Increase in milk price volatility experienced by Flemish dairy farmers: A change in risk profile

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Abstract

This paper reports on the increased volatility in the milk price received by Flemish dairy farmers and its consequence on the risk profile of selected Flemish dairy farms. The volatility of the milk price has doubled since January 2007. It is suggested that this increasing volatility could have a significant impact on the risk profile of dairy farms. Indeed our results show that the risk profile is changing depending on the volatility and average price for milk. However this change is not very substantial compared to some other subsectors. Also we show that in our case study of selected farms that if the milk price volatility doubles an average milk price increase of about 12% compensates for the increased volatility on return on assets. Finally this paper demonstrated the importance of regarding risk and return together when making normative statements on the consequences of milk price volatility.

Introduction

Until 2007 the milk price that Flemish farmer received was, except for predictable seasonable variability, relative stable. However from January 2007 a change in the price evolution occurred. No longer did the milk price fluctuate between the limits of 21 and 33 Euro per 100 litres, as in the past two decades.

First it peaked to an unprecedented price of 41.26 Euro per 100 litres in October 2007 only to fall down again to 20.34 Euro per 100 litres in June 2009. In this relatively small time span between January 2007 and June 2010, the volatility of the milk price doubled compare to the whole period 1989-2006. Today the price is climbing up again, but

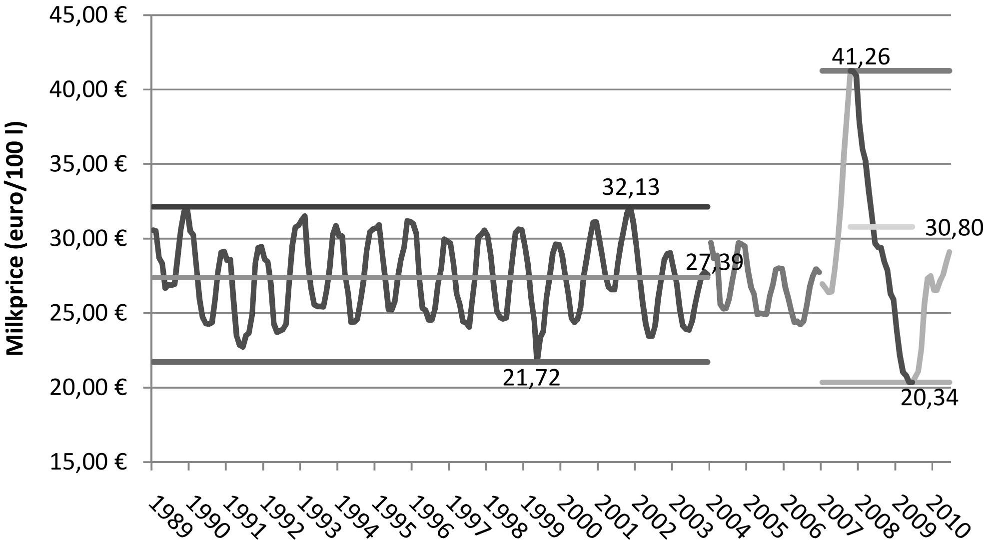

Figure 1: Evolution of the milk price since 1989 to June 2010. Source: BE-stat (2010)

nobody really knows how it will recover from this price rollercoaster. Most experts believe that the volatility that we have seen since January 2007 will remain (Keane and O Connor 2009, Jongeneel et al. 2010). This paper aims to get an insight on what impact the increased price volatility *might* have on individual Flemish dairy farms[1]. We therefore use a novel methodology of comparing risk-return profiles. More precise we will compare risk profiles of certain selected Flemish farms of different types and Flemish dairy farms for the period under a relative stable price with the risk profiles of the same dairy farms adapted to a milk price with the high volatility we observed in the past three years. In doing so we strive to clarify some aspects of the effects of the volatile milk price, e.g. whether the increased risk due to the increased volatility of the milk price is substantial and whether it is sufficiently repaid in a higher return.

Material & Methods

In this paper risk profiles of a number of farms are used to compare the risk situation on those farms. In order to clarify the changes in risk profile of Flemish dairy farms under a stable compared to a volatile milk price, two scenarios for volatile milk prices are proposed. Hereunder we discuss the data used for this research, the different milk price scenarios that are constructed, the calculation of the risk profiles and the methods used for comparing risk profiles.

Data

The bookkeeping data used for analyses in this paper are derived from the former Flemish C.L.E. bookkeeping network. This dataset contains bookkeeping data for individual Flemish farms from 1989 until 2003. It was chosen to only use the data of farms that had provided data to C.L.E. in the entire period 1989-2003 and restricted to those farms whose typology did not alter during the entire period e.g. arable farming, dairy farming or pig farming. Due to these restrictions only a number of specific farms are selected and therefore generalisation of the conclusions to the Flemish dairy industry as a whole should be done with caution. However the aim is not to make generalized conclusions on the impact of the price volatility on Flemish farms, but rather to get an insight in the possible effects of milk price on the risk profiles of dairy farms. An overview of the farms that were analyzed in this paper, organized by farm type is given in Table 1.

Table 1: Data analysed in this paper grouped by farm type or subsector

Farm type	# of farms analyzed
Arable Farming	16
Pig	27
Pig and Bovine	13
Dairy Farming	62

[1] It has to be noted that we are not trying to generalize our findings to the Flemish dairy industry as whole, but rather do a preliminary investigation on the consequences of milk price volatility.

Milk price scenarios

As already described in the introduction, most experts believe that the volatility that we have seen will not decrease. There is less agreement, however, on the price trend or average price. In this paper we consider two possible scenarios hereafter referred to as milk price scenario 1 and 2. Under the first scenario, the average or expected milk price remains the same as the average milk price in the period 1989-2003. However the volatility, i.e. the possible range of milk price values, doubles to reflect the recently observed milk price volatility. In the second scenario the milk price volatility doubles, like in the first scenario, but the expected milk price increases compared to the 1989-2003 milk price. The amount to which the milk price increases is based on the recently observed milk price spikes. That is, the most likely milk price in scenario 2 is exactly in between the minimum and maximum price (Figure 2). This increase amounts in an increase of average expected milk price of 12% (€30.80 / €27.39). This is quite a substantial increase of milk price and therefore the real future milk price distribution could be expected to be somewhere in between the scenario 1 and 2 milk price distributions.

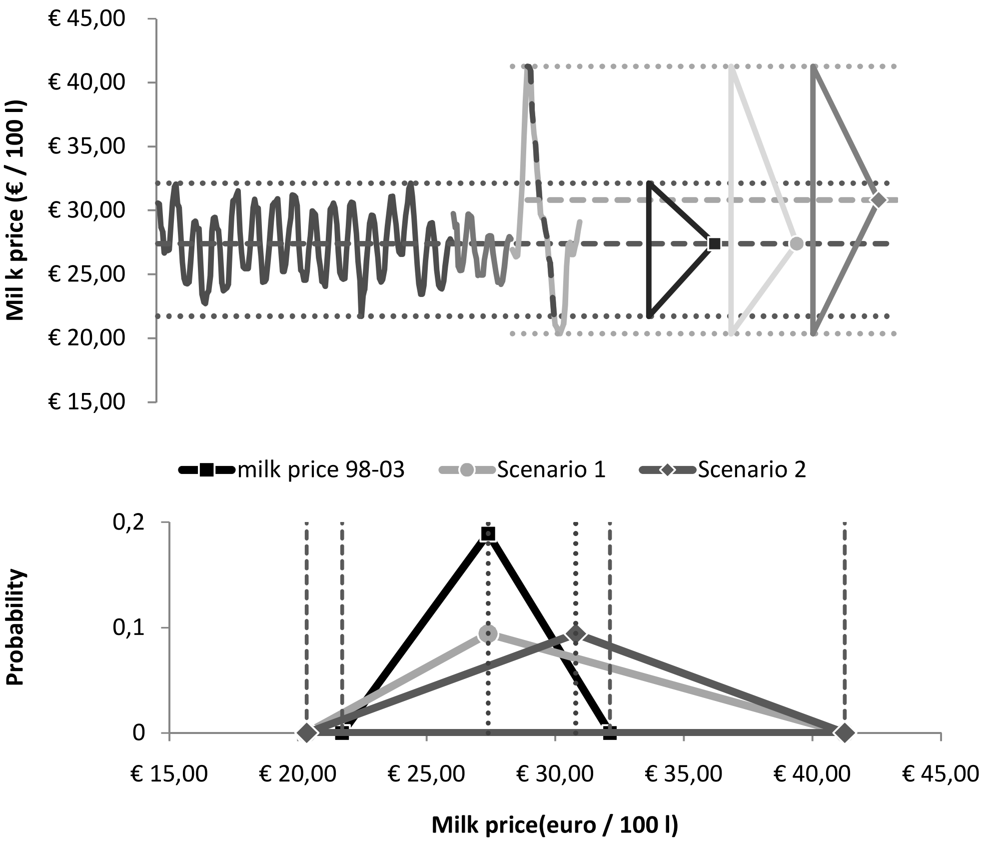

Figure 2: Milk price distribution for scenario 1 and 2 and a hypothetical milk price distribution based on the minimum maximum and average milk price in the period 1989-2003

As we will see in the next paragraphs, the milk price distributions under scenario 1 and 2 are approximates. That is to say, they are adjusted for each individual company to reflect the variability in received milk price between companies (see paragraph on milk price substitution).

Risk profile

While looking at risk at farm-level it is pertinent to consider not only the risks the farm is facing but also the return that the farm achieved under this risk. Indeed we all would be risk averse were it not for the premium on the return that can only be achieved by taking the risk involved. In this publication we calculate risk profiles in order to get an insight in the combined risk and return achieved at individual farms. A risk profile in fact is nothing more than a graphical representation of a measured variable of risk in a farm (or other asset) represented on the x-axis of the risk profile graph and the corresponding variable measuring return in the same company described on the y-axis. In the risk profiles presented in this paper, the average rate of return on farm assets (ROA) was chosen as the return variable and the standard deviation on the ROA as the risk variable. It should be noted that ROA is not the only variable that can be chosen for creating the risk profile of a company, however it is closest to methods already used in finance considering asset portfolio and therefore a proven method to select between different risk profiles (Markowitz 1952, Elton et al. 2007)

The ROA was calculated using the bookkeeping data for every individual farm and for each year between 1989 and 2003 by dividing net farm income over total farm assets (Equation 1). Net farm income is calculated by taking the total revenues of the farm and subtracting the fixed and variable costs and the costs for labour and land (Equation 2). Finally, farm assets are determined by adding all asset values excluding land (Equation 3).

$$\textbf{\textit{Return on farm assets (ROA)}} = \frac{Net\ income}{Farm\ Assets} \quad (1)$$

Net income = *Total Revenues – Variable costs – Fixed costs – Costs for labour – Cost for land* (2)

Farm Assets = *Average substitution value of machinery + Value of livestock assets + Value of circulating assets + Average substitution value of fixed assets* (3)

The time series of ROA's (for each year in the period 1989-2003) of each individual farm are averaged to get the average farms ROA (the return variable in the risk profile). Furthermore the standard deviation over the farms' time series ROA's is calculated (the risk variable). In addition to the individual risk and return variables, the average subsector (based on farm type) risk and return variables are calculated (Table 2).

Table 2: For each farm type the individual and subsector average ROA and standard deviation are calculated

Farm / Year	1989	1990	t/m	2003	Gem.(r)	Std. Dev. (ROA)
Farm 1	$ROA_{1;1989}$	$ROA_{1;1990}$	…	$ROA_{1;2003}$	$\overline{ROA_1}$	$\sigma(ROA_1)$
Farm 2	$ROA_{2;1989}$	$ROA_{2;1990}$	…	$ROA_{2;2003}$	$\overline{ROA_2}$	$\sigma(ROA_2)$
Farm 3	$ROA_{3;1989}$	$ROA_{3;1990}$	…	$ROA_{3;2003}$	$\overline{ROA_3}$	$\sigma(ROA_3)$
Up to	…	…	…	…	…	…
Farm x	$ROA_{x;1989}$	$ROA_{x;1990}$	…	$ROA_{x;2003}$	$\overline{ROA_x}$	$\sigma(ROA_x)$
Subsector Average					$\overline{\overline{ROA}}$	$\overline{\sigma(ROA)}$

Substituting milk price.

In order to get an insight in the changes in the risk profile of the dairy farm due to the effects of an increasingly volatile milk price, the risk profile as calculated above is recalculated for the dairy farms substituting the old milk price for new more volatile milk prices (Equation 4).

Total revenues given a volatile milk price = *Total revenues from data – revenues from milk delivered to the milk processing plant + (litres milk delivered to the milk processing plant * new volatile milk price given the milk price scenario)* (4)

It is chosen to recalculate the risk profile using the exact same data while only substituting the milk price rather than recalculating the risk profiles based on recent bookkeeping data. This is done mainly because substituting the milk price while keeping everything else the same (ceteris paribus), ensures that all changes in risk profiles can be attributed to the substituted milk price. Furthermore it provides the opportunity to simulate different scenarios.

When substituting the milk price from the bookkeeping data with a universal milk price from either one of the two scenarios without adapting this milk price to the individual farms, the variability between farms would narrow. In order to substitute milk price from the individual bookkeeping data without losing this inter-farm variability, the milk price distributions are modified to fit each individual farm. That is, the average milk price received in the period 1989-2003 is calculated and this average formed the basis for the milk price substitution. The milk price distribution which serves as the input for a Monte-Carlo simulation has a triangular distribution. The first two parameters defining this distribution, the minimum price, and maximum price, are determined by the milk price volatility as observed from January 2007 and are hence €20.34 and €41.26 per 100 litres respectively. The third parameter defining the distribution, namely the most likely price, is determined based on the scenario and on the averaged milk price received by the individual farm in the period 1989-2003. In scenario 1 this average milk price equals the most likely price in the milk price distribution. In scenario 2 the calculated average milk price is increased by 12%, representing a 12% average increase in milk price (see milk price scenarios).

The milk price is substituted in the calculation of the ROA using Monte Carlo simulation. Monte Carlo simulation is discussed in various papers (Hatings 1969, Broszkiewicz and Janicki 2005, Lauwers et al. 2010) and we refer to those papers on technical explanations on Monte Carlo simulations. We used 100 repeats per year and per farm for our simulation for each of the 14 years, resulting in a total of 1400 ROA's per farm. For each farm an individual average ROA and standard deviation on ROA's was calculated from these 1400 repeats (Table 3)

Table 3: The calculation of the average ROA (return variable) and standard deviation of ROA (risk variable) of the dairy farms under each one of the two volatile milk price scenarios

Repetition / year	1989	1990	t/m	2003
Repetition 1	$ROA_{1;1989}$	$ROA_{1;1990}$	…	$ROA_{1;2003}$
Repetition 2	$ROA_{2;1989}$	$ROA_{2;1990}$	…	$ROA_{2;2003}$
Repetition 3	$ROA_{3;1989}$	$ROA_{3;1990}$	…	$ROA_{3;2003}$
t/m	…	…	…	…
Repetition 100	$ROA_{100;1989}$	$ROA_{100;1990}$	…	$ROA_{100;2003}$
Farm average		$\overline{ROA}$	$\overline{\sigma(\mathrm{ROA})}$	

Comparing risk profiles

Risk profiles are by definition two-dimensional (comprising a return and a risk variable). This makes it often impossible to make a normative statement on selecting the better option between two risk profiles one having a high risk and high return and another low risk and low return.

One way of uniting the two variables is to regard a specific outcome, for example the chance of having a positive ROA. We can calculate the chance for each of the farms to have a positive ROA when we assume the farm's possible range of ROA's is normally distributed, with an average ROA and standard deviation as calculated. The corresponding probability is then simply calculated using the normal probability density function. The same methodology may be used to determine the chance that ROA is smaller than the rent paid on liabilities, which would cause the farmer having to use return on equity in order to repay debt. This calculation may be made farm-specific, according to the farm-specific rent on liabilities.

Furthermore, if a situation exists in which even the worst outcome of the high risk high return risk profile is not worse than the worst outcome under the low risk low return risk profile, we can conclude that the high risk profile with the higher average expected return should be favoured. Therefore it is often informative to show the whole range of possible returns in addition to the risk return graph. Again, assuming that the distribution of possible ROA's obtained by the farm is normally distributed, we need to choose limits to what "the whole range of possible return" includes. Give that a normal distribution has no limits they are usually chosen at the 0.025 and 0.975 percentile, as to include 95% of the possible range of outcomes. These limits can simply be calculated by subtracting or adding two standard deviations to the average expected ROA

Results

If we compare the risk profiles of the different type of farms calculated from the data over the period 1989-2003 one observation is that we can identify clusters of risk profiles based on their respective type: Arable, pig, pig and bovine and dairy farming (Figure 3). The group of pig farms are situated on the upper right side of the risk profile graph, representing an overall higher risk and return). This is in line with the general premise that pig farming is dealing with relative large risk caused by the historical high price volatility of pigs and piglets. The arable farms are situated somewhere in the middle of the graph representing farms with an average risk and return. The combined pig and bovine farms are situated even further down the risk axes in general slightly on the left of the arable farms, suggesting that expanding a pig farm with bovines might decrease the risk experienced on the farm. Finally the dairy farms are situated on the lower left corner of the risk graph, implying overall smaller risk and average return compared to the other farm types. Here of course we are considering dairy farms in the period 1989-2003, therefore dealing with a relatively stable milk price.

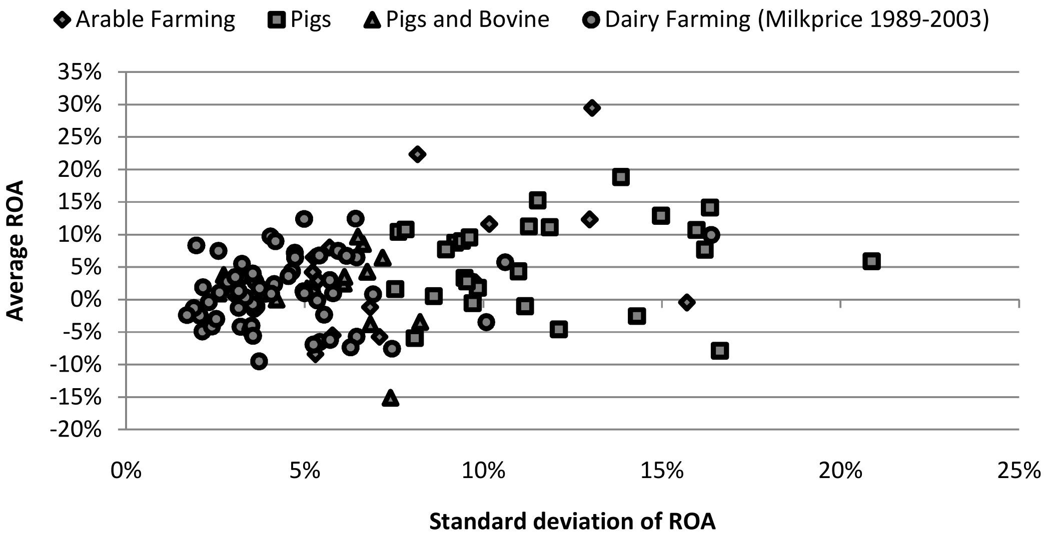

Figure 3: The risk profiles of the different farms in the dataset grouped regarding the farm type.

These differences between the different types of farms are more evident when considering the average risk profiles of the different farm subsectors (Figure 3Figure 1). We will hereunder continue to use the average risk profiles of the different farm subsectors for clarification purposes, however all calculations have been performed on the total sets of individual farms.

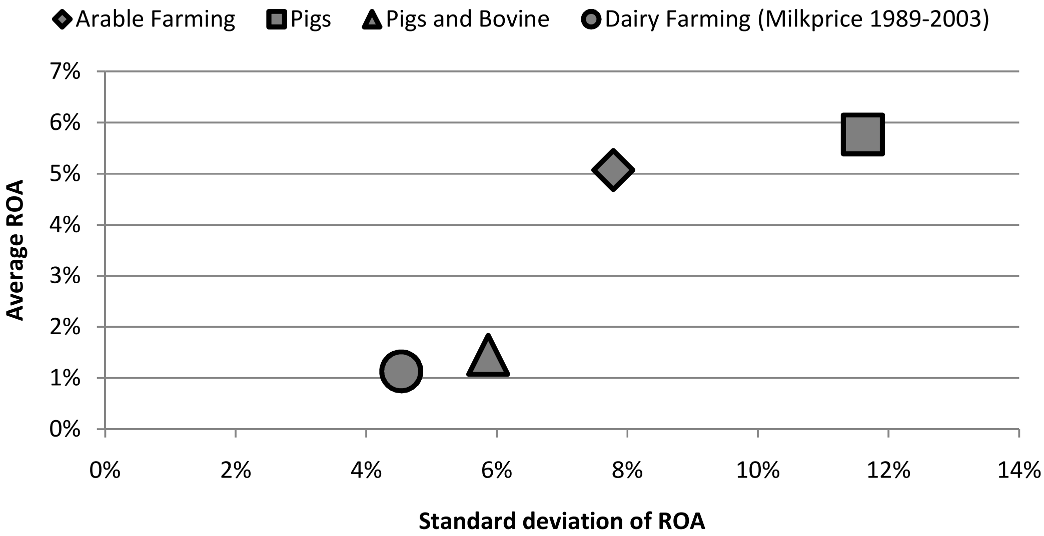

Figure 4: The average risk profiles of the different subsectors.

So far we considered the average situation of different farm types for 1989-2003. Hereunder we present the risk profile of the dairy farms under milk price scenario 1 and 2. Like expected the risk is increasing for the average of the dairy farms under both scenarios 1 and 2 milk prices, with increased milk price volatility. (Figure 5). Note that the risk originated from the volatility of the 1989-2003 milk price is even in reality not real risk but predictable volatility of season variation (we know what the milk price will do) while in new situation (scenario 1 and 2) the price is unpredictable and un independent of season variability.

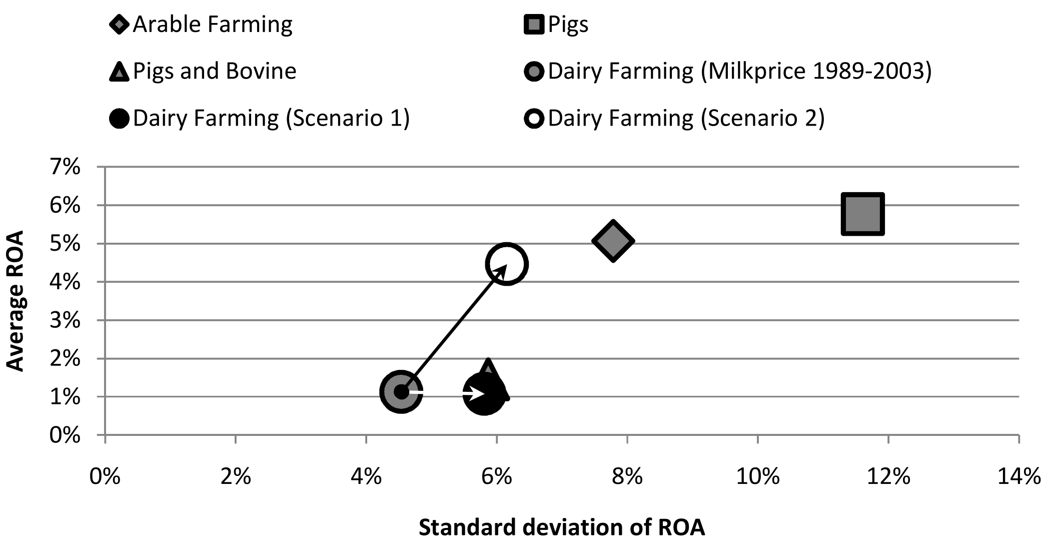

Figure 5: The Risk profiles for dairy farms calculated by substituting milk price under scenario 1 and 2 are added to the risk return profiles of the risk profiles of different farm types calculated on the bookkeeping data 1989-2003

We can also see that the newly faced risk is still relatively moderate compared to the risk faced by the average of the farms of the other subsectors. The average risk profile of dairy farms under milk price scenario 1 is positioned almost exactly in the same place in the risk return space as the average risk profile of the combined pigs and bovine farms. The average risk profile of the dairy farms under milk price scenario 2 has about the same risk factor but a higher return. A question that arises is whether this increase in return is high enough to compensate for the increase in risk. Obviously under scenario 1 showing both an increase in risk and a slight decrease in return we can state that the situation has worsened. In order to make a similar normative statement on whether the milk price under scenario 2 have improved or worsened the risk situation on the average dairy farms, we cannot base ourselves on just the risk profiles. After all we do not know by how much the return *should* increase to verify the increase in risk.

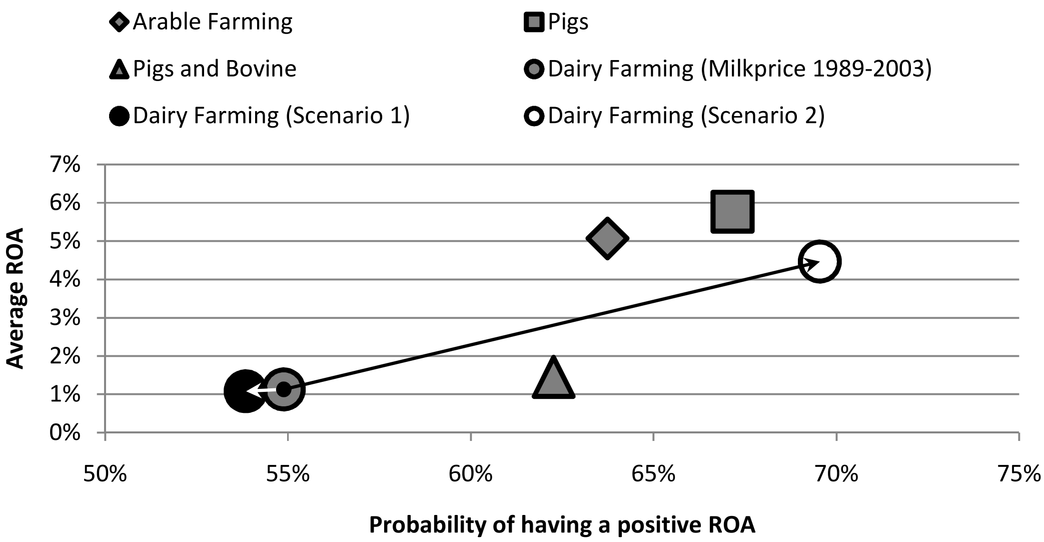

Figure 6: The Chance of having a positive ROA is on average decreasing for dairy farms under milk price scenario 1 and increasing by 15% under scenario 2 compared to under the stable milk price of 1989-2003

We could, for instance, regard the chance of having a positive ROA, i.e. the probability of being (positively) rewarded for investments in the farm. For scenario 1, in which doubling volatility in milk price was not countered by an increased milk price, we see a slight decrease in probability of having a positive ROA. However this decrease, of a mere 2%, is relative small compared with the differences between the dairy and other subsectors. For scenario 2, we see an increase in the chance of having a positive ROA of 27%, therefore transcending the average pig farm (If having a positive ROA is the criteria to maximise, milk price under scenario 2 is preferred over the old milk price (1989-2003).

Next to regarding a specific situation like probability of having a positive ROA, we can consider the whole range of possible ROA's achieved by farms. Since this range was calculated using a normal distribution, the span of ROA's is unlimited. However here we regard the 95% confidence interval of possible ROA's.

For the first scenario the average milk price farmers can expect to receive remains the same as during the period 1989-2003. The spread around this expected outcome is larger for both the positive (higher ROA) as negative side (lower ROA). This of course was to be expected whereas the milk price in the first scenario remains on average the same while having a greater volatility. For the second scenario however we see that the on average increase in milk price of 8% is substantial enough to bring the whole distribution of possible outcomes (given that we cut this distribution at both ends at the 0.025 and 0.975 percentiles) up to a position in which the worst outcome is quite similar for the old as the new milk price. This means that the second scenario is ultimately better than the situation of the stable but lower milk price, after all the average ROA is better and even in the hypothetical worst case the situation is not worse.

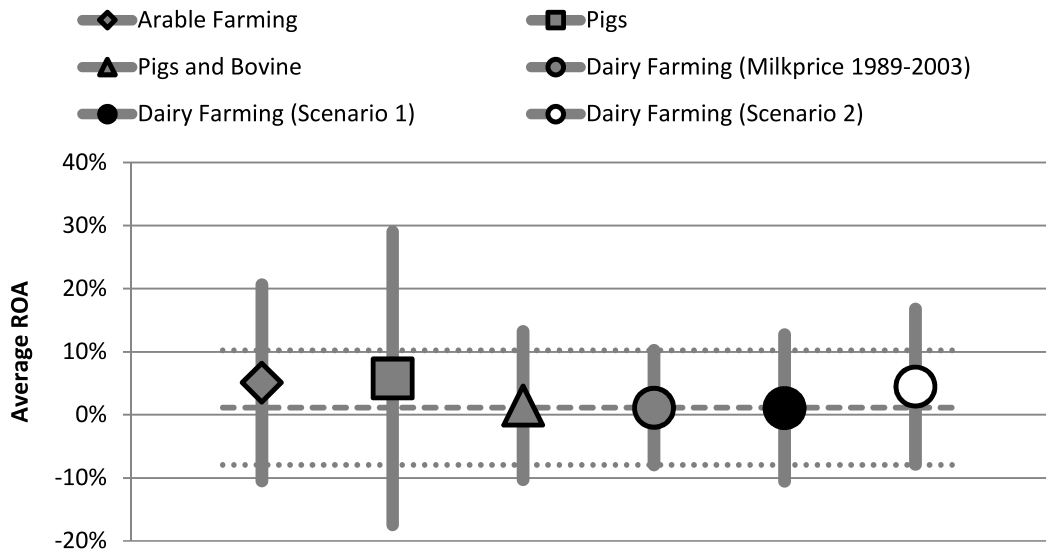

Figure 7: The range of possible outcomes of ROA for the average of the farms in each of the subsectors

Summarizing we saw that not milk price volatility but expected average milk price is having a big effect on the ROA. In fact a doubling of milk price volatility will result in a less than doubled risk while an increase (or decrease) in average expected milk will magnify in the ROA (Table 4).

Table 4: A summary of the changes in the average risk profile of dairy farms that occur under the two milk price scenarios compared to the 1989-2003 situation

Scenario	Percentage compared to the situation in 89-03:				
	Most likely milk price	Milk price volatility	Avg. ROA	Std. Dev (ROA)	p(ROA>0)
1	100%	200%	96%	128%	98%
2	112%	200%	394%	136%	127%

Discussion and conclusion

We have compared risk profiles for the Flemish dairy industry under either one out of two different scenarios for a volatile milk price with the situation of a less volatile milk price for the period 1989-2003. The two milk price distributions of the corresponding scenarios were chosen in order to represent two possible future scenarios between which it is anticipated that the real milk price will evolve. We have seen that for the worst of the two scenario's, in which the milk price volatility doubles but the on average expected return will remain compared to the 1989-2003 situation, that farmers will change to a slightly more risky situation without having a risk premium to compensate for this. The changes in the risk profile are somewhat moderate compared to the difference between risk profiles of different subsectors. For the somewhat optimistic scenario in which milk price volatility doubles and average expected milk price rises by 8%, the changes are positive. In fact even in the worst case the ROA will be only just as bad as in the 1989-2003 worst case. However on average the ROA will be better, therefore the evolution towards a milk price as described under scenario 2 would be positive. Of course our analyses depend entirely on the accuracy of the milk price distributions we chose. Besides this based on our relative small sample size we cannot make generalization for the entire section. And finally the prices used here were not indexed and trends were not distended, therefore any normative statements should be treated with care. However we can conclude that we showed that is pertinent to look at both risk and return combined when investigating the impact of the volatile milk price on the farms ROA.

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