J. Dairy Sci. 101:1–9
https://doi.org/10.3168/jds.2017-14305

Considering milk price volatility for investment decisions on the farm level after European milk quota abolition

H. D. Schulte,*[1] O. Musshoff,* and M. P. M. Meuwissen†
*Department of Agricultural Economics and Rural Development, Georg-August-Universität Göttingen, 37073 Göttingen, Germany
†Business Economics Group, Department of Social Sciences, Wageningen University and Research, 6706 KN, Wageningen, the Netherlands

ABSTRACT

After the abolition of the milk quota in the European Union, milk price volatility is expected to increase because of the liberalized market conditions. At the same time, investment appraisal methods have not been updated to capture the increased uncertainty. Therefore, the objective of this paper is to assess the effect of changing price volatility due to quota abolition on investment decisions at the dairy farm level. To contribute to the objective and to approximate milk price volatility after the European milk quota abolition, the risk-adjusted discount rate for risk-averse dairy farmers is derived based on the milk price volatility of a milk price series from New Zealand. New Zealand dairy farmers have faced liberalized market conditions for more than 3 decades. Afterward, the risk-adjusted discount rate is applied to appraise milking technology investments for an average German dairy farmer. The results show that it is still more reasonable to invest in a parlor system than an automated milking system, although the net present value of the parlor system investment varies between €191,723 for risk-neutral dairy farmers and €100,094 for modestly risk-averse dairy farmers. For the automated milking system investment, the same calculations lead to €132,702 for risk-neutral dairy farmers and €31,635 for risk-averse dairy farmers. According to higher levels of milk price volatility after milk quota abolition, the reduction of the expected utility of the underlying investment decision for modest risk-averse dairy farmers is almost similar to a milk price decrease of 5% for risk-neutral dairy farmers. Therefore, the findings urge finance providers and extension services to consider the change of increasing milk price volatility after dairy quota abolition when giving dairy farmers financial advice. The risk-adjusted discount rate is a flexible tool to do so.

Key words: milk quota abolition, risk-adjusted discount rate, investment decision, risk aversion

INTRODUCTION

In April 2015, the European Union (**EU**) abolished the milk quota regimen, thus enabling European dairy markets to increasingly connect to world markets (Jongeneel et al., 2010). Consequently, spillover effects from energy markets and horizontal transmissions of milk price volatility from international markets might increase milk price volatility in the EU after milk quota abolition (Jongeneel et al., 2010; Fousekis et al., 2017). Focusing on the farm level, a high share of dairy farmers is concerned about the dairy quota abolition, and they perceive milk price volatility as a greater risk after quota abolition (Scharner et al., 2016; Assefa et al., 2017).

Most of the decision makers in agricultural production are thought to be risk averse (Maart-Noelck and Musshoff, 2014). Risk-averse farmers, faced with increased milk price volatility, can be expected to pay a specific amount of money to eliminate exposure to this risk (El Benni and Finger, 2013). These are costs of risk, known as the risk premium, which we can approximate (Kim and Chavas, 2003; Hardaker et al., 2004, p. 101). Focusing on milk price volatility, the risk premium is dependent on the level of milk price volatility and the risk attitude of a decision maker (Di Falco and Chavas, 2006; El Benni and Finger, 2013). Nevertheless, investment appraisal studies in the dairy sector have barely considered the risk premium; rather, they have assumed a constant milk price (Purvis et al., 1995; Dijkhuizen et al., 1997), carried out sensitivity analyses of milk prices (Shortall et al., 2016), or simulated different levels of milk prices (Hyde et al., 2003). Thus, they referred to different levels of milk prices but did not account for the costs of risk regarding milk price volatility.

To account for investment risks on the dairy farm level, Tauer (2002) estimated risk-adjusted discount rates (**RADR**) for risk-averse dairy farmers by econometric analyses. Subsequently, Tauer (2006) used these

---

Received December 17, 2017.
Accepted April 22, 2018.
[1] Corresponding author: hinrich.schulte@agr.uni-goettingen.de

RADR for analyzing implications of entrepreneurial flexibility. However, estimating the RADR based on the econometric approach of Tauer (2002), it might become difficult to adjust the RADR if price volatility changes because its dependence on risk attitude is not obvious. To overcome this, expected utility approaches are a valuable alternative to calculate the RADR for risk-averse decision makers (Finger, 2016) because these better describe the relationship between the level of milk price volatility and the risk attitude of the decision maker. In this context, the objective of this paper is to assess the effect of changing milk price volatility on investment decisions of risk-averse dairy farmers after milk quota abolition.

To approximate milk price volatility after quota abolition, we used a farm-gate milk price series from New Zealand (**NZ**). New Zealand has liberalized market conditions and might strongly compete with the EU for export markets in China and Southeast Asia after milk quota abolition (Fousekis et al., 2017). Thus, the NZ data reflect milk price volatility under world market conditions, which might provide insights into EU milk price volatility after dairy quota abolition. To show the influence of milk price volatility, we measured the RADR for an investment decision between 2 milking technologies: a parlor system and an automated milking system (**AMS**). Thus, the novelty of the study is the approximation of milk price volatility to evaluate investment decisions after the European milk quota abolition.

MATERIALS AND METHODS

Net Present Value for Investment Appraisal

Calculation of the net present value (**NPV**) is a widely used investment method to maximize utility of a decision maker by choosing the investment that offers the highest net profitability (Shortall et al., 2016). One should invest when the NPV of the investment cash inflows exceeds the investment cash outflows and choose the investment with the highest NPV. The NPV is defined as follows:

$$NPV = -INV + \sum_{t=1}^{T}\left[\frac{NCF_t}{\left(1+i\right)^t}\right] + \frac{salv_T}{\left(1+i\right)^T}, \qquad [1]$$

where INV is the cost of the investment, NCF is the annual net cash flow (i.e., cash inflow minus cash outflows per period t), and $salv_T$ is the salvage value of the investment after T years.

Following the objective, we focus on the milk price. The milk price is part of the annual net cash flow, and one must discount the milk price by a risk-free interest rate i to address the time value. However, this implies that the decision maker is risk neutral, whereas most decision makers in agricultural production are risk averse (Gardebroek, 2006; Maart-Noelck and Musshoff, 2014). This means that the discounted value of the milk price for risk-averse dairy farmers is dependent not only on the risk-free interest rate but also on the volatility of the milk price and the level of risk aversion. To account for this, a risk-loaded component v is added to the risk-free interest rate i. The sum of these components leads to the RADR (Finger, 2016). Thus, one can calculate the discounted price P_0 of the expected milk price $E(P_t)$ in t as follows:

$$P_0 = \frac{E\left(P_t\right)}{\left(1+i+v\right)^t}. \qquad [2]$$

Discounting for $v \succ 0$ implies that the dairy farmer is risk averse and willing to pay a specific amount to prevent planning uncertainty. Subsequently, a certainty equivalent (CE) of the milk price for risk-averse dairy farmers exists where a certain and lower milk price has the same discounted value as an uncertain milk price $E(P_t)$:

$$P_0 = \frac{CE\left(P_t\right)}{\left(1+i\right)^t}. \qquad [3]$$

The difference between the expected milk price $E(P_t)$ and the $CE(P_t)$ of risk-averse dairy farmers is the cost of risk, denoted as $RP(P_t)$ (Kim and Chavas, 2003; Hardaker et al., 2004, p. 101). Following Pratt (1964), we assumed an exponential risk utility function and approximated the $RP(P_t)$ as follows:

$$RP(P_t) = E(P_t) - CE(P_t) = 0.5 \cdot r_a \cdot VAR(P_t). \qquad [4]$$

Subsequently, $RP(P_t)$ is dependent on the variance $VAR(P_t)$ of the milk price series and the risk attitude of the decision maker, which is denoted by r_a (i.e., constant absolute risk aversion). The variable r_a is the quotient of the r_r, which represents constant relative risk aversion (**CRRA**) and the expected value of the milk price $E(P_t)$ (Gardebroek, 2006). Usually, the range of r_r takes values from $r_r = 0$, which implies risk neutrality, to $r_r = 4$, which reflects a highly risk-averse decision maker (Hardaker et al., 2004, p. 109).

Furthermore, equating Equations 2 and 3 and having in mind the calculation of $RP(P_t)$ to solve for v leads to the following equation: