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Farm technical efficiency under a tradable milk quota system

F. J. Areal,[1] R. Tiffin, and K. Balcombe
Agricultural and Food Economics Department, The University of Reading, PO Box 237, Reading, United Kingdom, RG6 6AR

ABSTRACT

This paper incorporates the milk quota system into technical efficiency analysis of dairy farms in England and Wales. Our approach accounts for milk quota trade, allowing an investigation of the relationship between the way in which milk quota market is used by farmers and technical efficiency. In addition, several explanatory variables for inefficiency were used. Results obtained from a Bayesian stochastic frontier analysis show that the way in which farmers use the milk quota market is linked to farm efficiency. Other aspects such as environmental payments received by the farmer are linked to inefficiency.
Key words: technical efficiency, milk quota, Bayesian stochastic frontier

INTRODUCTION

The abolition of the dairy quota regimen in the European Union (**EU**) by March 31, 2015, will be the end of a policy that started in 1984 as a way to reduce the increasing EU common agricultural policy's (**CAP**) budget cost. The abolition of milk quotas, which is in concordance with World Trade Organization liberalization process, will expose EU farmers to international market competition, meaning an increase in milk production associated with raw milk price cuts. Under the new scenario, only the most efficient producers will have the chance to remain in business. Therefore, it is relevant, particularly for policy makers, to understand how the use of the quota market and its abolition may affect farm technical efficiency. Specifically, it helps policy makers to support those inefficient farms by identifying where inefficiencies arise as well as the drivers behind inefficiency.

The associated effects of quota regimens in the short and long run at the market (e.g., welfare changes, market inefficiency) and farm levels (e.g., higher average costs, farm inefficiency) using comparative static analysis were highlighted by Dawson (1991) and Van Kooten and Spriggs (1984). Dawson (1991) noted that the economic rent of quota (i.e., the difference between the milk price under the quota system and the competitive market price times the milk quota) will be used by efficient producers to acquire quotas from inefficient producers if quota trade is permitted. The introduction of a milk quota system affects farm and milk market efficiency by reducing the output of farms. In the early stages of the introduction of the quota system, UK milk production was reduced by culling cows and reducing concentrate feeding or by throwing milk down the drain (Harvey, 1985). Under a fixed milk quota system, where trading quota is not permitted, technical improvements, and structural change would be constrained. Under a more flexible system that allowed transferring milk quota it would be expected that efficient farmers would expand their business at the expense of less efficient farmers.

The introduction of a milk quota system has accelerated the changes in milk production in England and Wales. The dairy herd has suffered approximately a 40% decrease in the last few decades, from approximately 3,480,000 dairy cows in 1973 to approximately 2,090,000 in 2005 (Defra, 2011). This decrease in dairy cow numbers has been further pronounced since 1984, the year in which the quota system was put in place. Between 1973 and 1983 (i.e., before the introduction of the quota system), the decline in the dairy herd numbers was approximately 5%, whereas from 1984 to 2005, the dairy herd numbers plummeted by 37%. Despite this decrease in the dairy herd, the level of production has not been affected because of an increase in the milk yield per cow, which greatly increased in the 1990s. The number of dairy farms has also suffered a large cut in England and Wales. The number of holdings decreased from 28,093 in 1995 to 12,867 in 2007, a 54% reduction. However, holdings structure has adapted by increasing the number of cows per holding. Thus, the average herd size in England and Wales has increased from 76 in 1996 to 97 in 2004. Milk deliveries have passed from being over quota in the 1990s to being under quota during recent years, especially during 2007 and 2008, when the milk delivery reached 744 million liters under the 14,139 million liters of quota. This may leave room for efficient farmers to go over quota without being fined because the system allows farmers to go over quota with no penalties if the national milk deliveries

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[1]Corresponding author: f.j.areal@reading.ac.uk

are under. Both permanent and temporary transactions of quota have been decreasing during the period as well as the number of producers leasing quota (Rural Payments Agency, 2002–2007; Milk Development Council, 2009). Movements of net regional purchases of wholesale quota have been reduced between 2002 and 2007. A transfer of wholesale quota from England to Wales, Scotland, and Northern Ireland has occurred (Rural Payments Agency, 2002–2007; Milk Development Council, 2009). With regard to the net lease of wholesale quota in England and Wales, the pattern is similar to that of purchasing wholesale quota. In net terms, England leases quota out whereas Wales leases quota in (Rural Payments Agency, 2002–2007; Milk Development Council, 2009).

We developed a theoretical background to incorporate the milk quota market into technical efficiency analysis, which allowed us to investigate whether different business structures regarding the use of quota market were correlated with inefficiency. To our knowledge, this is the first time the EU milk quota trade system has been incorporated into stochastic frontier analysis. Recently, Breustedt et al. (2011) incorporated a milk quota system, where milk quota was not easily adjusted in the short run, into data envelopment analysis to examine the effect of abolishment of the EU milk quota on the competitiveness of organic dairy farming in the Bavaria region of Germany. Hennessy et al. (2009) studied the inefficiencies associated with regionalized milk quota trade and found that the more freely quota is traded, the more efficient the outcome of the sector as a whole. Colman (2000) studied the economic efficiency of UK dairy farms under a milk marketing quota system and found that despite tradable quotas, a significant number of dairy farmers achieved a poor match between available quota and production.

This article is dedicated to examining the technical efficiency of milk-producing farms under the CAP milk quota system using stochastic frontier analysis (Aigner et al., 1977; Meeusen and van den Broeck, 1977), which has been used previously to study technical efficiency in dairy farms (Lawson et al., 2004; Iraizoz et al., 2005; Cabrera et al., 2010). We address the abolition of quota and the likely implications for the English and Welsh dairy sector. Both average and individual performance of dairy farms in England and Wales between 2000 and 2005 were evaluated using a sample of a stochastic multiple output distance function, the parameters of which were estimated carrying out a Bayesian approach.

MATERIALS AND METHODS

We developed a theoretical background using microeconomic theory to establish the role of a production quota system that allows quota transfer at the farm level into a stochastic frontier analysis. Therefore, developing the theoretical background serves to assign a role to both the annual allocation of quota and leasing quota in the analysis of production frontier. Milk producers in England and Wales have an annual milk quota that partially binds production during the period studied. It is partially bound because producers can lease in or lease out milk during the production year. Therefore, we included in the analysis the fact that production is partially constrained by the annual quota Q, leasing in quota qui, and leasing out quota quo (see equation [1]).

The case of milk production under a quota is interesting because the conventional objective for the farmer of maximizing profits is partially constrained by the availability of quota. It is not completely constrained because the farmer can buy or sell, and lease in or lease out, quota. Not accounting for such constraints may lead to wrongly attributing the effects of such constraint to the farmer being unsuccessful in optimizing production (Färe et al., 1994). The problem that the dairy farmer faces is to adjust variable inputs and outputs to maximize the following profit function π subject to technological and supply restrictions:

$$\max_{x,qui,quo} \pi = \mathbf{p}'\mathbf{y} + p_q quo - \mathbf{w}'\mathbf{x} - w_q qui$$
$$\text{such that } f(\mathbf{x}) = \mathbf{y}, \text{ where } y_1 \leq Q + qui - quo \quad [1]$$
$$Q = Q_t = Q_{t-1} + \text{quota bought}_t - \text{quota sold}_t,$$

where $\mathbf{y} = (y_1,...,y_M)$ is a vector of outputs being y_1 milk output; quo, which is the quota leased out; $\mathbf{p} = (p_1,...,p_M)$ is a vector of output prices; p_q is the price of quota leased out; $\mathbf{x} = (x_1,...,x_K)$ is a vector of inputs; $\mathbf{w} = (w_1,...,w_K)$ is a vector of input prices; w_q is the price of leased in quota; qui is the quota leased in; and Q_t is the initial quota allocated in year t. The quota leased in and the quota leased out are treated as endogenous variables, as an input and an output respectively (i.e., they are optimized in this problem). The solution to the problem [1] represents both the optimal allocation of inputs and the optimal level of output. The regularity conditions require the profit function to be increasing in output, linear homogeneous in output and input prices, convex in output and input prices. The annual allocation of quota Q is treated as given (i.e., exogenous), as a quantity that is fixed annually.

The profit maximizing output supplies, input demands can be obtained using the Lagrangian method. The Lagrangian function from [1] is

$$L = \mathbf{p}'f(\mathbf{x}) + p_q quo - \mathbf{w}'\mathbf{x} - w_q qui - \lambda\left(f(\mathbf{x}) - Q - qui + quo\right). \quad [2]$$