Farm growth and exit:
Consequences of EU dairy policy reform for Dutch dairy farming

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Abstract - **The purpose of this paper is to analyse farm growth and exit and its interaction in Dutch dairy farming as consequences of the 2003 CAP reform and 2008 CAP Health Check. Results indicate that the decision to exit dairy farming is largely determined by household characteristics as age and the size of the household. Farm growth is strongly influenced by the availability of labour, capital and land. Simulation results show that the dairy policy reforms reduce farm growth and exit. This is mainly caused by the quota increases.**

I. INTRODUCTION

Production growth is for farms a perquisite for long term survival because it enables them to cope with real price and income decreases [1]. However, there are limits to growth potentials. These limits can e.g. come from endowments of labour and land. Another factor that potentially limits growth is the presence of a quota system. With tradable and binding quotas a farm can only grow if another farm sells quotas, e.g. because it exits. Exit in turn can be influenced by growth since growth can lead to high quota prices facilitating exit. Both exit and farm growth result from the behaviour of individual farmers. Besides factors affecting (future) income from farming, e.g. input and output prices, household characteristics and preferences play a role. Policy also affects exit and farm growth. For example, the 2003 CAP reform and the 2008 CAP Health Check[1] result in lower farm income leading to the decision to stop production. However, some farmers might decide to grow to ensure continuity. Although research has been done on farm growth and on farm exit no research analyses both in combination.

Dutch dairy farming is a sector where quotas are tradable and binding. The number of dairy farms is decreasing and the average size increasing. Quantifying the effects on exit and farm growth as a result of policy changes has not been taken into account in previous micro-economic research on Dutch dairy farming. Kimhi and Bollman [3] look at exit of farms in Canada and Israel but they do not look at farm growth. Weiss [4] does formulate a growth model for individual farms but not exit.

In the literature exit is modelled as a short term change (see e.g. [5]), i.e. exit is defined as not observing production in the present year given the information in the previous year. Exit, however, is a large disinvestment that can take some time. Therefore, a decision to exit can lead to an actual exit only after a few years. The exit decision is however still taken given the available information at the time the decision is made.

The purpose of this paper is to analyse farm growth and exit and its interaction in Dutch dairy farming as consequences of the 2003 CAP reform and 2008 CAP Health Check. Exit is defined as stopping dairy farming. Farm growth is defined as the change in quota amounts (a reduction being negative growth).

In this research we only look at the growth and exit of specialised dairy farms. In 1999/00, the last year of the main data set in this research, these farms owned 94.8 per cent of total milk producing cows and represent 87.8 per cent of all farms producing milk.

Section 2 presents the empirical model and its estimation. Section 3 describes the data used in estimation. Section 4 presents the estimation results. The possible effects of the dairy policy reforms are discussed in section 5. Finally, section 6 concludes the paper.

II. EMPIRICAL MODEL AND ESTIMATION

A. Exit

We assume exit takes place within three years after the decision to exit is taken. Exit is not immediate since it involves costs to realise. Therefore, not observing production in year *t*+3 is explained by information of

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[1] In 2008 there will be the so-called Health Check, an assessment of the 2003 CAP reform, that could lead to further EU policy reform (see e.g. [2]).

year *t*-1. To this end we define the following index function:

$$s_{i,t+3} = \begin{cases} 1 & \text{if } \mathbf{w}_{i,t-1}'\boldsymbol{\gamma} + \upsilon_{it} > 0 \quad \text{(farmer i decides to exit)} \\ 0 & \text{otherwise} \quad \text{(farmer i decides not to exit)} \end{cases} \tag{1}$$

where $\boldsymbol{\gamma}$ is a parameter vector to be estimated and υ_{it} is an error term with a standard normal distribution conditional on $\mathbf{w}_{it}$ and $s_{i,t-1} = 1$. This means that $s_{i,t+3}$ selects the farms that do not produce milk at time *t*+3 out of the group of farms that are producing milk at time *t*-1.

The set of explanatory variables in the selection equation ($\mathbf{w}_{i,t-1}$) contains the number of household members, age, age squared, the milk price index, the price index of milk quota, the price index for other outputs, the dairy cattle price index, the index for wages in the agricultural sector, on-farm labour, a discrete variable indicating the level of education of the farm manager, the number of hectares, a dummy indicating whether a farm earns off-farm labour income, a dummy indicating whether a farm has sheep, a dummy indicating whether a farm has pigs, a dummy indicating whether a farm grows crops and a dummy indicating whether a farm keeps cattle for meat. The dummies for the activities of farms next to milk production are chosen such that at least 15 per cent of all farms in the data set perform the activity. The price and income variables are divided by the price index of a composite of variable inputs to impose homogeneity of degree zero in these variables.

We assume that exogeneity assumptions hold for the explanatory variables. Because we use lagged values of the variables we cannot test for this. As a consequence we estimate the exit model by a cross-section probit estimation procedure [6].

B. Growth

In theory growth depends on the factors that influence farm profit and other income. All these elements are used as explanatory variables in the empirical equation:

$$y_{it} = \alpha y_{i,t-1} + \mathbf{x}_{it}'\boldsymbol{\theta} + c_i + \varepsilon_{it} \tag{2}$$

where y_{it} is the size of farm *i* at time *t*, $\mathbf{x}_{it}$ is a vector of explanatory variables, c_i is an unknown farm specific effect, ε_{it} is an error term and α and $\boldsymbol{\theta}$ are parameters to be estimated.

For y_{it} we use milk quota in kilograms representing the size of the dairy operation, not the size of the whole farm. Subtracting $y_{i,t-1}$ from both sides of (2) gives the structural growth equation:

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \Delta \mathbf{x}_{it}'\boldsymbol{\theta} + \Delta \varepsilon_{it} \tag{3}$$

where Δ is the first difference operator.

The vector of explanatory variables includes land, buildings, machinery, labour, farm price indices (of quota, other output and cattle), off-farm labour income and external non-labour income. The decision to grow in milk production is made together with choices on the amount of factor inputs and off-farm incomes. So, all these variables might be endogenous in the structural growth equation.

The growth equation is a dynamic panel data model. To estimate this equation we use the dynamic panel data estimation technique of Arellano and Bond [7] for a model with possibly endogenous variables.

First differencing of (2) eliminates the farm specific effects c_i. Unfortunately, the first differencing also eliminates the time-invariant variables in the model like number of household members and education.

C. Quota market

Total milk production of the farms that continue should be smaller or equal to the national quota:

$$\sum_{i}^{I} (1 - s_{it}) y_{it} \le \bar{y}_t \tag{4}$$

where *I* total number of farms, $\bar{y}_t$ national quota at time *t*.

III. DATA

The main data set used is rotating panel data set that contains annual observations of a large number of variables for a sample of Dutch dairy farms. It is not possible to determine whether a farm leaves the set based on statistical reasons or because of exit from milk production. For this we use another data set containing annual information on all farms in the Netherlands. This data set contains limited information but it does contain the number of dairy cows. With this variable we can establish whether a farm that leaves the rotating panel data set exits milk production. A negative growth could imply that a dairy farm is no longer considered to be specialised. However, we do not take that into account.

A farm is classified to be a specialised dairy farm if the size of the dairy part of the farm is more than 50 per cent of the total size using the Dutch size unit[2]. The rotating panel data set containing Dutch specialised dairy farms consists of 6338 observations on 1307 farms. The period investigated is from 1987/88 until 1999/00.

Appendix A provides an overview of the variables, their units, mean and standard deviation.

IV. ESTIMATION RESULTS

A. Exit

Table 1 gives the estimation results of the model explaining medium term exit from milk production (equation 1). The number of household members has a negative effect on the probability to exit. This reflects the availability of a successor or at least labour force in the future. Age has a positive effect up to 59 years and a negative effect afterwards. This confirms the expectation that the exit probability of older farmers is larger. If the quota price increases (decreases) the probability to exit decreases (increases). A higher (lower) quota price is positively correlated to farm income, and therefore decreases (increases) the exit probability. On the other hand high quota prices could make it attractive to exit because of the high return in case of selling the quotas. The insignificant parameter for the quota price means that we can not conclude that one of these two effects is stronger, although the negative sign indicates the first effect is more important. An increase in other output price can decrease the probability of exit because of the positive effect on income. On the other hand the relative increase of other output price compared to the milk price can make the farm decide to focus on this other output, and exit from milk production. The insignificant parameter for the other output price means that we can not conclude that one of these two effects is stronger. If cattle is seen as an input for milk production, the positive effect of the cattle price on the probability to exit seems counterintuitive at first, since a higher cattle price decreases income from milk production in this case. However, cattle is also an output for dairy farms. Cattle as output makes the positive sign plausible. Having off-farm non-labour income has no effect on exit. On one hand one would expect that having off-farm non-labour income would enable to exit because another source of income is available. On the other hand having off-farm non-labour income gives a source of income that enables to continue milk prodcution even if on-farm income is low. On-farm labour has a negative effect on the probability to exit milk production. High on-farm labour reflects either lack of off-farm labour opportunities or relatively high on-farm labour return. Both result in less exit. The level of education has a negative effect but insignificant effect on the probability to exit. More education could lead to larger off-farm labour opportunities (increasing exit) but also to a more profitable dairy operation (decreasing exit). The size of a farm expressed in land has a negative effect on the exit probability. This could indicate scale effects in the earning capabilities in milk production. The dummies for off-farm labour income and other farm activities are included to see whether the probability to exit from milk production is influenced by the presence of income from other activities. There are two possible ways of reasoning. The first is that having an income source next to income from milk production spreads the risk for the total household income. This means that a farm can level off occasional bad results from milk production with the other income sources. This process makes exit from milk production less likely. The second reasoning is that if a farm already has an income source next to income from milk production, it is easier to completely switch to that other income source. Based on this reasoning, having another income source, increases the probability to exit milk production. Only the dummy for keeping pigs is significantly different from zero. It has a negative value indicating that for pig production the risk spreading reasoning above is more likely.

[2] This variable is the nge, a value added based unit of output (CBS/LEI, 2006) [8].

Table 1 Probit estimation results for exit from milk production

Explanatory variable	Medium term exit estimate	t-ratio
Number of household members	-0.04	-1.15
Age	0.13	2.24**
Age squared/100	-0.11	-1.95**
Index price milk quota	-0.77	-0.90
Other output price index	1.17	0.79
Cattle price index	-5.45	-1.88**
Off-farm wage index	0.53	0.60
External non-labour income in 100.000 Euro	0.00	0.40
On-farm labour in 1000 hours	-0.16	-2.50**
Education level	-0.05	-0.43
Land in hectares	-0.02	-3.12**
Off-farm labour income dummy	-0.07	-0.58
Sheep dummy	-0.08	-0.52
Pig dummy	-0.27	-1.64*
Crops dummy	0.03	0.24
Meat cattle dummy	-0.08	-0.60
Constant	1.22	0.36

*(**) significance at 10 per cent (5 per cent) significance level.

B. Growth

Table 2 gives the estimation results of the growth equation (3). The parameter for lagged quota values 1.05 with t-ratio 11.03. However, to interpret the model as a growth model one should subtract lagged quota (or $y_{i,t-1}$ in terms of equation (3)) from both sides of the equation. In this case 1.05–1=0.05 is the effect of the quota ($y_{i,t-1}$) on the growth of quota ($y_{it} - y_{i,t-1}$). The positive sign suggests that relatively large farms grow faster than smaller farms, however the t-ratio for this number is only 0.53. This leads to the conclusion that there is no evidence for the dependence of growth on the level of milk quota.

Relatively large amounts of land, buildings and labour have a positive effect on growth in quota. Large amounts of these factor input make it easier to incorporate the extra quota in the farming process.

Other output price has a positive effect on growth in quota. This is a counterintuitive result, since it is expected that if the returns to other output increase more production factors are allocated to other output at the expense of milk production. A possible reason for this result is that dairy farms use the extra income to increase their core activity, which is milk production. The positive effect of the quota price on growth could be counterintuitive. A quota price increase is expected to decrease the demand for quota. However, acquiring quota is an investment that has an earning capacity that is reflected in the quota price. In this way the quota price reflects the profitability of milk production, which makes the positive effect of quota price on growth plausible. Next to that, farms might see quota partly as a speculative asset. When prices go up they are building up expectations and might be more willing to extend their quota.

External non-labour income has a negative effect on growth. The negative sign of reflects the fact that capital allocated off-farm can not be used to acquire quota. Another explanation can be that the increased household income reduces the need to increase farm income by growth of milk production. The fact that we do not find this income effect for off-farm labour income makes this explanation less plausible.

Table 2 Structural growth equation estimation results

Dependent variable: quota in kg	Estimate	t-ratio
Lagged quota in kg	1.05	11.03**
Factor inputs		
Land	0.21	3.07**
Buildings	0.38	2.21**
Machinery	-0.11	-0.09
Labour	0.67	2.59**
Farm prices		
Other output price	0.32	2.40**
Cattle price	0.45	0.15
Quota price	0.30	2.55**
Income		
Off-farm labour income	0.14	0.15
External non-labour income	-0.35	-1.72*
J-test statistic		46.46
Degrees of freedom (*df*)		40
t-ratio AR(1) test		-61
t-ratio AR(2) test		0.42

*(**) significance at 10 per cent (5 per cent) significance level.

V. POLICY SIMULATIONS

In this section we compare the situation in 1999/00 with hypothetical situations in the years 2002/2003 resulting from the scenarios.

A. Scenarios

We use equations (1), (3) and (4) in the simulations. If extra growth takes place extra farms have to exit milk production. This implies that the probability at which a farm exits (equation 1) goes up. We call this probability the cut off probability to exit. So, the cut off probability to exit is the probability at which enough farms exit to meet the extra demand for milk quota coming from the growth in milk production. All farms with a higher probability than the cut off probability to exit are assumed to exit. There is also an influence from the exit on growth since the farms that exit can have a different growth potential than farms that stay in milk production. We define the following scenarios:

Scenario 1: No policy change
In the first scenario we keep all exogenous variables constant except age (increasing by one every year). This implies that milk production for all farms grows every year according to equation (3). We keep the quota price constant (which is close to the actual situation before the 2003 CAP reform). The quota price has a positive effect on growth but also on exit.

Scenario 2: 2003 CAP reform
This scenario consists of three elements: milk price reduction, direct income payments and a milk quota increase. First, we assume a milk price reduction of 10 per cent at the end of the policy reform. Assuming that the marginal cost of milk production in 1999/00 is 50% of the milk price and that it is constant over time leads to a 20% reduction in the quota price. A lower quota price decreases growth and exit. Second, we model decoupled direct income payments as an increase in external non-labour income. This leads to a decrease in growth (significant) and an increase in exit (non-significant). The decoupled direct income payment equals 35 Euro per ton of milk produced in 1999/00. Finally, there is a 1.5% quota increase. A larger quota implies that less exit is needed to keep milk supply at the level of the national quota.

Scenario 3: 2008 CAP Health Check
To accommodate quota abolishment it is expected that in the 2008 Health Check the EU will take extra measures [2]. Here we assume, compared to the 2003 CAP reform, an extra 5% milk quota increase and an extra 10% milk price decrease. We assume that direct income payments will not be increased.

B. Results

Table 3 shows the results of the simulations. With a cut off probability to exit of 0 the probability to exit is exactly 50%. A negative cut off probability implies a smaller probability to exit while with a positive cut off probability the probability to exit is more than 50%.

Scenario 1: No policy change
The base scenario shows that to make milk supply equal to the national milk quota farms stop at a probability of exit less than 50%. The growth in milk production and the change in age (to a small extent) make farms to exit. In total 256 farms remain in production. In the sample we have 348 farms in 1999/00, this implies that in 2002/03 we have 26.4% farms less, this is a drop of 6.0% per year. This decrease is higher than the actual decrease in the period 1999/00 till 2002/03 which was 16.7% or 4.0% per year [9]. The larger calculated exit was expected since we only look at specialised farms. Moreover, the larger decrease could come from the fact that we keep all other variables constant while in reality they do change.

Scenario 2: 2003 CAP reform
Table 3 shows that with the 2003 CAP reform exit is less than with the base scenario. Table 3 also shows how this result can be decomposed. First, a milk price / quota price change does not have a large effect on exit and the average growth of milk production. The cut off probability to exit goes down slightly. So farms are, given a certain probability to exit, less likely to exit. However, the total number of farms that exit does not change. The negative effect on growth (so less farms have to exit) compensates for the positive effect on exit. Second, a national milk quota increase implies less exit resulting in a lower cut off probability to exit. The growth in milk production per farm does not change. So, the average growth of milk production per farm is now less than in the base scenario (14.44% compared to 14.58%). Third, a direct income payment of 35 euro per ton of milk production in 1999/00 lowers the cut off probability to exit. Exit and growth remain however almost equal. The decoupled direct income payment has a negative effect on the growth of milk production (so less farm have to exit) and a positive effect on exit. Apparently the opposite effects are of the same size. However, both effects do lower the cut off probability to exit.

Table 3 The cut off probability to exit, the farms that remain in production and the average percentage growth in milk production per farm.

	Cut off probability to exit	Farms that remain producing	% Growth milk production per farm
Scenarios:			
S1: Base scenario	-0.159	256	14.58
S2: 2003 CAP reform	-0.201	262	14.49
S3: 2008 CAP Health Check	-0.316	287	13.72
Elements of scenarios:			
Quota price: -8.28%	-0.160	256	14.58
Quota price: -20.00%	-0.162	256	14.58
Quota price: -40.00%	-0.162	256	14.58
Total quota increase: 1.5%	-0.170	262	14.44
Total quota increase: 6.5%	-0.286	287	13.77
Direct income payment	-0.177	256	14.58

Scenario 3: 2008 CAP Health Check

With the 2008 CAP Health Check the smallest number of farms exit. Especially the large quota increase and to a lesser extent the quota price decrease lower exit. Growth of milk production is the smallest in this scenario because the farms that do not exit in this scenario but do in the base scenario have a relatively small growth in milk production.

VI. SUMMARY AND CONCLUSIONS

The purpose of this paper is to analyse farm growth and exit and its interaction in Dutch dairy farming as consequences of EU dairy policy reform. Results indicate that the decision to exit milk production is largely determined by household characteristics as age and the size of the household. This result is in line with e.g. Kimhi and Bollman [3] and Glauben et al. [9]. Variables determining profitability, e.g. milk price, also affect exit but to a lesser extent. Growth is strongly influenced by the availability of labour, capital and land indicating that a relatively large production capacity results in more growth. The policy reforms reduce exit. This is mainly caused by the quota increases. A lower milk price has little influence on the decision to exit where the positive effect of more growth is offset by the smaller probability to exit. Decoupled direct income payments also have little effect on exit.

The analyses in this paper are subject to some qualifications. First, data and estimation techniques did not allow taking some potentially important household characteristics as illness and divorce into account in the exit equation. Second, in the simulations we keep all variables except milk price, age, national quotas and direct income payments constant while these variables do change over time and in some cases can be affected by the policy changes. Despite these caveats the paper gives valuable insights in the causes of farm growth and exit, how they interact and how they are affected by EU policies.

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Appendix A DATA

Table A1 Data for average specialized dairy farm in the Netherlands in 1999/00

Variable	Unit	Mean	Standard deviation
Quota	1000 kg	472.59	286.01
Cows[a]	Number	54.12	30.58
Land	Hectares	326	19.82
Buildings	1000 Euro of 1999	198.48	110.52
Machinery	1000 Euro of 1999	81.95	54.55
On-farm labour	Hours	4068	1484
Milk price index	1991 = 1	0.92	
Other output price index	1991 = 1	0.90	
Input price index	1991 = 1	0.92	
Cattle price index	1991 = 1	0.87	
Quota price index	1991 = 1	1.07	
Sheep[a b]	Number	186	49.22
Pigs[a c]	Number	50.62	159.36
Meat cattle[a d]	Number	3.37	13.53
Arable crops[a e]	Hectares	6.11	8.08
Off-farm labour income[a f]	1000 Euro	09	7.77
External non-labour income	1000 Euro	10.29	8.82
Off-farm wage index	1991 = 1	1.24	
Household members	Number	4.65	1.91
Education	Discrete variable	2.45	0.60
Age	Years	49.61	10.670