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Does hiring a manager improve efficiency – owner vs. non-owner management control of rice mills

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Abstract

Purpose – In this study, the impact of owner-operator and non-owner operator rice mills on productive efficiency is investigated.

Design/methodology/approach – Primary data collected from a survey of 111 rice mills in the Mwea region of Kenya are used. A metafrontier approach is employed to measure overall technical efficiency which is decomposed into managerial and organisational efficiency.

Findings – The results reveal no significant difference in overall technical and managerial efficiency between owner and non-owner operated mills. However, a significant difference exists in organisational efficiency of mills: non-owner operated mills were found to be performing significantly better than owner-operated.

Practical implications – The authors provide supporting evidence to the study and discuss some of the significant policy implications stemming from the study.

Originality/value – It is recognised that for owners to take the risk of divesting control to a hired manager rather than manage the firm themselves can have major strategic, financial and often emotional consequences. However, there is little empirical evidence on how production efficiency will develop as a result of hiring a manager with the underlying economic theory providing ambiguous guidance. Standard economic theory assumes that firms behave as profit maximisers, which can be achieved by operating efficiently. However, this may not always be the case and as the literature indicates, this may especially be so for small businesses in low- and middle-income countries.

Keywords Performance measurement, Data envelopment analysis, Efficiency, Developing countries, Owner and non-owner operated mills

Paper type Research paper

1. Introduction

It is recognised that for owners to take the risk of divesting control to a hired manager rather than manage the firm themselves can have major strategic, financial and often emotional

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consequences. However, there is little empirical evidence on how production efficiency will develop as a result of hiring a manager. The underlying economic theory provides ambiguous guidance. Standard economic theory assumes that firms behave as profit maximisers, which can be achieved by operating efficiently. However, this may not always be the case and as the literature indicates, this may especially be so for small businesses in low- and middle-income countries. There are also theoretical and logical explanations of why some firms choose to not operate efficiently and thus not maximise profits. For example, Singel and Thorton (1997) observed that utility-maximising entrepreneurs may trade profits for non-market goods and therefore not hire inputs to maximise their profits. Behrenz and Månsson (2021) also observed altruistic behaviour amongst firm owners when hiring persons entitled to a wage subsidy.

Hired managers look after the day-to-day operations and make decisions on behalf of the owner of the firm (Putterman, 2008). Decisions on behalf of the firm are based on the level of output and employment and consequently such decisions have implications for the firms' productive efficiency. Agency theorists suggest that separating ownership and control of a firm can have significant benefits which far outweigh the costs associated with delegating control of business decisions to managers (Fama and Jensen, 1983a). However, while the advantages of specialisation of functions are well-known to economists and employers, agency theory does not well accommodate the advantages of specialisation but is rather focussed on the problems associated with incentives that comes with it. In short, the focus, notably is on those issues arising from separating ownership and control. It is therefore clear that if these problems can be contained acceptably, the advantages can exceed the agency costs.

Previous studies of owner operated versus non-owner operated firms show that owner operated firms are more efficient. Coelli *et al.* (2002) and Rahman and Rahman (2009) investigated rice farming in Bangladesh using data envelop analysis (DEA) and found owner operated rice farms performed better than non-owner operated rice farms. Esmaeili (2006) employed stochastic frontier analysis (SFA) to examine the determinants of technical efficiency of the Iranian fishing industry and found that owner operated vessels were more efficient than those which were not owner operated. Yang *et al.* (2013) employed DEA to measure the efficiency performance of Taiwanese electronic firms and observed that the separation of control and ownership had a negative impact on efficiency. Durand and Vargas (2003) investigated productive efficiency across three industries (printing, automotive parts and chemicals) using DEA. Their findings showed that owner operated firms were more efficient than agent-led firms, but only where the firm was multi-layered. Manjunatha *et al.* (2013) used SFA to measure the efficiency of groundwater irrigated farms in the hard rock areas of South India and found that owner operators were more efficient than non-owner operators. Donkor and Owusu (2014) used SFA to measure the efficiency of Ghana's rice industry and found that owner operated rice farms (i.e. large farm size of 1.57 ha and over) are more technically efficient than fixed-rented and sharecropping farms. Koirala *et al.* (2016) used SFA to measure the efficiency of rice farming in the Philippines and observed that owner operators with more than 2 hectares of land (i.e. large farm size) were technically more efficient than share tenant and leasehold land operators. Schiersch (2013) investigates mechanical engineering firms in Germany. In the analysis a variable indicating activity by the owner is included. The author finds that companies with active owner(s) are significantly more efficient than those where the owner is less active. Lawin and Tamini (2019) using a stochastic metafrontier model and apply it to a matched sample of smallholders in Benin. The chief finding of this study is that non-landowners have a consistently higher efficiency and productivity. Moon *et al.* (2020) employed SFA to measure the productivity of rice production in the Boro region of northern Bangladesh. Their results revealed that productivity was higher for owner and cash tenants compared to others. McFadden *et al.* (2021) used a generalised heteroscedastic stochastic frontier model to measure the efficiency of midwest corn production in the USA and found that technical efficiency was significantly influenced by field ownership status. Paltasingh *et al.* (2022) examined the Marshallian inefficiency hypothesis of the shared agricultural tenancy system in Odisha, in eastern India. Their findings indicated that owner-operators with a secured tenancy arrangement are more efficient than sharecroppers, and that ownership status as it relates to the total operational system of landholding positively affects efficiency. That is, ownership produces greater efficiency than partial and pure tenants. Fama and Jensen's (1983a), study shows that owner operated firms perform efficiently under conditions of proprietorships, small partnerships and closed corporations in small-scale firms.[1] Yildrim *et al.* (2022) used DEA to compare the economic performance and productive efficiency of owner and sharecroppers in the Kaş District of Antalya Province in Turkey. They found that economic performance and productivity of owner operators were lower than that of sharecroppers. In light of these contradictory findings the question for this paper is, do owner managed firms perform better than firms operated by a hired manager? We examine this vexed issue using primary survey data of rice millers from the Mwea region of Kenya.

The studies of Fama and Jensen's (1983a) and Yildrim *et al.* (2022), either applied a statistical test of differences between the two groups (i.e. owner operated versus non-owner operated) in a second stage analysis or included an ownership control variable as an explanatory variable in the regression analysis. In this study, we apply, as does Lawin and Tamini (2019), a metafrontier approach and divide technical efficiency into two components: managerial efficiency and organisational efficiency. Managerial efficiency is computed for owner controlled and non-owner-controlled mills separately while organisational efficiency refers to the level of inefficiency exhibited by these two groups. In our empirical application we use a case study of rice milling in the Mwea region of Kenya which is mainly a small-scale cottage industry and therefore allows for a relevant analysis [2].

The outline of the paper is as follows. Following the introduction, Section 2 describes the theoretical framework of why and how ownership control of a firm is important for productive efficiency. Section 3 describes the methodology. Section 4 describes the data. Section 5 presents the results. Our findings clearly show that non-owner mill operators generate higher organisational efficiency while there is no significant difference between technical and managerial efficiency. Our results are shown to be not necessarily inconsistent with all the literature – it is backed by several studies that indeed show non-owners consistently have higher levels of technical efficiency and productivity. The paper concludes by outlining a number of policy implications in Section 6.

2. Theoretical framework – why and how ownership control is important for productive efficiency

Discussion on the efficiency of a business operation linked to owner operated or non-owner operated firms is based on the theoretical foundations of the principal agency theory and the possibility to set up complete contracts (see, for example, Coase, 1937 [3]; Jensen and Meckling, 1976; Fama and Jensen, 1983a,b; Williamson, 1975, 1985; Aghion and Bolton, 1992; Hart, 1995). There are two main theoretical concerns relating to asymmetric information which might influence productive efficiency. The first is the issue of moral hazard which relates to the risk of non-compliance of, in this case, a hired manager. According to the theoretical framework set out by Milgrom and Roberts (1992), complete contracts, whether explicit or not, guarantee the elimination of the potentially harmful effects of moral hazard on efficiency. Second, the issue of adverse selection refers to a situation where the agent hides information or gives erroneous information before the contract is in place. In the case of adverse selection, the possibility of enacting complete, or nearby complete contracts, will depend on the owners' capacity to control the operation of the firm (Jensen, 1983). According to Alchian and Woodward (1988), it is likely that adverse selection is of no importance if the owner is managing the firm. However, in the case of non-owner operations, adverse selection poses a problem for the efficient use of resources. In summary then, it could be argued that if ownership and control of a firm is with the owner, it reduces the risk for both moral hazard and adverse selection and thereby inefficient use of resources. Hence, we test the hypotheses that owner operated mills do perform more efficiently than non-owner operated mills.

Another aspect of the owner operated business is highlighted in Singel and Thorton's (1997) framework. They introduce a slack variable to the profit maximising model in which the owner operated firms have non-business motives. Using data from 116 family dairy farms in Utah, Singel and Thorton (1997) observed that utility-maximising entrepreneurs trade profit for non-market goods and do not hire inputs to maximise profits. In this case, productive efficiency for such firms will be lower than non-owner operated firms that have a greater focus on profit maximisation. The second strand of literature focusses, as does Singel and Thorton (1997), on family-operated firms. Patel *et al.* (2018) using two archived datasets and primary datasets convincingly showed that family-owned franchisees had lower performance relative to non-family-owned franchisees. They note that of the small businesses surveyed, those that were family-owned had 6.7% lower sales when compared with non-family-owned businesses. Schultze *et al.* (2001) and Behrenz and Månsson (2021) observed that there were situations where employers employ out of altruistic motives. This behaviour is prominently found in family-owned and family-operated firms where social concerns play a significant role and which can negatively impact on productive efficiency (see, for example, Schulze *et al.*, 2001). Hence, the theory posited above, which takes its departure from the moral hazard/adverse selection discourse, claims that owner operated firms are less efficient than non-owner operated firms and thus contradicting the bulk of the extant literature's findings. There is also strong evidence emerging in the more recent literature on farming that clearly demonstrates that non -tenured farmers (a proxy for non-ownership) are more technically efficient than landowners. For an excellent study, see, Lawin and Tamini (2019).

3. Measuring efficiency and the metafrontier

Section 3.1 introduces the DEA framework and its role in measuring efficiency while section 3.2, provides the concept of the metafrontier.

3.1 Measuring efficiency

In this study a DEA framework is used to compute technical efficiency [4] (Farrell, 1957; Charnes *et al.*, 1978) [5]. Let $x_n, n = 1, 2, \ldots, N$ be a vector of inputs and $y_m, m = 1, 2, \ldots, M$ be a vector of outputs for the k = 1,2, . . ., K firms. Then the technology T, can be defined as:

$$T(\mathbf{x}, \mathbf{y}) = \{(\mathbf{x}, \mathbf{y}) : \mathbf{x} \text{ can produce } \mathbf{y}\} \tag{1}$$

Technical input-efficiency is here defined as the maximum radial contraction of inputs that can be made at a constant output level while retaining the same technology. A rice mill that cannot reduce its inputs is considered to be efficient and these mills are used to construct the reference technology. This reference technology, or the isoquant, is constructed as piece-wise linear convex combinations of observed efficient units as illustrated in Figure 1 below [6]. The radial technical input-efficiency score under variable returns to scale (VRS) for rice mill i is obtained from the following linear programme:

$$TE_i = \min \lambda_i \tag{2}$$

s.t.

$$\sum_{n=1}^{N} z_k x_{n,k} \leq \lambda_i x_i, \quad k = 1, \ldots, K \tag{3}$$

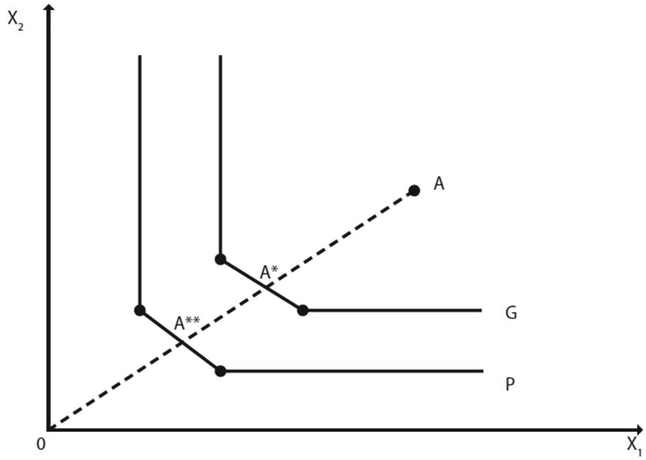

Figure 1.
Illustration of the metafrontier approach

$$\sum_{m=1}^{N} z_k y_{m,k} \geqq y_i, \quad k = 1, .., K \tag{4}$$

$$\sum_{k=1}^{K} z_k = 1 \tag{5}$$

$$z_k \geqq 0, \quad k = 1, \ldots, K \tag{6}$$

λ_i is the efficiency score. In the input-based framework λ_i takes a value between 0 and 1 and is interpreted as the extent to which inputs can be reduced while still being able to produce the observed output. For example, if $\lambda_i = 0.8$ this means that for mill i it would be possible to multiply the input vector x_i by 0.8 and still be able to produce the observed output vector y_i. Restrictions [5] impose variable returns to scale (Banker *et al.*, 1984). The motivation for using variable returns to scale for the study is that we only have access to data for one year and there is variation in mill sizes. Using variable returns to scale means that we allow for deviation from long run optimal scale (scale inefficiency) which is reasonable in the short run. An alternative would have been to use constant returns to scale and thereby evaluate the long run efficiency. The intensity variable z is used to construct convex combinations between the mills that are efficient, i.e. located on the isoquant.

3.2 Metafrontiers

Much of the recent literature on metafrontiers refers to O'Donnell *et al.* (2008) work. However, a metafrontier approach has been used both in developed and developing countries contexts (see for example, Charnes *et al.*, 1981; Grosskopf and Valdmanis, 1987; Månsson, 1996; Fontain and Lin, 2019; Cummins and Rubio-Misas, 2021). In this study, the empirical strategy outlined in Grosskopf and Valdmanis (1987) is followed. The meta technology is constructed from all observations independent of whether the mill is operated by the owner or not. The meta, or pooled frontier, measures overall technical efficiency. Frontiers are also constructed for each distinct group that is captured in the analysis which, in this study, is the type of operation adopted by the business whether owner operated, or non-owner operated. As illustrated in Figure 1, the overall technical efficiency can be decomposed into managerial efficiency and organisational efficiency.

Figure 1 illustrates the overall technical efficiency and its decomposition using a metafrontier. Here, the G frontier represents the group, i.e. owner operated, or non-owner operated rice mills and the P frontier represents the pooled frontier. The rice mill to be evaluated in this illustration is mill A which, in this example, is assumed to be non-owner operated. An input-based framework is used in the analysis where X_1 and X_2 represent two different inputs. The overall technical efficiency (*TE*) score for unit A is computed as $\|0A^{**}\|/\|0A\|$. Overall technical efficiency can be decomposed into two parts, i.e., management efficiency and organisational efficiency. Managerial inefficiency is defined as the amount of inputs that can be reduced when the comparison is made with peers belonging to the same group, i.e. owner operated, or non-owner operated rice mills. Managerial efficiency (*ME*) is computed as $\|0A^{*}\|/\|0A\|$, i.e., the distance to the group frontier. Organisational inefficiency is defined as the part of overall inefficiency that cannot be reduced due to the fact that a rice mill is operated by a specific operator (owner, non-owner). Organisational efficiency (*OE*) is computed as, $\|0A^{**}\|/\|0A^{*}\|$, i.e. the distance between the group frontier and the pooled frontier. The relation between the three measures can be stated as follows:

$$TE = ME \cdot OE \tag{7}$$

To test for differences between owner operated and non-owner operated rice mills in terms of overall managerial and organisational efficiency, the method proposed in Simar and Zelenyuk (2006), which is a development of Li (1996) to the Farrell framework, is used.

4. Data

As noted in Durand and Vargas (2003), evaluating a private firm's performance is challenging because of access to reliable data. Furthermore, data on owner operated and non-operated firms is usually unavailable publicly especially for small-scale firms. Daily and Dollinger (1993) noted the problem in collecting primary data due to the difficulty in recognising *a priori* a private non-listed firm's governance form. Nonetheless, this study was able to obtain data on owner operated and non-owner operated mills through survey interviews.

This study uses primary data obtained from survey interviews of rice millers in the Mwea region of Kenya (see Figure 2). The study was conducted in the seven sub-counties of the areas that had rice mills. Purposive sampling was used to obtain a sample of the mills that were in operation in the study area. The study area of Mwea included Murinduko (Muu and Riagicheru), Kiarukungu (Kiarukungu), Wamumu (Wamumu), Mahiga-ini (Mahiga-ini and Gathigiri), Muthithi (Kabiriri, Rukanga, Kinyaga and Kandegwa), Thiba (Thiba and Nguka), Kangai (Mathigaini, Kombuini and Kathiga) and Nyangati (Nyangati).

The Mwea region was chosen because it is the biggest paddy rice producer in Kenya, with 50% of its area used for irrigated rice growing. The region also has the largest number of rice millers with 200 small and 5 large scale millers, the majority of which are privately owned. The Mwea population draw their livelihood from rice farming and milling. Hence the rice millers remain a key player in the rice market accounting for about 80% of the locally milled rice supply. From this population, our survey interviews carried out in June 2014, covered 150 small-scale millers using a well-structured questionnaire. The field work survey instrument (questionnaire) and process was scrutinised by the Queensland University of Technology (QUT) Human Research Ethics Committee and then assigned approval number 1400000195. Enumerators conducted face to face interviews with the rice millers in the study area to collect the data. The socio-economic characteristics captured in the questionnaires included: millers' age, gender, the number of household members, years of schooling, years of experience and

Figure 2.
Map of Mwea irrigation scheme

Source(s): National Irrigation Board (2022)

market distance. The questionnaires also captured technology components included, mill type (if electricity or fuel operated), the age of the mill (number of years used), the number of days the mill operated and the number of times the mill was serviced annually. From the survey, 122 small business rice processors were randomly selected, of which 111 rice millers remained in the study's final sample. 11 millers (9.0%) were dropped of which nine were considered outliers after performing an outlier detection test using the concept of super efficiency. The remaining two had incomplete information and were therefore also considered to be outliers. Details and results of the super efficiency outlier detection are presented in Table A1 in Appendix 2. 40% of rice millers from our sample of 111 were owner operated.

The input-output model consists of one output and four inputs. Paddy output is the amount of processed rice measured in kilogrammes. Inputs are energy, labour and capital. Energy consumed by the mill is measured as energy consumed (kWh) over a period of one year. To measure energy, we converted fuel to kWh using an energy conversion factor of 11.63 litres of fuel equalling to 1 kWh of electricity. Labour is measured as the number of hours worked in the mill in one year. Capital is measured by two variables. The first is the number of machine-hours used by a mill in one year. The second is *other operating expenses*. For this input we assume that all operators face the same price for operating a mill. The summary statistics of the data are provided in Table 1.

The statistics presented in Table 1 show that the mills on average processed 376,170 kg of paddy per year. It can also be observed that there is a large spread in the data. The smallest mill produces 10,400 kg and the larges mill 1,872,000 kg.

As for inputs, the average use of energy equivalents was 15,099 kWh per year. The average number of working hours per year was 3,393 h which corresponds to around 1.8 full-time workers if 1,800 operating hours is assumed to represent a full-time equivalent. Each mill operated their machines, on average, for at least 1,655 h a year. Finally, the average operating expense was 116,991 ksh per year. Since cost data are used for operating expenses, it is assumed that each rice mill faces the same input price for each component that make up the variable 'other operating costs'.

5. Results

The results are presented in three parts. Section 6.1 presents the overall technical efficiency while Sections 6.2 and 6.3 provide the decomposition of overall technical efficiency into managerial efficiency and organisational efficiency, respectively.

5.1 Overall technical efficiency

In Table 2 descriptive statistics for overall technical efficiency for the rice mills are presented. Overall technical efficiency was observed to be higher for non-owner operated mills than that of owner operated mills. The reported average inefficiency was around 35% for owner operated mills compared to around 30% for non-owner operated mills. Moreover, amongst the owner operated mills, 20.4% were fully efficient compared to almost 27% of the non-owner operated mills that were fully efficient.

To compare the two groups (owner operated versus non-owner operated Kenyan rice mills) the Simar–Zelenyuk (2006) approach is used [7]. The result is presented in Table 3.

The Simar–Zelenyuk test reveals that, although there were differences between the two groups, it was not significant. In our discussion of the theoretical framework in Section 2, the

Variable	Mean	Std. dev	Min	Max
Total paddy (Kg)	376,170	337,599	10,400	1,872,000
Energy equivalent (kWh)	15,099	11,253	2,412	72,571
Labour (hours/year)	3,393	3,189	312	15,552
Machine hours (Hrs)	1,655	902	312	4,380
Operating expenses (Ksh)	116,991	134,569	9,200	816,000

Table 1. Summary statistics for rice mills in Kenya (N = 111)

Overall efficiency	Mean	Std. dev	Min	N	Number of overall technical efficient mills (%)
Owner operated mills	0.649	0.261	0.223	44	9 (20.4)
Non-owner operated mills	0.704	0.255	0.235	67	18 (26.9)

Table 2. Overall technical efficiency of Kenyan rice mills by operator type

Overall TE	Owner operated vs. non-owner operated Kenyan rice mills
Li-statistic	0.23
Bootstrapped p-value	0.846

Table 3. Overall technical efficiency – Owner operated vs. non-owner operated rice mills

hypothesis was that owner operated mills would be revealed as more efficient than non-owner operated mills. The results at hand give no support to this hypothesis. Interpreting the results in contractual terms indicates that, with respect to overall technical efficiency, the contractual arrangements between the owner and management seems to fulfil the necessary conditions that non-owner operated mills are not less efficient.

5.2 Managerial efficiency

Managerial efficiency is technical efficiency obtained from evaluating efficiency against peers in the same group. That is, owner operated mills are compared with other owner operated mills and non-owner operated mills are compared with other non-owner operated mills. In Table 4 descriptive statistics for managerial efficiency are presented.

Overall, managerial efficiency was found to be very similar between the two groups with owner operated mills being only slightly less efficient compared to non-owner operated mills. An efficiency score of 0.724 implies that owner operated mills on average have an inefficiency of around 27.6% when only compared to other owner operated mills. The corresponding figure for non-owner operated mills is an average inefficiency of 26.9% when only compared to other non-owner operated mills.

To compare the two groups the Simar–Zelenyuk (2006) approach is used. The result is presented in Table 5.

The results reported reveals that there were no significant differences in managerial efficiency between owner operated and non-owner operated rice mills. This can be interpreted as indicating that, given the operational pre-conditions, none of the operations carried out by the mills varied greatly.

5.3 Organisational efficiency

Organisational efficiency is interpreted as the part of efficiency that cannot be improved due to the fact that a rice mill belongs to one the other group. Organisational efficiency is reported in Table 6.

Table 4. Managerial efficiency of Kenyan rice mills by operator type

ME	Mean	Std. dev	Min	*N*	No. Efficient mills (%)
Owner operated mills	0.724	0.266	0.249	44	16 (36.4)
Non-owner operated mills	0.731	0.250	0.243	67	21 (31.3)

Table 5. Managerial efficiency: owner operated vs. non-owner operated rice mills

ME	Owner operated vs. non-owner operated Kenyan rice mills
Li-statistic	−0.570
Bootstrapped *p*-value	0.351

Table 6. Organisational efficiency of Kenyan rice mills by operator type

Organisational efficiency	Mean	Std. dev	Min	*N*	Number of organisational efficient rice mills (%)
Owner operated mills	0.893	0.100	0.615	44	9 (20.5)
Non-owner operated mills	0.957	0.074	0.673	67	24 (35.8)

While the results for managerial efficiency showed there was considerable similarity between the two groups, the result for organisational efficiency reveals a different pattern. The descriptive statistics in Table 6 reveal a substantial difference in organisational efficiency. A first observation is that non-owner operated mills had higher efficiency than owner operated mills. The organisational efficiency for owner operated mills was 0.893 implying that owner-operated mills on average had an inefficiency of around 11%. The organisational efficiency for non-owner operated mills was 0.957 implying that non-owner operated mills on average had an inefficiency of about 4%. The results are interpreted as showing that a large part of the inefficiency observed for owner operated mills cannot be reduced by mimicking other mills that also are owner operated. As shown by Singell and Thornton (1997), and also discussed in Behrenz and Månsson (2021), this might reflect owners adopting a utility maximising solution rather than a profit maximising solution. Again, we observed that family franchisees generated at least 6.7% lower sales per employee than nonfamily franchisees. A second observation is that the share of fully efficient mills was much higher amongst the non-owner operated mills than for the owner operated mills. Almost 36% of the non-owner operated mills were efficient while only around 20% of the owner operated mills were efficient. What this implies is that non-owner operated rice mills offered a better effective organisational structure than the owner operated rice mills.

To compare the two groups with respect to organisational efficiency, the Simar–Zelenyuk (2006) approach is used. The result is presented in Table 7.

The result of the test confirms that the observed difference in efficiency between owner operated and non-owner operated rice mills was statistically significant at the 1% level. That is, non-owner operated mills were less organisationally inefficient than owner operated mills. These results are consistent with the findings of Lauterbach and Vaninsky (1999) who in their study found that owner manager firms were less efficient in generating income than non-owner managed firms in a survey of 80 Israeli firms. It is worth noting that most rice mills in the Mwea region are family owned and operated which implies that there may be a reluctance to hire managers that can run the mills more professionally even with the existence of a shortage of internal resources. Furthermore, it is worth noting that there are a number of agricultural studies that clearly demonstrate non-owners can indeed be more efficient and productive than landowners which are contrary to the bulk of the extant beliefs and empirical findings. For example, Lawin and Tamini (2019) show from a random study of 2,873 smallholder farmers in Benin that their meta-frontier mean for non-owners (without land tenure) was 0.82 which is much higher than for landholders (with land tenure) which was 0.45. Furthermore, the average technical efficiency in relation to the meta-frontier was 0.92 for non-owners and 0.86 for owners. The authors point out that this difference in technical efficiency could well be due to reasons relating to self-selection in the land market. Here it is argued that farmers who move out of their family land to rent to non-owners to undertake sharecropping are those with inherent managerial skills and who are likely to have been involved less in subsistence agriculture. The authors show that their results are consistent with two other previous studies by Feng (2008) and Ma *et al.* (2017) who found a negative impact off ownership control on technical efficiency in China. They also point to three other studies from Ethiopia and the Philippines in which it is shown that farm ownership has a positive impact on efficiency. They are Ahmed *et al.* (2002), Ghebru and Holden (2015) and Koirala *et al.* (2016).

Organisational efficiency	Owner operated versus non-owner operated rice mills
Li-statistic	6.430
Bootstrapped p-value	0.000

Table 7. Organisational efficiency, owner operated vs. non-owner operated rice mills

They attribute their findings to biases resulting from endogeneity. Lawin and Tamini's (2019) study is of those farmers both with and without tenure. On the other hand, our study is in relation to mill owners and non-owners where it is shown that non-owners are organisationally more efficient than mill owners. The findings of this study thus can have profound implications especially for communities that are reliant on competing resources as is discussed below.

6. Conclusions

Our study adds to the literature by adopting a metafrontier approach which makes it possible to divide overall technical efficiency (the output from previous research) into two components – managerial and organisational efficiency. The study also tests the hypothesis that owner operated mills have a higher productive efficiency than the non-owner operated rice mills.

The results show that the overall technical efficiency does not differ regardless of who is managing the firm. This is also the case for managerial efficiency. In other words, when efficiency is computed within the ownership groups. This finding in terms of the theoretical framework gives some indication that the contracts that exist between the owner and the operator take into consideration the most vital production aspects. However, when examining organisational efficiency – that is, the part of inefficiency that cannot be improved by mimicking peers in the operational type-group, the results show significant differences. The results further show that non-owner operated mills have higher organisational efficiency compared to owner operated mills. As shown by Singell and Thornton (1997), and further discussed in Behrenz and Månsson (2021), this is likely to represent a utility maximising solution for the owner and not a profit maximising solution. The result is also in line with the findings of Patel *et al.* (2018) who observed that family-operated franchisees often recorded lower sales per employee of 6.7% when compared with non-family operated franchisees. Lawin and Tamini (2019) also showed that non-tenured farms from a random sample in Benin are more efficient than tenured farmers. One possible explanation for this result could be that owner organizations' lack of efficiency could be related more to maximising the shares of income amongst, for example, family members, than relying purely only on business objectives. On the other hand, in a non-owner operated mill, the social pressure to employ out of altruistic motivations may well be less important than in the case of an owner operated firm. Another plausible explanation, which is along the lines of Lawin and Tamini's (2019) argument, is that there could well be self-selection occurring amongst non-owner operated mill managers. That is, those who are recruited as mill managers are better educated with superior specialist organisational and work environment arranging skills which results in improved efficiency. Such skills not only add value to a business but are also beneficial for employee engagement and enhancing employee experience. Owners may have less of these skills as well as having less time to devote to improving organisational collaboration which is likely to increase organisational inefficiency. It should be noted here that many mill-owners are also rice farmers which may prevent them devoting the required time to achieve organisational efficiency. Hired managers are free from such encumbrances. Therefore, the findings of this study have real policy implications for agricultural communities which could be harnessed to improve efficiencies using current technologies but by reallocating their existing resources. That is, we show that there is room to better reallocate human resources by concentrating on one activity. For example, rice producers are left to concentrate solely on rice cultivation, leaving the rice milling business to hired managers. Such a strategy of specialisation can bring about productivity increases simultaneously in both rice production and in milling operations. In this study we are focussing on technical efficiency, i.e. resource use. An extension of this research would be to study cost efficiency and decompose that into its component allocative and technical efficiency. Of special interest would be the component allocative efficiency which relates to mix of inputs and pricing of inputs. For example, it might well be that owner-controlled mills' hiring of family members leads to payment of more or less than market prices. However, this type of analysis requires input prices, which were not collected.

Notes

1. Alvarez and Crespi (2003) suggest that technical efficiency in small firms is associated with experience of workers, modernisation of physical capital and innovation in products. They do not, however, include ownership control in their study.
2. For a presentation and a review of previous research on Kenyan rice production see Appendix 1.
3. Please not that some researchers do not consider Coase (1937) to be a paper about agency theory. However, there are many that do so.
4. This study is focussed on technical efficiency, i.e. resource use. If input prices were available, it would have been possible to study allocative efficiency as well. A study of allocative efficiency, is however, is beyond the scope of the present study.
5. One early study regarding aspects of small businesses and efficiency is Lang and Golden (1989).
6. The assumption of convexity means that it will be possible to construct a new unit by taking shares of existing units and add them up (convex combinations). However, the convexity assumption has lately been questioned by, e.g. Kersten *et al.* (2019) who, in an experimental setting, shows that applying this assumption can lead to misleading results. To relax this assumption these authors, suggest use of the free disposal hull reference technology (see, e.g. Tulkens, 1993). It is therefore important to put this assumption into the context of the subject for the study. We believe that it will be possible to take parts of two or more rice mills and construct a new one by adding the parts. Our motivation for assuming convexity is based on the production studied.
7. A Mann-Withney *U* test has also been performed and gave, qualitatively, the same results regarding sign and significance level.

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Appendix 1

There is an extensive literature on Kenyan rice production, but for the sake of brevity, we name only a few recent studies such as Stoop *et al.* (2009), Mati *et al.* (2011), Muhunyu (2012), Nyamai *et al.* (2012) and Omondi and Shikuku (2013). There are good reasons to focus on rice production because Kenya's rice demand has been outstripping output, with annual estimated rice consumption of 538,000 tons exceeding the annual output estimated at 112,800 tons (https://www.irri.org/where-we-work/countries/kenya accessed on 24 April 2020). As it is anticipated that Kenya's future demand for rice will increase due to rising income and urbanisation, the widening gap between demand and supply has to be supplemented by imports and therefore imposes a considerably foreign exchange burden (RoK, 2010b). Kenya's rice import dependency ratio is currently more than 80% with local production meeting only 20% of the demand which indicates that domestic production is inadequate. To achieve self-sufficiency, the Kenya National Rice Development Strategy (NRDS) 2008–2018 details targets and recommendations on both demand and supply.

The literature on Kenyan rice production, however, focusses on rice farming and ignores post-harvest management. Post-harvest management covers activities such as drying, threshing, cleaning, additional drying, storage and processing (http://www.fao.org/3/ac301e/AC301e03.htm accessed on 24 April 2020). Studies that covered post-harvest management include Majiwa *et al.* (2018) and Ndirangu and Oyange (2019). As observed by the International Rice Research Institute (IRRI, 2016), losses in post-harvest management, especially for rice, can be as high as 30% caused by spillage, grain loss or loss of quality. Thus, rice output could simply be increased through minimising losses during the post-harvest management stage and should not be ignored. As also noted in Ndirangu and Oyange (2019, p.38) "efficiency of the milling industry is important in realisation of improved rice supply".

Appendix 2

Outlier detection using super efficiency

It is a well-known fact that the DEA approach is sensitive to outliers (Banker and Gifford, 1988). There are a number of methods to detect outliers (see, e.g. Wilson, 1993; Simar, 2003; Kapelko and Oude Lansink, 2015). One method that has been proposed and gained popularity in recent studies is the use of 'super efficiency' (Banker and Gifford, 1988). Banker and Chang (2006) and Banker *et al.* (2017) used experimental data to demonstrate that the method performed well in practical applications. This study applied the super efficiency model to detect and remove potential outliers. Following Agrell and Niknazar (2014) and Edvardsen *et al.* (2017), an observation was defined as a potential outlier if the output-based super-efficiency score, assuming constant returns to scale (CRS), was below 0.75 or had a super-efficiency score of above 1.25 in an input-based framework. The super-efficiency scores were calculated using the package 'benchmarking' in R (Bogetoft and Otto, 2015). Table A1 reports the super efficiency scores for input-based and output-based model for each mill.

Of the 122 observations 9 were identified as outliers. In addition, 2 variables had missing data thus leaving 111 observations for the analysis.

Observations	Frequency	Percent
Total	122	100%
Non-outlier	113	93%
Outlier	9	7%
Missing data	2	2%
In the analysis	111	90%

Table A1. Classification of outliers using super efficiency scores for Kenyan rice mills

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