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A farm level analysis of the impact of milk quota reform: integrating econometric estimation with optimisation models

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Abstract

This paper explores the implications of an expansion of the EU milk quota. The paper begins by examining the relative competitiveness of dairy farming in the EU. FADN data is used to derive production cost measures and partial productivity indicators for selected Member States. The results show that Irish dairy farmers have relatively low cash costs of production and that output per hectare and per labour unit is low, suggesting that Ireland may be well placed to expand production if the milk quota regime were reformed. The subsequent sections of the paper address the implications of an expansion of the EU milk quota. Results of an analysis conducted using the FAPRI-Ireland partial equilibrium model are summarised while the results and methods of a farm level analysis are discussed in more detail. The FAPRI-Ireland farm level model integrates econometric and linear programming modelling to simulate the farmer behaviour. Results suggest that the majority of Irish farmers would benefit from milk quota expansion, although the extent to which they would benefit largely depends on the availability and price of traded quota in their local quota market.

1. Introduction

This paper describes a farm level analysis of the effect of an expansion in the EU milk quota. A detailed farm level model is developed for Ireland using Irish Farm Accountancy Data Network (FADN) data. Two milk quota scenarios are examined. The first scenario involves a once off 3 percent increase in the milk quota in 2008/09, with no further quota changes up to the elimination date. In the second scenario the milk quota is also increased by 3 percent in 2008/09, but that is followed with a series of successive annual quota increases, totalling 21 percent. The model results show the impact of quota reform on dairy farm numbers and farm incomes in Ireland. FADN data for various EU member states are also used to determine the relative competitiveness of milk production and to project future competitiveness. This analysis allows us to infer how Ireland might compete under a reformed dairy policy.

The paper is presented in three sections. The first section presents Farm Accountancy Data Network (FADN) data on farm level costs of production on dairy farms for a number of EU member states. In addition the relative competitiveness measures are used to speculate how the dairy farm sectors of the various EU Member States (MS) that are examined may develop given the possible challenges that will arise even before milk quotas expire. The second section of the paper provides a brief description of an analysis of milk quota expansion conducted using the

FAPRI-Ireland partial equilibrium model. The final and core section of the paper presents the results of the farm level analysis of the milk quota expansion scenario.

2. Competitiveness of milk production across the EU

The FADN gathers farm accountancy data in all EU MS to determine the financial situation on farms by measuring the level of gross output, costs, income, investment and indebtedness across the spectrum of farming systems. Here this data is used to analyse the relative competitiveness of dairy production across the EU. Costs of production as a percentage of output values for specialist dairy farmers were collated for the 2001 to 2003 period. These costs of production are decomposed into cash and imputed costs. Cash costs include all specific costs, directly incurred in milk production, for example fertiliser, feedstuffs, seeds etc. plus external costs such as wages of hired labour, rent and interest paid, plus depreciation charges. While imputed costs include family labour, equity capital and owned land. Imputed costs for land and labour were derived by using FADN measures of average land rental and agricultural labour rates in each country.

The examination of the cash costs of dairy production in isolation can be useful in that cash costs as a percentage of output value can be used to measure the resilience of the dairy sector to cope with a price-cost squeeze over the short run. If, for example, there was a substantial fall in milk prices, producers locked into a high cash cost structure would have a much lower chance of survival, other things been equal, (Boyle 1992). For a true competitiveness comparison, however, it is important to consider the opportunity cost of owned resources, i.e. imputed costs, in addition to the cash costs of production. This gives a measure of the total economic costs of production: in the long-run both cash and imputed costs must be covered if the business is to be sustained. Imputed costs can also be used as a leading indicator of the potential for the average dairy farmer in the EU MS to expand profitably, as they reflect the typical costs of land and labour in each country. Additionally, the total economic cost measure makes allowance for the differences that exist in production systems across EU MS. In some countries, for example Ireland and Belgium, most of the land is generally owned and most of the labour tends to be provided by the farm family and therefore does not appear in the cash cost calculation In other countries, for example the Netherlands and Denmark, there is a greater reliance on rented land and hired labour which inflates the cash cost measure. These MS distinctions can be lost when examining either cash or imputed costs in isolation.

Figure 1 presents dairy farm cash and imputed costs measured as a percentage of output value for the period 2001 to 2003 (the most recent years available). The average Italian dairy farm had the lowest cash costs as a percentage of output value in the 2001 to 2003 period. The relatively low cash cost to output ratio evident in Italy (60 per cent) may be due to the higher than average milk price paid in Italy rather than due to lower than average costs. Ireland and Belgium had only slightly higher ratios. In terms of cash costs, Denmark was the poorest performing country with cash costs at 87 per cent of output value. This is due largely to the high level of borrowing inherent in Danish dairy farming which is a feature of agriculture in general in that country.

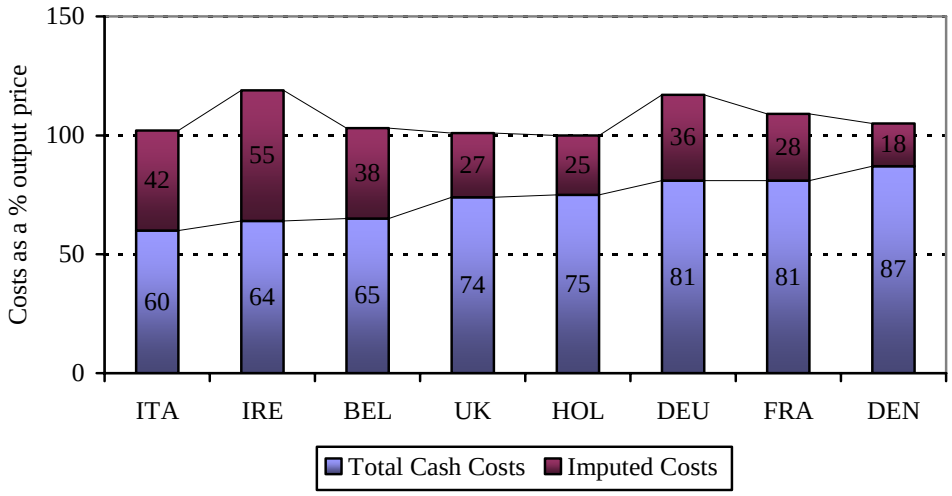


Figure 1: Average cash, imputed and total economic costs for all specialist dairy farms in selected EU member states (2001-2003)

When imputed costs for owned land and labour were also included to reflect total economic costs, the results were somewhat different. There was a relative alignment of the total economic cost profiles: Italy came much more into line with other MS but Ireland, Germany and France had noticeably higher profiles. Differences in imputed costs across EU MS can be attributed to three main factors:

- the varying degrees of reliance on owned versus hired resources (as outlined above);
- the varying cost of land and labour; and
- the relative efficiency of resource use.

Looking specifically at the efficiency of resource use, Thorne and Fingleton (2006) have derived partial productivity measures of dairy production across the EU (Figure 2). These measures of partial productivity are calculated as an index with partial productivity in Ireland at a base of 100.

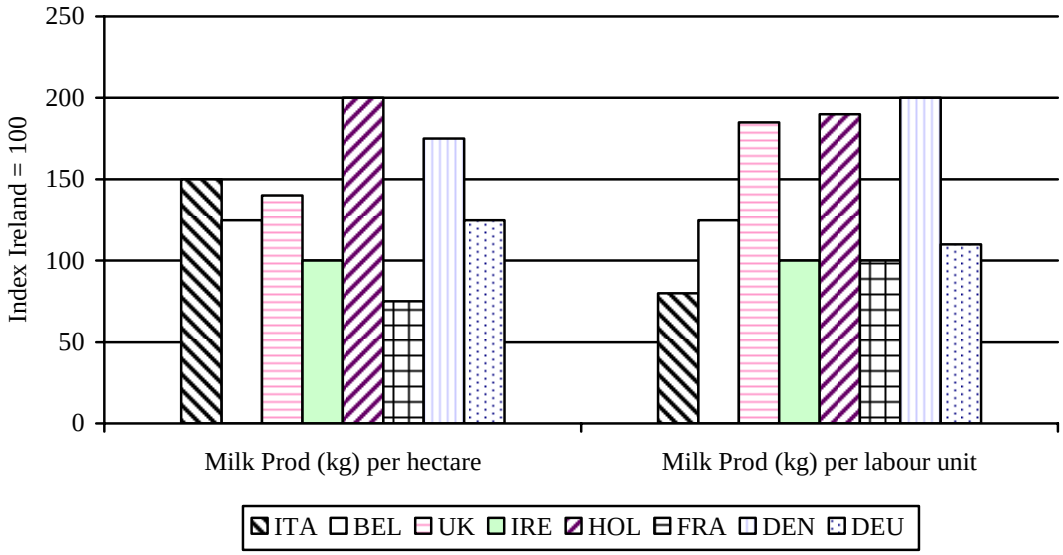


Figure 2: Index of average productivity indicators for all specialist dairy farms 2001-2003 (Ireland=100)

Figure 2 shows the relatively high milk output per hectare in the Netherlands and Denmark and milk production per labour unit in Denmark, the Netherlands and to a lesser degree the UK. These three MS also had among the lowest imputed costs, providing evidence that the more efficient use of land and labour lowers total economic costs. On the other hand, France and Ireland tend to have relatively low output per hectare, while Italy, Ireland and France have low output per labour unit. This lower output per labour unit and per hectare may partly explain the high imputed costs evident in Italy and Ireland. The situation with France is more complex as imputed costs are low despite the low output per hectare, this may be attributed to the cost of land and labour or to the ratio of owned to hired land and labour in the French production system.

Low output per hectare can be explained in some MS by the production system in operation. Milk production in Ireland for example, is a pasture based system and hence lower stocking rates and

lower milk output per hectare can be expected. The relatively low productivity of labour in Italy, France and Ireland may be explained by the structure of farming in these MS. Eurostat data show that 85, 80 and 65 per cent of herds in Italy, France and Ireland respectively consist of 50 cows or fewer. This compares to the much larger structure in the Netherlands and Denmark where between 60 and 65 per cent of dairy herds consist of 50 cows or more, while almost 30 per cent of herds in the UK have 100 cows or more.

It could be argued that the various milk quota transfer policies implemented by MS in recent years are responsible for the current structure of farming and to some degree may explain the relative international competitiveness of EU MS. In France and Ireland, for example, movement of milk quota between producers has been relatively restricted when compared with quota transfer between producers in Denmark, the UK and the Netherlands where a freer market for milk quota exists. The poor size structure and low output to resource ratio that now exists in some MS is largely due to the slow pace of structural change as a result of the restrictive quota transfer policies. On the other hand, MS that adopted a more market based quota transfer mechanism facilitated the restructuring of resources towards more efficient producers, i.e. those that could pay the highest price for quota.

The data presented in Figure 1 shows that the average dairy farmers in the EU MS examined achieve low margins per litre of milk produced leading one to question the future resilience of the industry and the ability of the EU to increase milk production if the EU milk quota were expanded. The ensuing section of the paper addresses the impact of a possible milk quota expansion.

3. The impact of a potential reform to the EU milk quota regime

The Mid Term Review of the Common Agricultural Policy made provisions for a review of the milk quota regime in the 2008 “CAP Health Check” with a view to the phasing out of milk quotas by 2015. There are now indications at EU Commission level that a decision on the phase out of quotas may be imminent and that some reform of the quota regime may be implemented following the Health Check. The dilemma policy-makers face is to identify a policy to phase out quotas by 2015 with the minimum disruption possible, the so called “soft-landing policy”. Several mechanisms that would bring milk quota to an end have been proposed, however a gradual quota expansion seems most likely.

In 2007 the FAPRI-Ireland partnership conducted an analysis of the implications for Ireland of an expansion of the EU milk quota. Two milk quota expansion scenarios were analysed. Scenario 1 assumed a once-off 3 percent increase in the EU milk quota in 2008/09. Scenario 2 assumed a 3 percent per annum increase in the EU milk quota from 2008/09 to 2014/15 a total increase of 21 percent. In both scenarios it is assumed that milk quotas do not extend beyond 2015. Both scenarios are compared to a baseline which assumes no change to current agreed policies, i.e. the EU milk quota continues unchanged between now and 2015 and is then removed. Full details of how this is modelled are available from Binfield et al (2007), here a brief summary of the results are provided.

The results of scenario 1 show that the quota increase of 3 percent is largely taken up by EU MS and it is estimated that overall EU milk production increases by 1.6 percent. The increase in supply has negative consequences for price and the EU average milk price falls by 3.5 percent compared to the baseline, the price falls slightly more, by 4 percent, in Ireland. The results suggest that compared with Scenario 1, a series of annual milk quota increases might better achieve the 'soft landing' sought by policy makers. The results show that most MS take up the increase in quota in the first couple of years of expansion; Overall EU milk production increases by just 4 percent by 2014 and the average EU milk price is projected to be almost 7 percent lower than the 2014 baseline milk price. The situation of Ireland is somewhat different, due to low production costs and small farm structure as outlined above, it is expected that Ireland would increase national production by the full quota increase. Milk production in Ireland increases by 21 percent over the period while the milk price declines by 15 percent relative to the baseline. The next section of the paper describes the FAPRI-Ireland farm level model and presents the results of the farm level analysis.

4. The impact of EU milk quota expansion at the farm level in Ireland

4.1 The FAPRI-Ireland farm level model

The FAPRI-Ireland farm level model applies the price projections produced by the FAPRI-Ireland partial equilibrium model to FADN data for Ireland, National Farm Survey data (NFS). A series of models are then used to simulate farmers' likely responses to the policy change under examination. The models integrate econometric and optimisation techniques. A multi-period

profit maximising linear programming (LP) framework is used to simulate production decisions. Linear programming is an optimisation technique which operates by maximising or minimising an objective function subject to a number of constraints. In this case the objective function is assumed to be profit maximisation and farm net margin is maximised over the ten year period in a block diagonal matrix form subject to the usual physical, financial, technological and policy related constraints. Irish National Farm Survey (NFS) data are used to specify the models. All activities that exist on the farms in the base data year, 2006, are included in the LP choice set as well as all likely activity options. Transfer activities are used in the LP model to link multi-year activities, such as livestock systems. The input-output co-efficients used are those recorded in the base year and are assumed to remain fixed through time despite policy changes, in other words for any given production process only one combination of the factors of production is assumed. Hence the scope of the models is confined to the analysis of resource allocation decisions, enterprise mix and volume of production decisions, participation in policy schemes and the resulting impact of these decisions on income. The advantage of LP for use in policy analysis is that it does not rely on time-series data and it does not extrapolate future relationships from historical ones, and therefore it can go beyond the realm of past observations and analyse unprecedented changes. This is a major advantage in the analysis of policy scenarios that may differ substantially to previously implemented policies.

The disadvantages of using LP however are its normative nature and its limited scope to project changes to the structure of farming, i.e. farm numbers, composition of the farming population in terms of the number of full and part time farms and so forth. To overcome these weaknesses, the FAPRI-Ireland farm level modelling system supplements the LP model with a number of exogenously estimated models of farmer behaviour that can quantify the effects of non-pecuniary factors on farmers' decision-making. Three exogenous models are estimated: first, entry to and exit from farming; second, labour allocation; and third, land and milk quota distribution. The first model simulates the Irish farming population. The second model estimates the number of part-time farmers and the amount of farm labour to provide the right hand side parameters for the labour constraint in the LP models. The third model simulates the allocation of land and milk quota; again, to provide the right hand side parameters for the land and quota constraints in the LP models.

The entry and exit model is an econometric model based on retirement and succession. The entry decision is modelled as the occupational choice of the nominated farm heir. The heir is faced with a discrete choice of whether to enter farming as a full-time occupation, a part-time occupation or to enter a non-farming occupation. This decision is modelled using a multinomial logit model. This model uses data on farm heirs that have already made occupational choices and from that data estimates the probability of future farm heirs entering farming based on their personal and farm characteristics. This model is used to examine the effect of policy reform on the number of new entrants to farming. From this, inferences on the implications for total farm numbers are drawn. The decision of farm operators to engage in off-farm employment is also modelled using econometric techniques. The decision of the farmer to engage in off-farm employment is a binary one and therefore can be modelled using a probit model. Like the multinomial model, the probit model uses data on the farmers that are currently employed off the farm and from this can estimate the probability of farm operators engaging in off-farm employment given a change in policy. The number of hours spent working off the farm is also modelled in a similar manner. Finally, the decision to exit the dairy enterprise and to sell the milk quota off the farm is also modelled. The estimation of exit from dairying is based on a profitability analysis. Historical levels of profitability and the rate of exit from dairying are examined to identify a minimum level of profitability below which exit has occurred historically. Using the LP model producers operating below the minimum level of profitability are projected to exit production. The Irish milk quota transfer system is simulated and the milk quota of exiting farmers is reallocated based on the rules governing the transfer of quota. Further information on the FAPRI-Ireland farm level modelling system is available from Hennessy and Rehman (2007).

4.2 The Farm Level effects of milk quota reform

As the milk price declines in most milk quota expansion scenarios profit per unit of production also declines. The potential benefit of the quota expansion scenarios, therefore, is the ability to produce more milk, albeit at a lower milk price. Whether the net effect of producing more milk at lower milk prices, has negative or positive implications for profit depends on the costs of production and especially the costs of expansion. Expansion potential is estimated using NFS data and the costs associated with expansion are taken from the Moorepark Dairy Systems Model (Shalloo et al 2004) and are derived from production research at Teagasc Moorepark Research Centre, full details are available from Hennessy (2007).

Table 1 presents estimates of dairy enterprise net margin under the Baseline and the two scenarios for a case study farm selected from the NFS. This is a typical 300,000 litres farm with an enterprise net margin of €19,250. We first examine the circumstances of this farm in 2010. In the Baseline, in 2010, it is assumed that the farm has not increased in size and 300,000 litres are produced at a net margin of €19,642. In Scenario 1 production on the farm increases by 3 percent in 2010 to 309,000 litres. The additional litres are supplied by increased feed, lengthening lactation and retaining less milk on the farm at a total cost of €450 (5 cpl). Despite the increase in milk production, profit declines relative to the Baseline. The 3 percent increase in quota is insufficient to offset the decline in gross output. Under Scenario 2 production has increased by 3 percent each year from 2008 to 2010 brining production in 2010 to 327,0000 litres. Gross output per litre falls further under Scenario 2 than in Scenario 1, reflecting the more rapid decrease in milk price. The increased production offsets the lower milk price with enterprise net margin approximately €1,000 (5 percent) higher than in the Baseline.

Table 1: Case Study Analysis of a farm currently producing 300,000 litres of milk and expanding in line with national quota increase

	Baseline 2010	Scenario 1 2010	Scenario 2 2010	Baseline 2012	Scenario 1 2012	Scenario 2 2012
Quota (Litres)	300,000	309,000	327,000	300,000	309,000	345,000
Additional Quota (expansion stage 1) (expansion stage 2)		9,000 (9,000)	27,000 (27,000)		9,000 (9,000)	45,000 (30,000) (15,000)
Gross Output CPL	28	26.8	26.4	28.9	27.7	27
Total Output €	84,000	82,812	86,328	86,328	86,700	85,593
Costs on Base Quota CPL	11.1	11.1	11.1	11.1	11.5	11.6
Total Direct Costs €	33,300	33,300	33,300	33,300	34,500	34,800
Expansion Costs CPL (stage 1 costs cpl) (stage 2 costs cpl)		5 -	5 -		5.1 -	5.1 8.5
Expansion Costs € additional direct costs €		450	1,350		459	2,805 1,740
Fixed Costs €	31,058	31,058	31,058	32,165	32,165	32,165
Dairy Net Margin €	19,642	18,004	20,620	20,035	18,169	21,640

In Scenario 2 milk production on the farm has increased by 45,000 litres by 2012. It is assumed that 30,000 litres is Phase 1 low cost expansion, i.e. 5cpl, and that for the other 15,000 litres additional housing, labour and bulk tank capacity must be purchased and the value of heifer sales

and profit on beef enterprise is foregone. As outlined above, this Phase 2 expansion costs approximately 8.5cpl. Total expansion costs, including low and high cost expansion, are €4,545, which includes the cost of production on the additional milk of €1,740. These expansion costs are smaller than the increase in the value of gross output of €7,140 and so Scenario 2 is preferable to the Baseline as profit is 8 percent higher. This example assumes that farmers only increase production by the national increases. In Table 5-2 it is assumed the farmer produces the same amount of milk in both scenarios. The farmer receives the milk quota increases free in Scenario 2, but the additional quota must be purchased in the Baseline.

Table 2: Case Study Analysis of a farm currently producing 300,000 litres of milk and expanding in line with national quota increase and quota purchase

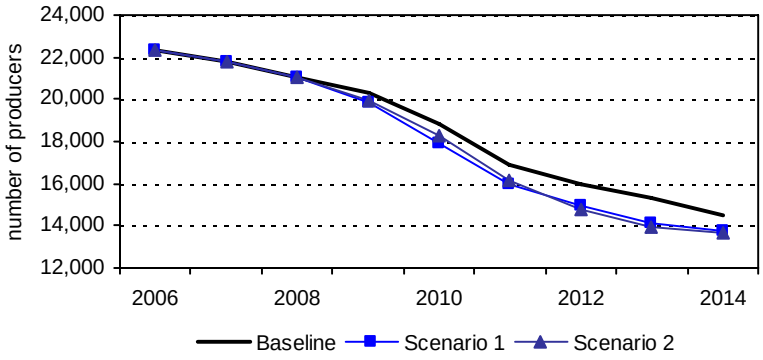
	Baseline	Scenario 2	Baseline	Scenario 2	Baseline	Scenario 2
	2008		2010		2012	
Quota (Litres)	309,000	309,000	327,000	327,000	345,000	345,000
Purchased Quota	9,000	-	18,000	-	18,000	-
Additional Quota	9,000	9,000	27,000	27,000	45,000	45,000
(expansion stage 1) (expansion stage 2)	9,000	9,000	27,000	27,000	30,000 15,000	30,000 15,000
Gross Output CPL	33.4	32.6	28	26.4	28.9	26.9
Total Output €	103,206	100,734	91,560	86,328	99,705	93,150
Costs on Base Quota CPL	11.1	11.1	11.1	11.1	11.5	11.6
Total Direct Costs €	33,300	33,300	33,300	33,300	34,500	34,800
Expansion Costs CPL (stage 1 costs cpl) (stage 2 costs cpl)	5	5 -	5	5 -	5.1 8.5	5.1 8.5
Expansion Costs €	450	450	1350	1350	2805	2805
Additional direct costs €					1,725	1,740
Fixed Costs €	29,819	29,819	31,058	31,058	32,165	32,165
Net Margin €	39,637	37,165	25,852	20,620	28,510	21,640
Surplus for Quota Purchase €	2,472		5,232		6,870	

Enterprise net margin is €2,472 higher in the Baseline in 2008 than on Scenario 2. It follows then that if the farmer could purchase 9,000 litres for 27cpl or less in 2008 the Baseline is preferable. Similarly, in 2010, the farmer would be better off if 18,000 litres could be purchased for 29cpl or less and finally in 2012 the Baseline is preferable if a further 18,000 litres of quota could be

purchased at 38 cpl or less. It follows then that if farmers have access to sufficient quota to allow them to increase their farm size by at least 3 percent per year at reasonable quota prices then they are better off under current policies. The likelihood of farmers having access to this amount of quota, in the baseline depends on (i) current farm size, as small farmers will find it easier to access 3 percent of their current quota and (ii) the milk quota exchange in which they operate, i.e. if supply of quota is plentiful relative to demand.

The net effect of the two milk quota expansion scenarios is not straightforward. The national milk quota increases come at a reduced milk price relative to the Baseline and farmers must increase production to offset the price decline. Farmers locked into a high cost structure will not find the additional expansion profitable and profits on their existing production will be squeezed. Low cost farmers, especially those with large capacity to expand, can increase production profitably. However, if low cost farmers can increase their quota by at least 3 percent per year through the milk quota exchange at reasonable quota prices, then the Baseline is preferable. However, this will not be possible for all farmers, as major restructuring would be required to facilitate such expansion for all farmers. It seems then that there will be both winners and losers under Scenario 2. Those that are likely to benefit most from quota expansion are those operating in regions where quota is difficult and costly to access. To determine the effect of milk quota expansion on all existing creamery milk producers, the FAPRI-Ireland farm level model is used.

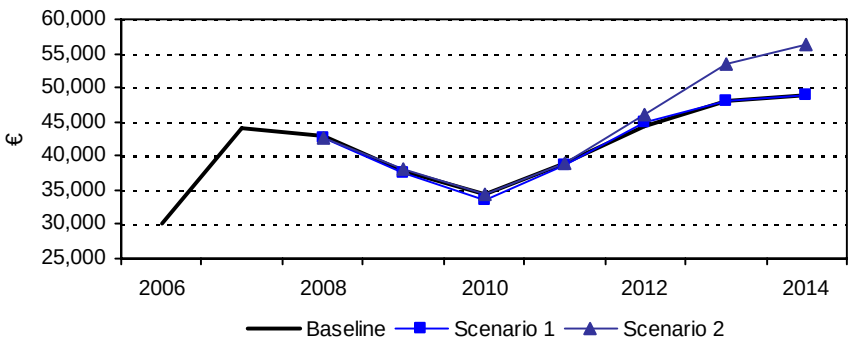
Figure 3 presents projections of changes in dairy farm numbers from 2006 to 2014 under the Baseline and milk quota scenarios. There is little difference in the rate of structural change in the baseline and the two scenarios in the early part of the projection period with farm numbers declining slowly from 2006 to 2010. Farm numbers decline marginally faster in the two milk quota expansion scenarios as high cost farmers feel the price cost squeeze and exit the sector. By 2014 farm numbers are approximately 14,500 in the Baseline and 13,750 in Scenario 1 and 13,650 in Scenario 2.



Source: FAPRI-Ireland Farm-Level Model (2007).

Figure 3: Baseline and Scenario Projections of Dairy Producer Numbers 2006 to 2014

Figure 4 presents the projected average family farm income across all creamery milk suppliers that remain in production in the three scenarios. The figure shows that farm incomes are projected to be considerably higher in 2007, 2008 and 2009 relative to 2006 levels under the baseline and the two scenarios. This increase in incomes is almost entirely from the market as there is very little increase in farm scale over this period due to slow exit rates. Farm incomes decline in 2010 as net margins per litre fall. This decrease in profitability leads to restructuring in the sector, with less profitable and less efficient farmers exiting the sector, while those that remain increase in scale. Average farm incomes then increase faster under Scenario 2 than in the Baseline or Scenario 1. By 2014 farm incomes are projected to be almost 15 percent higher in Scenario 2 than in the Baseline and over 80 percent higher, in nominal terms, than 2006 levels.



Source: FAPRI-Ireland Farm-Level Model (2007).

Figure 4: Baseline and Scenario Projections of Average Family Farm Income for Creamery Milk Producers 2006 to 2014

Despite farm numbers being lower in Scenario 1 than in the Baseline, average farm incomes are more or less the same in both scenarios by 2014, this is due to the lower milk price. As a result of the increase in farm incomes, the proportion of farmers that are economically viable also increases as the least profitable farms exit production and the remaining farms increase supply.

5. Conclusions

This paper presents first an overview of the international competitiveness of European dairy farming and then the results of analysis of the impact of an expansion in the EU milk quota. The competitiveness indicators suggest that Ireland has one of the lowest cash costs of dairy production in the EU. Furthermore, the grass based production system in operation in Ireland offers the country some insulation from recent increases in grain based feed products, further enhancing the competitive advantage. An analysis of partial productivity indicators suggests that the scale of farming in Ireland is small relative to its competitors. It is hypothesised that the restrictive regulations that have governed the transfer of milk quota in Ireland over the last decades has impeded the process of structural change relative to other Member States. This situation gives Ireland an advantage in that there are still productive resources that are underutilised and therefore potential may exist to expand production if the milk quota regime were reformed. To explore this issue further an analysis of a milk quota expansion policy scenario was conducted.

Quota rent estimates used in the milk quota expansion scenario suggested that Ireland was better placed than other EU Member States to increase milk production. Hence it is expected that even with the more aggressive milk quota expansions scenario, i.e. 3 percent each year, that Ireland would still fills its milk quota. The paper describes an analysis that was conducted using farm data to ascertain whether individual farmers would benefit from quota expansion. The results show that the modest increase in quota of a once off 3 percent would not be to the benefit of farmers, as the milk price decline offsets the advantage of the volume increase. The results of the more aggressive scenario are more positive, medium and low cost farmers would increase profit by producing more milk even at the lower milk price. The results are not clear-cut however, the number of farmers that benefit and the degree to which they benefit is affected by geographic location. The trade of milk quota in Ireland is market based but is ring-fenced to geographic areas. Farmers operating in areas where the local quota market has a plentiful supply of milk

quota at reasonable prices would maximise profits under current milk quota policies. However, farmers operating in regions where the demand for and price of quota is very high would benefit from the liberalisation of milk quota policy both at a domestic and European level.

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