z-variables, R_{ft}, $(R_{ft} \times \ln SP_{ft})$ and $(R_{ft} \times \tau_{ft})$, are included in the cost function[56]. Once again, the H_0 hypothesis is rejected at

[54] For more on the use of this test in stochastic frontier models, see Coelli (1995) and Coelli and Battese (1996).

[55] The LR test statistic, 64.655, exceeds the 1% critical value for the mixed χ^2-distribution with 7 degrees of freedom, 17.755.

[56] Note that the parameters δ_0, δ_{SP} and δ_τ must be zero if γ is zero, given that the cost function already involves an intercept term, β_0, a first-order coefficient for the speed effect, β_{SP}, and a parameter associated with the year of observation, β_τ. If there are no random inefficiency effects in the model, then the coefficients δ_0, δ_{SP} and δ_τ are not identified.