Drying and Milling Cost Functions of Paddy: Empirical Estimates for Government Processing Complexes in Malaysia

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ABSTRAK

Kajian ini menggunakan kaedah fungsi kos statistik untuk model kos pengeringan dan pengilangan bagi kilang-kilang padi kerajaan di Malaysia. Fungsi-fungsi kuadratik dan songsang dianggarkan. Hasil daripada kajian ini menunjukkan bahawa skala ekonomi wujud dalam pengeringan dan pengilangan. Kos ekonomi dicapai pada paras output yang tinggi. Seterusnya kajian yang lebih terperinci terhadap data kos dan output menunjukkan bahawa kebanyakan kilang padi kerajaan beroperasi pada tingkat kuantiti yang kebanyakan kos ekonomi tidak dipergunakan.

ABSTRACT

In this paper, the statistical cost function approach was used to model the drying and milling cost for government paddy/rice processing complexes in Malaysia. The quadratic and inverse cost functions were estimated. The results suggest that there exists cost economies at relatively high output levels for both the drying and milling operations. Examination of output data indicates that a large number of government paddy mills operate at low outputs, with cost economies unexploited.

INTRODUCTION

Over the years, paddy processing in Malaysia has been increasingly taken over by the government. In 1983, capacity utilization by private millers was at 33 percent whereas the government mills utilized more than 80 percent of their available capacity (National Paddy and Rice Board, 1984). The increasing role of the government complexes can be attributed to the present paddy pricing system and the closure of many private processing plants in recent years. During the 1981–83, 25 private rice mills were reported to have closed down (National Paddy and Rice Board, 1984) because of low profit margins.

The shutdown of many private mills is symptomatic of adjustments within the paddy postharvest industry. Rising input cost and stagnating output price have placed a squeeze on privates millers' margin. Various government programmes, notably the price control on rice, has adversely affected millers' activities. At the same time, the high capital investment required to enter the postharvest industry effectively discourages new entrants.

If the present trend continues, with no significant changes to the paddy and rice pricing system, it is likely that there will be a further increase in the role to be played by government complexes in paddy processing. Already calls to increase the number of government mills and complaints concerning the inadequacy of the present government paddy procurement system are being raised by various quarters. The impli-

cations of setting up more government mills are tremendous in terms of cost.[1]

This paper reports a study on the cost efficiency of government rice processing mills. While industrial organization theory suggests that private firms are either cost minimizers or profit maximizers, the objective of government statutory bodies may be quite different. With regard to government mills, there is no written information available as to how they should be operated. It is, however, generally understood that complex managers are expected to minimise monetary losses. Given the current government paddy purchasing policies and rice price, it would not be possible for these complexes to generate any profit. Unfortunately, published work in the area of cost efficiency of government mills are scanty. Runte and Ali (1973) provided an economic evaluation of drying units in the country, while Fredericks and Wells (1983) considered the technical and economic aspects of rice processing in Malaysia. In both studies, cost analysis was given scanty treatment. An earlier paper on the same topic (Ghaffar and Hassan, 1985), provided some preliminary estimates of costs associated with rice drying and milling in Peninsular Malaysia. Although this particular study suffers from several drawbacks, notably the small number of observations used for the computation of costs, it nevertheless provides a general idea of cost patterns within government rice mills. Items such as fuel, electricity and labour make up a good portion of the total operation cost. Administrative overhead contributes the largest portion to total operation cost.

MATERIALS AND METHODS

Modelling, Drying and Milling Cost Relationships

The approach used in this study is the statistical cost function approach. One generally accepted drawback of this approach was outlined by Friedman (1955) and is now commonly known as the "regression fallacy". However, several researchers are of the opinion that regression fallacy is not a

serious problem on pragmatic grounds and also, if the objective of estimating the cost function is to estimate expected cost functions instead of certain cost functions from perfect technological frontiers (Heady, 1956; and Walters, 1960, Walters, 1963, Bhati, 1974).

Statistical cost analysis essentially involves the examination of the relationship between the cost of producing some output and the size or level of the output produced. Economic theory suggests that for any firm of a given size, its cost per unit of output (AC) curve in the short run will be U-shaped. As the firm increases its capacity or size in the long run, there will be short-run average cost curves (SACs) for each size (*Figure 1*). A curve enveloping the SACs from below in the manner shown in *Figure 1,* is the long-run average cost curve (LAC). LAC therefore represents the cost-size relationship. LAC initially declines due to internal physical and pecuniary economies of scale occurring as the firm size increases. The firm whose SAC's lowest point coincides with the lowest point on the LAC operates at the optimum size according to the minimum per unit cost of production criterion. When the size of firms increases beyond the optimum size, internal diseconomies set in and as a result the LAC takes an upward turn. Thus in short, the internal economies and diseconomies give rise to the U-shape of LAC.
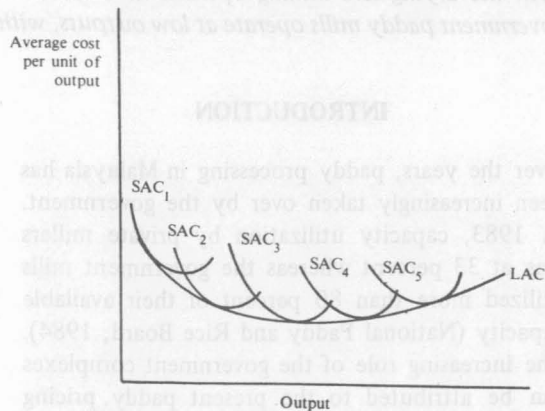

Fig. 1: *Hypothetical shortrun and longrun Average Cost Curves*

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[1] A study conducted by LPN indicates that if the trend in shut down of private rice processing plants continues, the government would have to build at least 66 more processing plants which would cost the government over 1 billion ringgits (NPRB, 1984).

In many studies on average cost relationship, the following functional forms have been used widely (e.g. Barthwal and Nair, 1979; Bhati, 1974; and McLemore *et al.* 1983).

$$AC = \alpha + \beta Q + \delta Q^2 + u \qquad (1)$$
$$AC = \alpha + \beta (1/Q) + \delta (1/Q)^{2 \cdot} + v \qquad (2)$$

Where
AC = average cost
Q = level of output or throughput
u, v = random error terms

The linear version of relation (1) is expected to give a negative sign for the coefficient of Q and a positive sign for Q^2. This relationship generally leads to an average cost curve that has the U-shape. Relation (2) is expected to give a positivie sign for the coefficient of $(1/Q)$ and a negative sign for $(1/Q)^2$. This relationship implies that average cost is inversely related to output and that the curve declines continuously. Log linear version of equation (1), without the Q^2 variable, also leads to a declining average cost. Such an application in existing literature is, however, quite limited.

Data and Data Collection

Cross-sectional data on the costs of various output and activities of government rice mills were collected by means of specially designed questionnaires to cover the four processing activities namely: buying, drying, milling and administration. The questionnaires have been designed to match the monthly reports submitted by each complex to LPN Headquarters. Detailed data from all the 31 government rice mills for 1984 and 1985 were obtained and the costs were grouped into four components, namely labour, energy, repairs and maintenance, and other costs. Both drying and milling operating costs were categorized in the same manner. These components were then aggregated to get estimates of total operating cost for drying and total operating cost for milling.

As a measure of the throughput, the quantity of continuously dried paddy was used. This choice was made as all paddy had to go through the continuous drying unit during processing

(Ghaffar and Hassan, 1985). For milling output, the quantity of rice produced was used.

As the processing complexes were built in different years, they were stratified into four phases according to the year the complexes were commissioned. These time periods were defined by LPN to reflect technological change. Phase I is for mills commissioned in the pre-war period up to 1971. Phase II covers 1972 to 1973 while Phase III is for the period from 1974 to 1982. Phase IV is for complexes which started operating from 1983 onwards. Drying facilities in many of the complexes in the earlier phases had also been upgraded. This was mainly in the form of installation of batch dryers to cater for the peak harvesting period. Only 25 of these LPN mills were integrated mills i.e. having both drying and milling facilities.

Data from all the 31 government mills were scrutinized to ensure that the data used were sufficiently accurate. For estimating the milling cost function, data·from eleven mills were excluded. This is because four of these mills did not have milling activities while seven others were eliminated because many of their figures for various items were not reported. Seven mills were not included in the estimation of the drying cost relationship. One mill was eliminated because of various inconsistencies in cost and output figures. The other six were dropped as many items related to cost and output were not available.

RESULTS AND DISCUSSION

For the drying cost function estimation, 48 data points were used while for the milling cost function estimation, 40 data points were used.

As the data used were collected over two separate years, it is possible that there is the year to year effect i.e. the coefficients obtained for one particular year may differ substantially from the ones estimated for the other year. The Chow test (Chow, 1960) was used to determine if the coefficients of the two regression models for the two separate years were significantly different from each other. We found no evidence to suggest that the parameters of the cost functions for the two separate years were significantly different

from each other.[2] Also no attempt was made to estimate separate cost functions for different phases, as intercept dummies used to differentiate phases have coefficients not significantly different from zero.

The functional forms for the drying relationship estimated were:

$$DAC = \alpha + \beta DQ + \delta DQ^2 \qquad (3)$$
$$DAC = \alpha + \beta(1/DQ) + \delta(1/DQ)^2 \qquad (4)$$

where

DAC = drying average cost in units of M$1,000
DQ = drying output, in units of 1,000 metric tons
DQ^2 = drying output squared

The functional forms estimated for the milling relationship were:

$$MAC = \alpha + \beta MQ + \delta MQ^2 \qquad (5)$$
$$MAC = \alpha + \beta(1/MQ) + \delta(1/MQ)^2 \qquad (6)$$

TABLE 1
Coefficient Estimates of Average Drying Cost Model[a]

Coefficient	Estimate	t-value
α	3.275	0.859
β	275.403	4.799
δ	−507.290	−3.782
R^2	0.372	−
F	13.601	−

[a]The model used was $DAC = \alpha + \beta(1/DQ) + \delta(1/DQ)^2$

[2]Test of equality of coefficient for different regression equations was done using the F-statistic which was calculated using the formula

$$F_{(k, n-k)} = \frac{(RSS - \sum\limits_{i=1}^{2} RSS_i)/k}{(\sum\limits_{i=1}^{2} RSS_i)/(n - 2k)} \quad ; i = 1,2$$

where RSS = Residual sum of squares of the regression fitted to the entire period.

where

MAC = milling average cost in units of M$1,000
MQ = milling output, in units of 1,000 metric tons
MQ^2 = milling output squared

To each of the drying and milling average cost models, a stochastic error term was included additively.

Initial attempts at estimating the average drying cost function included estimating the log linear version of equations (3) and (4) without the variables DQ^2 and $(1/DQ)^2$ respectively. However, none of these variables yielded coefficients significantly different from zero. The 'best' equation for the average drying cost model is as shown in Table 1. All the estimated coefficients except the intercept term are significant at the one percent level. The positive sign for the coefficient of (1/DQ) is consistent with the a priori expectation that average cost declines as output increases, hence suggesting the presence of size economies. As for the variable $(1/DQ)^2$, any definitive interpretation is not possible. However it should have the right sign such that the appropriate curvature of the estimated function can be obtained. The emphirical result indicates that the curve of the estimated regression is continuously declining *(Figure 2)*.

As in the average drying cost model, various forms of the average milling cost model were also estimated. The best regression is as shown in Table 2. The results indicate that in general, there is support for the negative relationship between average milling cost with output. The estimated value of β is consistent with a priori expectation.

RSS_1 = Residual sum of squares of the regression for the first n/2 observations.

RSS_2 = Residual sum of squares of the second n/2 observations.

n = Number of observations.

k = Number of estimated parameters.

The F values obtained were 2.593 and 0.263 for drying and milling cost models respectively, both not significant at 5% level.

Fig. 2: Estimated drying Average Cost Curves

M$1 = US$0.38 (July 1986)

The negative sign obtained for β suggests the presence of cost economies. That is, there is a reduction in the average cost as milling output is increased. The nature of size economies may be seen further by drawing the actual and estimated cost curves. The actual cost curve appears to take the typical U-shape (*Figure 3*).

Since both the underlying cost structures are characterized by size economies, it is of interest to consider the extent to which cost could be saved if output was to be increased. This may be achieved by computing the cost elasticity with respect to output. The elasticity of cost with respect to output for drying and

M$1 = US$0.38 (July 1986)

Fig. 3: Estimated Milling Average Cost Curves

milling was computed as −0.649 and −1.054 respectively.[3] These elasticity values imply that a one percent change in output will lead to a reduction of 0.65 percent and slightly more than one percent reduction in drying and milling cost respectively. These figures indicate that if output was to be expanded, cost savings can be achieved by using existing facilities, as a substantial portion of present capacity is not utilized.[4] Examination of the cost output data further reveals that the minimum cost outputs were about 15,730 tons for drying and 8,000 tons for milling, respectively. The results indicate that currently, only about 45 percent of optimum drying output, and 52 percent of optimum milling output, were produced.
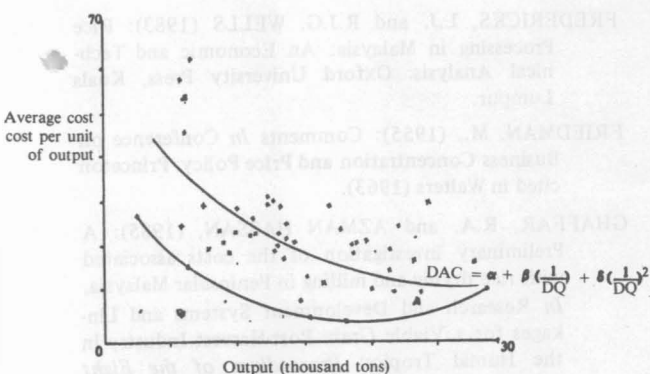
TABLE 2
Coefficient Estimates of Average Milling Cost Model[a]

Coefficient	Estimate	t-value
α	94.198	8.032
β	−14.907	−4.112
δ	0.719	2.906
R^2	0.536	−
F	21.378	−

[a]The model used was MAC = $\alpha + \beta MQ + \delta MQ^2$

CONCLUSION

This paper has presented estimates of average cost functions for both drying and milling of paddy, using data from government owned processing plants. Although both average and total cost representations of cost-output behaviour are theoretically acceptable, empiricial work in the estimation of cost functions do not seem to indicate any definite preference for either one type over the other. In practice, as indicated by existing literature, there is a fair mix of the two approaches. In some cases the choice of
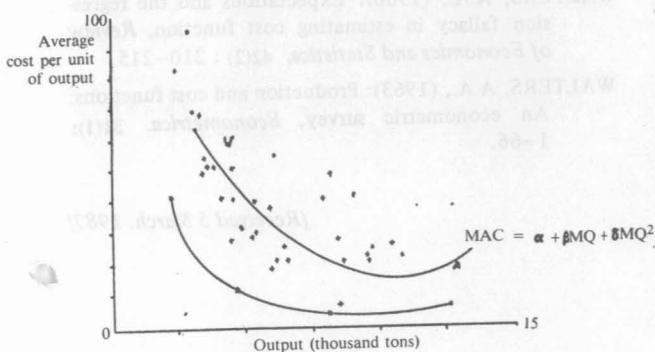
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[3]These elasticities were computed at the mean.

[4]Drying and milling capacities vary among the processing complexes. A study reported by Ghaffar and Hassan (1985) indicates that drying and milling capacities were 20,000 and 16,000 metric ton per year respectively. Capacity here was measured with the assumption that each complex runs for 16 hours/day, 200 days a year.

whether to use average or total cost may not be obvious. Researchers are often constrained by data availability or other estimation problems. The results obtained here indicate, however, that the use of average cost is appropriate for paddy processing.

To the extent that the results obtained in this study provide a fair representation of cost-output relationship, some tentative conclusions can be drawn. For both drying and milling operations, cost economies were present. Cost economies were available at relatively high output levels. However, examination of the cost output data indicated that for both years, large numbers of the government paddy processing plants operated at outputs that leave substantial cost economies unexploited. It is possible that because of the seasonal nature of the paddy crop, with peak harvesting occuring in a short space of time and the need to process the paddy within a short time period, such cost economies are at best theoretical and cannot be exploited. However, this can only be true for drying and not for milling because the latter can surely be staggered out over the year. Further investigation as to why government mills operate at nonoptimal output levels is ongoing.

REFERENCES

BARTHWAL, B.R. and K.N.S. NAIR, (1978): The cost structure of Indian industries: Some empirical evidences, *The Indian Economic Journal*, 27(2): 35–47.

BHATI, U.N., (1974): Cost functions for Selangor padi farm, *Kajian Ekonomi Malaysia*, 11: 1–13.

CHOW G.C., (1960): Tests of equality between two sets of coefficients in two linear regressions, *Econometrica*, 28: 591–605.

FREDERICKS, L.J. and R.J.G. WELLS (1983): Rice Processing in Malaysia: An Economic and Technical Analysis. Oxford University Press, Kuala Lumpur.

FRIEDMAN, M., (1955): Comments *In* Conference on Business Concentration and Price Policy. Princeton cited in Walters (1963).

GHAFFAR, R.A. and AZMAN HASSAN, (1985): A Preliminary investigation of the costs associated with rice drying and milling in Peninsular Malaysia, *In* Research and Development Systems and Linkages for a Viable Grain Post-Harvest Industry in the Humid Tropics: *Proceedings of the Eight ASEAN Technical Seminar on Grain Post-Harvest Technology*, eds., R.L. Semple and A.S. Frio: 424pp.

HEADY, E.O. (1956): Budgeting and linear programming in estimating resource productivity and cost relationships, *In* Heady, E.O. et al., Resource Productivity, Return to Scale and Farm Size. Ames. Iowa.

MC LEMORE, D.L., G. WHIPPLE and K. SPIERLMAN (1983): OLS and frontier function estimates of long-run average cost for Tennessee Livestock Auction Market, *Southern Journal of Agricultural Economics*, 15(2): 79–83.

NATIONAL PADI AND RICE BOARD (NPRB) (1984): The Status of the Rice/Padi Processing industry; Problems and Suggestions, A paper presented at *Seminar Penilaian ke atas Kecekapan dari segi Kos dalam Pemprosesan Padi/Beras*, LPN, Kuala Lumpur 1984 (in Bahasa Malaysia).

RUNTE, R. and A. ALI, (1973): Evaluation of existing artificial units in Malaysia, Alor Setar. (Unpublished)

WALTERS, A.A., (1960): Expectations and the regression fallacy in estimating cost function, *Review of Economics and Statistics*, 42(2) : 210–215.

WALTERS, A.A., (1963): Production and cost functions: An econometric survey, *Econometrica*. 31(1): 1–66.