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The effect of milk quota abolishment on farm intensity: Shifts and stability

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ABSTRACT

We investigate whether milk quota abolition in the Netherlands is likely to lead to a shift towards more intensive farms, and whether the legislation introduced by the Dutch government to prevent this from happening is likely to be effective. To this end, a mathematical programming model is developed and applied to ten Dutch dairy farms of varying size. The mathematical programming model allows us to calculate shadow prices, which we use to evaluate the stability or likelihood of a shift in the farmer decisions in our model. Our results suggest a strong increase in intensity for the largest farm type when milk quotas are abolished, while further intensification is limited for the smaller farm types. Although most farm types increase the number of cows on the farm, for the smaller ones this can only be achieved when the costs of expanding decrease considerably. The new legislation introduced by the Dutch government to prevent strong intensification appears to be successful.

1. Introduction

Since 1984, the European Union (EU) has applied a supply quota for milk to prevent the overproduction that resulted from milk price support. This price support for milk was subject to critique, as it distorts global trade. In the 1990s, the World Trade Organisation urged the EU to abolish its system of price support [35,3], in response to which the EU decided to gradually liberalise its dairy policy. From 2003 onwards, support prices were reduced and the supply quotas were enlarged in steps. In recent years, world market prices for dairy products increased strongly, decreasing the gap between EU prices and world market prices. It is therefore that the EU has decided to abolish the supply quotas for milk completely [34], per 1st of April 2015 [18]. When production quotas such as those for milk are abolished, the industry structure (i.e. the number of farms and farm size distribution) is likely to be influenced [4,9,48], which may have important consequences for the land use and landscape in rural areas dominated by dairy farming, such as the Netherlands.

Within the Netherlands the abolishment of milk quotas has led to environmental concerns, as further intensification (i.e. number of livestock per hectare) is expected [39]. Such intensification is likely to lead to an increase in the amounts of nitrogen and phosphate produced, which poses a major threat to the fragile natural ecosystems that are – in the Netherlands – often spatially interwoven into the agricultural area. Soon after the introduction of the milk quota, the Dutch government issued regulations to protect the environment [23] limiting the amount of nitrogen and phosphate from manure and artificial fertilizer that can be put on the land. Excesses of nitrogen and phosphate were to be removed from the farm [8], which led to a considerable trade in these excesses, among agricultural sectors and even with other countries. To prevent even larger excesses due to quota abolishment (the ceiling for the application of phosphate on land has remained unchanged), an additional law, referred to as the "Wet verantwoorde groei melkveehouderij" (law to ensure responsible growth of the dairy sector) or "Dairy law" (in Dutch *Melkveewet*), has been introduced in January 2015. Any phosphate surplus in excess of the amount prior to the milk quota abolishment has to be processed [17], meaning considerable extra costs for the farmer.

Yet, more restrictions were deemed necessary. Although the Dairy law addresses environmental concerns by regulating potential phosphate surpluses, it still allows farms to grow and/or intensify. Intensive dairy farming has become a topic of societal debate for various reasons. Firstly, it is associated with cows that remain permanently indoors, which is considered to result in a loss of cultural ecosystem services (meadows with cows are considered

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esthetically pleasing) [54]. Secondly, animal welfare is considered to be at stake in high-intensity farms, also due to the fact that many cows never leave the stable [44,47]. Thirdly, many people consider the existence of very large farms (and large stables in particular) undesirable. Most people associate farming with family farms, and oppose the idea of industrialization of farming [27]. Whether or not these arguments are justified, the ministry of Economic Affairs accommodated them by implementing a further measure (i.e. the 'Order of Council') in September 2015 that imposes a restriction on the intensification of Dutch dairy farms [40]. The measure specifically ensures land-based growth by demanding that – for intensive farms – further increases in the on-farm phosphate surpluses are only allowed when a certain amount of land is available [38,40]. This means that most farmers who want to increase their dairy herd can only do so if they purchase additional farmland.

The objective of this paper is to investigate whether the abolition will lead to a shift towards larger and more intensive farms in the Netherlands. In addition, we explore the effectiveness of the Order of Council. We do this for a range of farm sizes, as we expect that responses to policy changes will differ strongly per size category. More specifically, we expect that large farms are more likely to intensify when milk quotas are abolished than small farms. This is because larger farms have higher economic and environmental efficiencies [7], have lower per-unit production costs, and are therefore more likely to invest in more animals. Taking into account this variability within the farm population is thus essential to reveal the potential impact of policy reforms.

A mathematical programming model is developed and applied to ten representative Dutch dairy farms of different size as measured by Standard Output (SO). SO is the average monetary value of the agricultural output at farm gate price, and is considered a good measure of the economic size of a farm [19]. The model is used to analyse the likelihood of a shift towards a more intensive farm. We formulated three policy options: one reflects the situation with the milk quota still in place, the second reflects the situation in which milk quotas are abandoned but the Order of Council is not in effect, and the third captures the situation in which the Order of Council is introduced. Section 2 provides a short background. Section 3 discusses the methods we use. The results are presented in Section 4. Section 5 provides a sensitivity analysis and Sections 6 and 7 provide the discussion and conclusion.

2. Background

Agricultural land takes up about half of the total surface area in the Netherlands [13,14] and about 40 percent of agricultural land is used by dairy farms [10]. The majority of Dutch dairy farms is specialised in milk production [52]. In 2014 there were around 17,000 dairy farms in the Netherlands [10] which had an average SO of 339,000 euro. An average Dutch dairy farm as described by the Farm Accountancy Data Network (FADN) has 50 ha of land and 90 dairy cows, which comes down to an average intensity of 1.8 cows per ha in 2014 [29]. Considering an average phosphate production of 45.5 kg per cow, and an allowed application rate of 95 kg phosphate on grassland [8], 1.8 cow per ha would not require any manure to be exported off-farm. However, since most farms also apply artificial fertilizer, and keep young cattle which are not included in the average of 90 cows as recorded in the FADN, most dairy farms export or process manure. In 2014, 85.6 million kg of phosphate [50] and 257 million kg of nitrogen [15] was produced by dairy farms. The Dutch government has made an agreement with the European Commission that allows farms to apply an additional amount of nitrogen to their land when at least 80 percent of their land is grassland. This is referred to as derogation and in exchange for the increased application of nitrogen allowed by the European Commission the Dutch government has to ensure that the total amounts of nitrogen and phosphate from manure stay below a so-called phosphate and nitrogen ceiling [50]. In 2014 77% of the dairy farms had an excess of phosphate that had to be exported from the farm or processed [15]. If we consider the whole agricultural sector 172 million kg phosphate was produced of which 137 million kg could be applied on land, 28 million kg was exported to other countries, and 10 million kg was processed [16].

As for the other issues around farm size and intensification, 69% of all dairy farms allow their cows to graze outside [11]. Within the Netherlands there is a general trend towards increasingly larger farms. This trend is also visible for the Dutch dairy sector. The number of farms with more than 250 cows has increased from 44 in 1980 to 355 in 2015. From 2011 onwards, the number of dairy farms in the Netherlands has decreased, while the number of dairy cows has increased. Thus, more cows are kept on bigger farms [12].

3. Method

3.1. Mathematical programming

Mathematical programming is a method for identifying an optimal allocation of resources [31]. Within a mathematical programming model, an objective function is specified, which is maximized or minimized given a set of constraints. In this paper we assume that farms' main goal is to optimize their gross margin or profit. The assumption of profit maximization is in line with assumptions that are generally made in economic modelling [36], although it should be mentioned that in reality farms might have other objectives such as the minimization of labour use and risk or the environmental impact of farming as well [45,1,43,53]. Mathematical programming allows us to study changes in the optimal farming decisions, which are the result of constraints becoming more or less binding.

In our model a farm maximizes gross margin given a set of technological and institutional constraints. These constraints can be both equality and inequality constraints. The basic structure of a mathematical programming model with only technological and inequality constraints is given in Eq. (1).

$$\max_{x_i} Z = \sum_{i=1}^{N} (p_i x_i - w_i x_i) \tag{1}$$

subject to:

$$\sum_{i=1}^{N} a_{ik} x_i \leq b_k \forall_k \, [\pi_k] \tag{1a}$$

$$x_i \geq 0 \forall_i \tag{1b}$$

where: Z is gross margin defined as total revenues minus total variable costs, p_i refers to revenues per unit of activity i, w_i is the variable costs per unit of activity i, x_i is the level of activity i, b_k is the total availability of a resource k, a_{ik} is the quantity of resource k demanded by activity i, and π_k is the shadow price of input k.

Eq. (1) states that farms maximize gross margin by choosing the optimal activity levels under the assumption of exogenous output and input prices. Optimization takes place according to two types of restrictions. First, restriction 1a gives inequality restrictions, for example that the total use of fixed inputs should be less than or equal to the endowments of these inputs. Second, restriction Eq. (1b) states that activity levels cannot be negative.