Analysis of the economics of BoHV-1 infection in Ireland

Incorporating analysis of the impact of the disease on animal productivity, national genetic gain and international trade

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Glossary

AFBI-NI	Agri-Food and Biosciences Institute – Northern Ireland
AIMS	Animal Identification and Movement System
BoHV-1	Bovine herpesvirus 1
Brexit	The exit of the United Kingdom of Great Britain and Northern Ireland from the European Union
CAFRE	College of Agriculture, Food and Rural Enterprise
CGE	Computable General Equilibrium
CMMS	Cattle Movement and Monitoring System
BSE	Bovine Spongiform Encephalopathy
DAFM	Department of Agriculture, Food and the Marine
EEC	European Economic Community
ELISA	Enzyme linked immunosorbent assay
EU	European Union
FAPRI	Food and Agricultural Policy Research Institute
FTA	Free Trade Area
GBSM	Grange Beef Systems Model
IBR	Infectious bovine rhinotracheitis
ICBF	Irish Cattle Breeding Federation
IFJ	Irish Farmers Journal
MDSM	Moorepark Dairy Systems Model
MFN	Most Favoured Nation
MP	Multiparous
NFS	National Farm Survey
NI	Northern Ireland
NISBP	Northern Ireland Suckler Beef Programme
NLE	No Live Exports
NTB	Non-Tariff Barrier
PE	Partial Equilibrium
PP	Primiparous
ROI	Republic of Ireland
SCC	Somatic Cell Count
SD	Standard deviation
UV	Unvaccinated
WTO	World Trade Organisation

Contents

1 Executive Summary

The development in other EU member states of formal IBR control/eradication programmes raises the possibility that other Member States could ban the import of Irish live cattle under the additional guarantees provided in European Commission Decision 2004/558/EC (European Commission, 2004) where they either have an eradication programme approved or evidence of freedom from infection according to Articles 9 and 10 respectively of Council Directive 64/432/EEC (EEC, 1964). Such restrictions on economic activity would be expected to have negative effects on the Irish agricultural economy. IBR is also known to have a negative impact on bovine productivity that would be expected to be reflected in a negative impact on the farm level profitability of dairy and beef production. DAFM contracted Teagasc to undertake an analysis of the economic implications of IBR with a view to considering the costs and benefits that would be associated with an IBR control/eradication programme in Ireland.

The study undertaken does not constitute a formal cost/benefit analysis (see Boardman et al. 2006; Drèze and Stern, 1987). No attempt is made in this study to identify all of the costs or the benefits that might be associated with an IBR control/eradication programme in Ireland. What the study was tasked with accomplishing was an evaluation of the

i) on-farm losses associated with reduced output on farm that are associated with IBR;

ii) potential costs associated with a loss in genetic gain;

iii) costs associated with the loss of the live export trade in calves and weanlings to EU markets.

This study is comprised of three parts – two studies of the farm level losses associated with IBR conducted using the Moorepark Dairy Systems Model (Shalloo et al., 2004) and the Grange Beef Systems Model (Crosson et al., 2006) and a study using the FAPRI-Ireland model (Donnellan and Hanrahan, 2014) examines the economic impact of the loss of live exports to EU markets that might arise as a result of disease status and/or the absence of a disease control programme.

Due to dramatic changes in the level of Irish live cattle exports over the period since the original delivery of this report and the formal exit of the UK from the EU (Brexit) at the end of January 2020, the economic analysis using the FAPRI-Ireland model has been updated. This revised analysis is presented as an Annex to this report.

The analysis of the farm level costs associated with IBR on Irish dairy and cattle rearing farms undertaken using the Moorepark Dairy System Model (MDSM) and the Grange Beef Systems Model (GBSM) are based on recently completed or on-going scientific studies concerning the prevalence of IBR within the Irish dairy and suckler cow herds and the impact of IBR on the biophysical performance of dairy and suckler cows in Ireland. No analysis of the impact of IBR on cattle finishing farms was undertaken. The impact of the IBR disease on animal performance and farm profitability may be greater than on cattle rearing farms, but analysis of this issue using existing bio-economic models will require experimental data and scientific research that are not yet in existence.

The third part of this study looks at the sectoral implications of a possible policy response by EU trading partners to the endemic presence of IBR within the Irish bovine population and absence of a national IBR control/eradication programme. While the absence of barriers to trade is one of the defining principles of the EU Single Market, EU member states can restrict trade in live animals on the basis of animal disease (European Commission, 2004). To evaluate the impact on the Irish agricultural economy of such a possible restriction on live cattle trade an extreme live export scenario was examined using the FAPRI-Ireland model of the Irish agricultural economy (Donnellan and Hanrahan, 2014). A Baseline no policy change scenario and an alternative "no live export scenario" were simulated over a medium term horizon and the impact of a ban on live cattle exports measured as the difference in agricultural sector income under the no live exports scenario and the Baseline.

No formal model-based assessment of the potential costs associated with the loss in genetic gain associated with IBR was conducted. The magnitude of economic losses associated with a loss in genetic gain resulting from the IBR-based exclusion of a bull from a breeding programme are not expected to be significant. This expectation of an only minimal loss in genetic gain as a result of IBR is due to the large amount of genomic data that are now available on bull calves that are used for breeding purposes. If an individual bull is excluded because of IBR, it is now possible to replace that animal with one that is likely to be only marginally inferior from the perspective of its contribution to the genetic gain in the national herd. Because of this assessment, no further model-based assessment of the magnitude or the costs of genetic gain foregone due to IBR was undertaken.

Dairy farm system analysis

The BoHV-1 (IBR) status of a dairy herd is found to have a significant effect on the performance and profitability characteristics of Irish dairy farms (Sayers, 2017). Using the Moorepark Dairy System Model and three different milk prices regimes (24 cpl, 29cpl and 34cpl) the profitability was reduced by an average of €60 per cow per year when herds were classified as seropositive for BoHV-1. At a milk price of 29 cent per litre this was equivalent to a 22% reduction in profit.

When the measure of foregone income per cow of €60 per year is aggregated to an overall industry level, assuming a national dairy cow population of 1.296 million cows nationally and an 80% prevalence of IBR, it is estimated that IBR is costing the Irish dairy industry €62 million annually in terms of foregone profit as compared to a situation where IBR was not present.

Suckler farm system analysis

In contrast to the significant biophysical effects of BoHV-1 status on dairy herd performance and profitability the biophysical and farm level economic effects of BoHV-1 status on suckler cow herds taking progeny to weaning were more modest. As noted above no analysis of the biophysical and farm level economic effects of BoHV-1 status on cattle finishing farms was possible due to the absence of research on the biophysical impacts of BoHV-1 status on cattle performance in Irish cattle finishing production systems. The modest biophysical effect of BoHV-1 seropositivity, with output per hectare 3.2% lower for seropositive herds, was reflected in similarly modest impacts on farm level profitability as simulated by the GBSM. Net margin per farm was found to be 6% with lower for the seropositive herd using the GBSM, with the negative impact on incomes of lower output per hectare reflecting the higher costs per hectare on seropositive herds. The absolute magnitude of the loss in net margin associated with BoHV-1 seropositivity depends on the weanling price assumed. Four different weanling prices were evaluated and the loss in net margin associated with BoHV-1 was found to range from €10 to €21 per hectare (equivalent to a loss in net margin per hectare of 4.1% to 3.6%).

Due to the significant heterogeneity amongst Irish suckler cow production systems it is not possible to aggregate from the GBSM estimate of the impact of IBR on profit per cow on suckler herds where progeny are sold as weanlings to a national farm level cost for all Irish suckler cow production. However, the magnitude of the aggregated economy-wide farm level cost of IBR on suckler farms is likely to be significantly lower than that associated with IBR on Irish dairy farms. Given that the average Cattle Rearing farm in the Teagasc NFS consisted of just over 35 hectares (Hennessy and Moran, 2016), if the loss in margin per hectare from BoHV-1 seropositivity on all cattle rearing farms were assumed to be the same as those on suckler farms, where progeny are sold as weanlings, then the average cost per farm would range from €350 per farm to €735 per farm.

Readers should note that no evaluation has yet been undertaken of the biophysical losses associated with BoHV-1 on Irish cattle finishing farms and the economic value of losses would be in addition to those on cattle rearing farms.

Sectoral level analysis of a live export ban

In certain instances, restrictions on trade in live cattle can be imposed by EU Member States on animal health and disease grounds. It is possible that markets that currently import Irish cattle (or that are on the land route to markets that import Irish cattle) could ban imports of Irish cattle on the grounds of the presence of IBR in the Irish cattle population and the absence in Ireland of an approved IBR control programme. What would be the impact of such a ban on live cattle exports? The FAPRI-Ireland model-based simulations of a no live exports (NLE) scenario indicate that a ban on live exports of cattle would lead to a loss in agricultural sector income of approximately €50 m per annum by 2024, equivalent to 2% of projected Irish agricultural sector income.

Under the NLE scenario, cattle that under the Baseline would have been exported live, are raised to slaughter in Ireland. This change in the nature of Irish cattle disposals (more slaughter and less live exports) leads to an increase in the volume of Irish beef output. Irish cattle sector output value is higher in the NLE export scenario than under the Baseline. This is despite a small reduction in Irish cattle prices as a result of the live exports ban. However, the additional cattle fattening activities under the no live exports are also associated with additional expenditure on intermediate inputs (feed, fertiliser etc.). The projected increase in input expenditure is sufficient to more than offset the higher cattle output value projected under the NLE scenario and this is projected to leave aggregate agricultural sector income 2% lower under NLE scenario than under the Baseline.

The projected magnitude of the loss in agricultural sector income derived using the FAPRI-Ireland model is subject to caveats that reflect the nature of the FAPRI-Ireland model. The model is a Partial equilibrium model of the agricultural economy and cannot provide insights on the incidence of loss within the Irish cattle sector. The FAPRI-Ireland model does not distinguish live cattle exports on either an age or breed basis. Other things being equal, the younger the age composition of future Irish live exports and the greater proportion of those exports made up of dairy progeny the higher are the likely costs to the agricultural economy associated with forcing the Irish agricultural sector to bring those animals to slaughter. The FAPRI-Ireland model, like most other PE models of agricultural commodity markets, does not incorporate non-competitive behaviour within supply chains. If the live export trade is critical, as argued by some, to ensuring competitive behaviour on the part of Irish meat processors (i.e. it prevents them from exploiting their market power) then the absence of such competitive pressure could lead to reductions in cattle output prices in excess of those projected by the FAPRI-Ireland model.

The FAPRI-Ireland model is a non-spatial model and does not distinguish agricultural commodity exports and imports (including live trade) by destination or source. This is why the scenario analysed – the no live export scenario – assumes all live trade is halted. Live exports of cattle have been dominated by exports to EU markets though exports to non-EU markets have in some years accounted for over 15% of cattle shipped. The prospect of increased live cattle exports to Middle East, North African and Turkish markets represents an important positive element in the short to medium term outlook for the Irish and EU cattle sector. Because these markets are not part of the EU and Article 9 based restrictions on trade are irrelevant. However, these markets' import licences in general require that cattle imported are from farms that are free of a set of specified animal diseases. Thus the simulated impact of a ban on live exports is a relevant to non-EU as to EU markets in terms of the threat it poses to existing and potential future trade flows.

Finally, no account is taken of the impact of Brexit in the sectoral level (or farm system level) simulations reported here. The FAPRI-Ireland model was used to assess the economic impact of a ban on live cattle exports as compared to a Baseline where no restrictions on live cattle exports are introduced. The FAPRI-Ireland Baseline prepared in 2015 was used in this analysis and under the Baseline there is no change in the composition of the EU. The analysis was conducted in advance of the UK referendum in June 2016 on whether to remain or leave the EU. The UK vote to leave the EU and the expected triggering of Article 50 of the Treaty on European Union (TEU) and the expected exit of the UK from the EU at some point in 2019 will fundamentally change the nature of the trading relationship between Ireland, the UK and the EU.

The €50m cost in foregone income that could arise because of the absence of an IBR control or eradication programme in Ireland are additive to the farm level costs associated with the biophysical effects of BoHV-1. It has not been possible to estimate an aggregate of these biophysical costs for Irish beef production, but the costs on Irish dairy farms of BoHV-1 are estimated to aggregate to over €60m per annum. The potential overall costs to the Irish economy of BoHV-1 and the absence of an IBR eradication or control programme could be in excess of €100 m per annum.

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2 Costs Associated with IBR Status on Irish Dairy Farm

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Introduction

Infectious bovine rhinotracheitis (IBR), caused by bovine herpesvirus 1 (BoHV-1), is a highly contagious viral disease of cattle (Muylkens et al., 2007). It has a worldwide distribution and significant efforts have been made, particularly in EU countries, to control and eradicate BoHV-1 (Ackerman and Engels, 2006). The importance of a disease can be characterised by its economic consequences and the primary motivation for eradication of BoHV-1 from livestock populations is its reported impact on the economic success of farming enterprises. Clinical signs of infection include abortion (Givens and Marley, 2008; Graham et al., 2013), sub-optimal fertility, respiratory disease, reduced milk production, and increased mortality under experimental conditions (Bowen et al., 1985; Chiang et al., 1990; Miller et al., 1991) and natural field infection (Hage et al., 1998;; Nandi et al., 2009; Raaperi et al., 2012; Moeller et al., 2013).

More specifically, Hage et al. (1998) described a significant decrease in milk production of 9.52kg over a 14-day infectious period in BoHV-1 seronegative animals that became infected with the virus. Raaperi et al. (2012) highlighted that herds with a BoHV-1 within-herd seroprevalence of between 1 and 49%, have a higher risk of abortion (Odds Ratio = 7.3). Moeller et al. (2013) reported that 2% of calves submitted for necropsy to the California Animal Health and Food Safety Laboratory in Tulare, California over a six year period had lesions consistent with systemic BoHV-1 infection.

Although sub-optimal performance due to infection with BoHV-1 has been reported widely, it should be noted that many studies have yielded contradictory results. Reproductive losses, for example, were not found to be associated with exposure to BoHV-1 in beef herds (Waldner, 2005; Waldner and Kennedy, 2008) or in a dairy herd during a subclinical BoHV-1 infection (Hage et al., 1998). These contradictory publication findings are most likely due to the timing of infection, differences in the type of cattle herds being investigated (beef versus dairy), and livestock management systems operating. This stresses the importance of completing investigations specific to a particular region and livestock system.

The Republic of Ireland (hereafter referred to as Ireland), is a net exporter of agricultural produce, with over 90% of dairy produce exported (Geary et al., 2010). The majority of Irish dairy farmers operate a pasture-based system. Irish dairy cows graze pasture for approximately 10 months of the year (Drennan et al., 2005). Limited data are available on the impact of BoHV-1 in such a system, and it is important to examine whether the impact of BoHV-1 in Ireland is similar to that reported previously in more intensive livestock systems. Prevalence estimates of BoHV-1 exposure can be established using bulk milk analysis. A recent Irish study (Sayers et al., 2015) outlined a bulk milk seroprevalence in Irish dairy herds of 80%. The same study highlighted that 8.2% of the study herds contained at least one BoHV-1 seropositive weanling of over 180 days of age and 6.1% of herds studied contained at least one BoHV-1 seropositive weanling of over 270 days of age. The objectives of the current study were to use these Irish BoHV-1 prevalence data to document associations between milk production, fertility performance, mortality, economic performance and viral status.

Data

Selection of herds for this 2009 study has previously been described, as has their BoHV-1 status (Sayers et al., 2015). Briefly, members of HerdPlus® (a breeding information tool) recorded on the Irish Cattle Breeding Federation's (ICBF) database were used as the sample population. This population had 3,500 members in 2009. Stratified proportional random sampling based on herd size and geographical location was used to select farmers from this population for participation in the study. Of the 500 farmers invited to participate, a total of 312 were eventually recruited on a voluntary and non-incentivised basis.

Over the 2009 lactation, four bulk milk samples (taken on the 23rd March, 8th June, 31st August and 2nd November) were submitted by each study farm. Commercially available enzyme linked immunosorbent assay (ELISA) kits were used to test bulk milk samples for the presence of antibodies against, (i) Ultrapurified IBR lysate (Institut Pourquier, France) in unvaccinated (UV) herds and, (ii) IBR gE, (IDEXX laboratories, USA) in vaccinated (V) herds. Kit manufacturer positive cut-off values were applied, as outlined in Table 1, to classify herds as bulk milk positive (Pos) or negative (Neg). Analyses were completed by commercial accredited laboratories; IBR lysate by National Milk Laboratories Ltd. (UK), and IBR gE by Enfer Diagnostics Ltd. (Ireland).

Data relating to on-farm vaccination protocols were collected by questionnaire from each participating farmer. On the basis of this self-reported information, herds were classified as vaccinated (V) or unvaccinated (UV). A complete set of test results and vaccination data were not available for seven herds and production data were therefore sought for 305 herds for inclusion in the analysis.

A complete set of BoHV-1 prevalence and vaccination data were available for 305 herds, 12% (n=36) of which were vaccinated, and 80% (n=244) of which recorded bulk milk positive results (Sayers et al., 2015). Only a single vaccinated herd recorded a negative bulk milk result. Study herd demographic and performance data have previously been described by O'Doherty et al. (2015). Briefly, farm herd size ranged from 28 to 540 cows, the average herd size of the study population being 101 cows. The average daily milk yield per cow (305-day milk yield) of Primiparous (PP) cows in these herds in 2009 was 4,628 kg (SD 825 kg), with average fat and protein yields of 210 kg (SD 32 kg) and 177 kg (SD 29 kg), respectively. Multiparous (MP) cows had an average milk yield of 6,073 kg (SD 884 kg) and average fat and protein yields of 252 kg (SD 34 kg) and 220 kg (SD 30 kg), respectively. The average somatic cell count (SCC) of MP cows (211,000 cells per mL) was almost double that of PP cows (128,000 cells per mL) although the ranges of SCC were similar (PP range 39,000-716,000 cells per mL and MP range 59,000-896,000 cells per mL).

Table 1. ELISA kits used to test bulk milk samples for anti-BoHV-1 antibodies in vaccinated and unvaccinated study herds.

BoHV-1 herd vaccination status	BoHV-1 antigen target (Kit manufacturer)	Positive cut-off value	Sensitivity	Specificity	Within-herd prevalence detectable
Unvaccinated	Ultrapurified IBR lysate (Institut Pourquier, France)	≥25 %S/P[1]	100%	99.6%	10.0 – 15.0%[3]
Vaccinated	IBRgE, (IDEXX Laboratories, USA)	≤0.8 S/N ratio[2]	72.0 – 88.4%	100%	Not available

[1] %S/P = (OD 450 of sample – OD 450 of negative control) /(mean OD 450 of positive control – OD 450 of negative control) x100
[2] S/N ratio = (sample mean – absorbance 650 nm)/negative control mean
[3] Wellenberg et al. (1998) and Kramps et al. (2004).

On average there were six cases of neonatal mortality, four cases of young-calf mortality, and four cases of adult-cow mortality in each study herd in 2009. The mean mortality rate for neonatal and young-calf mortality as a percentage of calves born was 5.2% and 3.4%, respectively.

Model

The Moorepark Dairy Systems Model (MDSM) (Shalloo et al., 2004), a stochastic budgetary simulation model was used to simulate a model farm integrating biological data. The model was used in this study to quantify the economic implications of BoHV-1 status on farm profitability at different milk prices. The MDSM integrates animal inventory and valuation, milk production, feed requirement, land and labour utilization and economic analysis. Feed requirements were calculated by the MDSM meeting the net energy requirements for maintenance, milk production, and body weight (BW) change across lactation (Jarrige, 1989) minus energy requirements supplied through concentrate supplementation. Variable costs (fertilizer, contractor charges, medical and veterinarian, artificial insemination, silage and reseeding), fixed costs (machinery maintenance and running costs, farm maintenance, car, telephone, electricity and insurance) and sales values (milk, cull cow and calf) were based on the most up to date costs and prices (2016).

Scenarios analysed

Using the MDSM model (Shalloo et al., 2004) herds were defined as BoHV-1 negative and positive and compared against each other. The herds were compared across three base milk prices of 24.0, 29.0 and 34.0 € cents per litre (€ c/l), assuming reference milk contents of 33.0 g/kg protein and 36.0 g/kg fat and a relative milk constituents price ratio of 1:2 for fat: protein, within a multiple component (A+B-C) milk payment pricing regime. Table 2 shows the key assumptions used in the model for the two BoHV-1 scenarios examined. All calves were sold at 1 month of age. All male and female calves were assumed to be sold for market values of

€50 and €300, respectively. Replacement females were bought for €1,545 per head based on market conditions 1 month prior to calving. Labour costs were calculated based on the methodology reported by Shalloo et al. (2004) which assumes a labour requirement of 30 hours per cow per year, with 1,848 hours considered equal to one labour unit per year, giving an annual cost of €22,855 per labour unit.

Results

Production effects

There was a statistically significant (P value <0.1) reduction in milk yield, protein kg, fat kg in seropositive herds and a statistically significant (P value <0.1) increase in replacement rates and the number of carryover cows (cows not calved 2009) within the herds that tested positive for BoHV-1 (Table 3). Fuller details of the associations between BoHV-1 infection and milk production, reproductive performance and mortality in Irish dairy cow herds can be found in Sayers (2017).

Economic effects

Milk volume and milk solid sales in herds classified as BoHV-1 positive were each 4% less when compared to negative herds (Table 4 and 5). Milk receipts on farms classified as BoHV-1 positive were 4% lower irrespective of milk price, while livestock sales increased in the BoHV-1 positive herds due to higher replacement rates. Overall total costs were similar irrespective of BoHV-1 disease status, however, there were differences in individual cost items (and costs composition). In terms of profitability, herds that were BoHV-1 positive had a lower overall level of net profitability (Table 4). At the 29cpl net profit was 22% lower per farm, per cow, per kg MS and per hectare. The corresponding reduction in profit at a price of 34cpl was 12%. At 29cpl profitability was reduced by €60 per cow per annum when the herd was classified as BoHV-1 positive.

Table 2. Assumptions used in the model farm for effect of IBR status on herd profitability.

Gross milk price, € c/l	
Average	**29.0**
Low	**24.0**
High	**34.0**
Labour costs, €/year	**22,860**
Replacement heifer costs, €/head	**1,545**
Reference cull cow price, €/head	**451**
Reference male calf price, €/head	**50**
Concentrate costs, €/tonne	**270**
Land rental cost, €/ha	**450**

Table 3. Contrast of Predictive Margins for Fertility, milk production and mortality parameters across Unvaccinated (UV) Positive (Pos) and Negative (Neg) BoHV-1 Bulk Milk Herds.

Production Parameter Variables compared	Contrast of predictive margin	CI (95%)	P value
Herd milk yield (Kg)			
UV Pos *vs*. UV Neg	-197.56	-431.39, 36.27	0.098
MP milk yield (Kg)			
UV Pos *vs*. UV Neg	-245, 99	-490.30,-1.67	0.048
Herd fat yield (Kg)			
UV Pos *vs*. UV Neg	-9.02	-18.62, 0.58	0.065
MP fat yield (Kg)			
UV Pos *vs*. UV Neg	-10.73	-20.79,-0.68	0.036
MP protein yield (Kg)			
UV Pos *vs*. UV Neg	-8.07	-16.76, 0.62	0.069
Cows not calved 2009 (%)			
UV Pos *vs*. UV Neg	0.55	0.10, 0.64	0.007
Number of calves per cow per year*			
UV Pos *vs*. UV Neg	-0.03	-0.06, 0.00	0.053

Table 4. Milk production receipts and costs for farms with different IBR status.

Feed system	IBR Negative	IBR Positive
Herd size, no. cows	80	80
Stocking rate, no. cows/ha	2.07	2.11
Milk sales, kg	399,342	383,084
Fat plus protein sales, kg	30,036	28,813
Milk receipts, €/farm		
at 24 € c/l milk price	105,000	100,725
at 29 € c/l milk price	126,966	121,796
at 34 € c/l milk price	148,977	142,911
Livestock sales, €/farm	30,112	30,359
Concentrate feed, €/farm	15,269	15,235
Fertilizer, €/farm	10,860	10,598
Contractor, €/farm	6,057	6,006
Veterinary, €/farm	7,631	7,632
Labour, €/farm	21,700	21,633
Depreciation, €/farm	18,288	18,252
Replacement costs, €/farm	30,987	31,682
Land rental, €/farm	-2,433	-2,828
Total costs		
per farm, €/farm	135,645	135,467
per cow, €/cow	1,696	1,693
per kg milk fat plus protein, €/kg	4.52	4.70
per ha, €/ha	3,391	3,387

Table 5. The effect of IBR status and base milk price on farm system profitability.

Feed System	IBR Negative	IBR Positive
Net profit at 29 € c/l milk price		
per farm , €/farm	21,489	16,743
per cow, €/cow	269	209
per kg milk fat plus protein, €/kg	0.72	0.58
per ha, €/ha	537	419
Net profit at 24 € c/l milk price		
per farm , €/farm	-617	-4,463
per cow, €/cow	-8	-56
per kg milk fat plus protein, €/kg	-0.02	0.15
per ha, €/ha	-15	-112
Net profit at 34 € c/l milk price		
per farm , €/farm	43,640	37,992
per cow, €/cow	546	475
per kg milk fat plus protein, €/kg	1.45	1.32
per ha, €/ha	1,091	950

Conclusions

The BoHV-1 status of a herd has a significant effect on the performance (Sayers, 2017) and profitability characteristics based on Irish herd data. On average across three different milk prices the average profitability was reduced by approximately €60 per cow per year when herds were classified as seropositive for BoHV-1. When scaled up to an overall industry level with the assumption of 1.296 million cows nationally and an 80% herd-level prevalence it can be concluded that BoHV-1 is costing the Irish dairy industry approximately €62 million annually.

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3 Prevalence of bovine herpesvirus 1 (BoHV-1) in spring calving suckler herds on the island of Ireland and a bioeconomic analysis of the impact on herd profitability

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Introduction - 'BeefCow' research programme

'BeefCow' is a large Department of Agriculture, Food and the Marine (DAFM) funded all-Ireland beef cow fertility research programme, led by Teagasc Grange and involving University College Dublin (UCD), Irish Cattle Breeding Federation (ICBF), Agri-Food and Biosciences Institute in Northern Ireland (AFBI-NI) and the Irish Farmers Journal (IFJ). The aim of the project, which is on-going, is to examine a range of factors affecting the fertility of beef heifers and cows. One of the main elements of this research programme was to conduct a comprehensive epidemiological study on the key factors affecting reproductive efficiency of commercial beef cow herds, with particular emphasis on the prevalence and impact of the pathogens leptospirosis (hardjo bovis), bovine viral diarrhoea virus (BVDV), bovine herpesvirus 1 (BoHV-1) and *Neospora caninum*. Results relating to the seroprevalence of BoHV-1 (causative agent for infectious bovine rhinotracheitis) will be discussed in this brief report.

Specifically, the main objectives of this aspect of the study were to determine: (i) the seroprevalence of BoHV-1 in beef cow herds on the island of Ireland, (ii) the relationship between BoHV-1 herd status and herd reproductive (calving interval and survival/re-appearance of the cow herd) and productive (mortality and live weight gain of progeny) and, iii) to model the economic implications of herd seroprevalence to BoHV-1.

Materials and methods

Almost 6,000 cows from 161 spring calving suckler cow herds (Table 6) across the island of Ireland (32 counties) were blood sampled during the summers of 2014 and 2015. A comprehensive survey was also carried out to determine farm management practices including the vaccination policy undertaken in each individual herd in the sample. These herds consisted, principally of those involved in: (i) The Teagasc/Irish Farmers Journal BETTER Farm Beef Programme; (ii) The ABP Beef UK, College of Agriculture, Food and Rural Enterprise (CAFRE) and IFJ sponsored Northern Ireland Suckler Beef Programme (NISBP); (iii) research herds in both the Republic of Ireland (Teagasc) and Northern Ireland (AFBI and CAFRE) and (iv) commercial herds sourced through the Teagasc Advisory service in the Republic of Ireland and AFBI and CAFRE in Northern Ireland.

Table 6. Breakdown of participating spring calving herds in the Republic of Ireland (ROI) and Northern Ireland (NI).

Herd type	Number of herds	Number of cows
Teagasc/IFJ BETTER Beef herds (ROI)	17	984
Northern Ireland Suckler Beef Programme herds (NI)	8	349
Research herds (ROI &NI)	5	392
Commercial herds (ROI & NI)	131	4,212
Total	**161**	**5,937**

A questionnaire was completed with all herd owners enrolled in the study to determine the vaccination status of each herd for BoHV-1 (and other pathogens). Seroprevalence of BoHV-1 in vaccinating herds was measured using a commercially available BoHV-1 gE Antibody Kit. Seroprevalence in non-vaccinating herds was tested for using a commercially available BoHV-1 gB Antibody Kit. All analyses were conducted by the DAFM Regional Veterinary Laboratory Service. For the purposes of the analyses conducted a seropositive herd was defined as a herd harbouring at least one seropositive case of BoHV-1.

BoHV-1 gE antibody kit

Sera from cows in vaccinating herds were screened using a commercially available BoHV-1 gE Antibody Kit (Idexx Laboratories) without modification. A sample/negative ratio (S/N) of less than 60% was the cut-off for determining positive serum samples. Samples with an S/N of greater than 70 % were considered negative and samples with an S/N greater than 60 % and less than 70 % were considered suspect. The manufacturer reports the sensitivity to be 98.4 %, while the specificity is estimated at 99.8 %.

BoHV-1 gB X3 antibody kit

Sera from cows in non-vaccinating herds were screened using a commercially available BoHV-1 gB X3 Antibody Kit (Idexx Laboratories) without modification. A blocking % of greater than 55 % was the cut-off for determining positive serum samples. Samples with blocking % of less than 45 % were considered negative and samples with a blocking value of greater than 45 % and less than 55 % were considered suspect. The manufacturer reports the sensitivity to be 100 %, while the specificity is estimated at 99.8 %.

Bioeconomic modelling

The Grange Beef Systems Model (Crosson et al., 2006; GBSM) was used to model the effect of seroprevalence to BoHV-1 on whole farm physical and financial performance. The GBSM is a bioeconomic model of Irish pasture-based suckler beef systems. The French net energy system (Jarrige, 1989) modified for Irish conditions (O'Mara et al., 1997) is used in GBSM to calculate animal feed requirements. Where the energy consumed in the form of grazed grass or grass silage is unable to meet the animals' energy requirements within the animals' intake capacity, supplementary concentrates are fed to meet the energy deficit. Financial performance is calculated as net farm margin. Net farm margin includes all livestock revenues, direct costs and overhead costs. Costs and prices prevailing in 2016 were used to facilitate economic analysis. No subsidy payments (farm support payments) are included in revenues. Labour and land costs are not included in direct or overhead costs since it is assumed that family labour is freely available and land is owned; however, a rental charge is included for any land requirement in excess of that owned by the farmer.

Animal level prevalence of BoHV-1 was matched to calving interval, calf mortality and average daily gain records for all cows (n = 4,240) and their calves available from the Irish Cattle Breeding Federation (ICBF) database. The definitions assumed for the outcome variables were as follows:

> **Calving Interval**: Calving to calving interval was determined from calving records for 2013, 2014, 2015 and 2016 for all cows enrolled on the study. Cows which had a calving to calving interval of less than 300 days were removed from all analyses.
>
> **Re-Appearance:** Re-appearance rate effects were quantified as the percentage of cows that were scanned pregnant (at least 30 days after the end of the breeding season) and calved in the following spring-calving season (up 30th June).
>
> **Calf mortality (≤28 days):** Calf mortality percentage (including stillbirths) was quantified up to 28 days of age and was determined from recorded pertaining to calf mortality for all calves born to cows enrolled in the study in 2014 and 2015.
>
> **Calf mortality (29-225 days):** Calf/weanling mortality percentage was quantified from 29 days to 225 days of age and was determined from records pertaining to calf mortality for all calves born to cows enrolled in the study in 2014 and 2015.
>
> **Average daily gain to weaning (225 days):** Average daily gain (ADG; kg/day) was determined from live-weight measurements extracted for all calves born to cows enrolled in the study in 2014 and 2015. Age at the time of measurement was accounted for in all statistical analysis pertaining to live-weight measurements. Calves with an ADG of greater than 2.5kg/day were removed from all analyses. Control terms for herd, year, parity, calf sire, calf sex, calf breed (early or late maturing), cow breed (early or late maturing), number of lifetime movements (cows) were also included in the statistical model.

These data were then used to generate two scenarios (representing herds that were either entirely seropositive or entirely seronegative to BoHV-1) for a 40 hectare spring calving (mean calving date 15 March) suckler herd using the GBSM (Crosson et al., 2006).

Results

In order to analyse the within herd seroprevalence, sampled herds were divided into seven regions (Table 7) similar to those outlined by Ryan et al. (2012).

Table 7. Regions in the Republic of Ireland and Northern Ireland.

Region	Counties
1	Donegal, Leitrim, Sligo, Roscommon
2	Mayo and Galway
3	Clare, Tipperary and Waterford
4	Limerick, Kerry and Cork
5	Wexford, Kilkenny, Carlow, Wicklow, Laois, Offaly, and Kildare
6	Longford, Cavan, Monaghan, Louth, Meath, Westmeath, Dublin
7	Northern Ireland

Overall, 90% of herds sampled in the study were classified as being BoHV-1 positive based on the identification of at least one seropositive case within the herd.

The within herd seroprevalence of BoHV-1 recorded by region is presented in Table 8. At an individual herd level, the overall mean BoHV-1 seroprevalence was 39.8% (median 38.1%), with seroprevalence ranging from 18.6% in Region 2 (Mayo /Galway) to 52.3% in Region 7 (Northern Ireland). The level of seroprevalence reported for Northern Ireland may be an overestimate, as non-marker vaccines continue to be available on the Northern Irish market and the laboratory analysis used in the current study was not capable of differentiating between seroconversion as a consequence of vaccination or natural exposure to BoHV-1.

Table 8. Within herd seroprevalence of BoHV-1 in accordance with geographical location (as per Ryan et al., 2012).

			Cows tested (n)		BoHV-1 Prev. %	
Geographical region	No Herds	% BoHV herds	Mean	Median	Mean	Median
1	14	90	32.5	30.5	49.2	54.8
2	18	83	23.2	19.0	18.6	10.6
3	16	94	39.5	36.0	48.2	46.3
4	17	76	32.0	31.0	30.6	26.9
5	48	94	38.4	30.5	44.1	48.2
6	26	96	38.7	33.0	36.1	33.1
7	22	100	37.1	38.5	52.3	44.5
Overall	**161**	**90**	**35.5**	**30.0**	**39.8**	**38.1**

The proportion of herds vaccinating against BoHV-1 by region (as per completed survey response) is shown in Table 9. The overall level of vaccination across all regions was 18.6%. Region 1 had the lowest proportion of herd owners who indicated an active vaccination programme for BoHV-1 (7.1%), whilst the region with the highest proportion of herds vaccinating for BoHV-1 was Northern Ireland (45.5%).

In addition to the questionnaire used in this study, the findings of a recent national breeding and reproductive management survey carried out by our group, incorporating data from 537 beef cow herd owners indicates that the level of vaccination in beef cows for BoHV-1 was 15% (Parr et al., 2017, in preparation).

Table 9. Effect of geographic region on proportion of herds vaccinating against BoHV-1.

Geographical region	Number of herds	Herds vaccinating for BoHV-1	
		Number	%
1	14	1	7.1
2	18	2	11.1
3	16	2	12.5
4	17	2	11.8
5	34	3	8.8
6	40	10	25.0
7	22	10	45.5
Total	**161**	**30**	**18.6**

Only cows (n = 4,240) blood sampled in the Republic of Ireland with accompanying production and mortality measures (supplied by ICBF) were used. As expected, the frequency of seropositivity increased with cow parity (Table 10), which reflects the increased potential for exposure to the pathogen as the animal ages.

Table 10. Prevalence of BoHV-1 according to parity group[1].

	BoHV-1 - Negative	BoHV-1 – Positive
Parity 1	73% (512/699)	27% (187/699)
Parity 2-3	62% (781/1258)	38% (477/1258)
Parity 4-5	56% (918/1628)	44% (710/1628)
Parity ≥6	52% (337/655)	48% (318/655)

[1] Only data from cows (n = 4,240) in herds in the Republic of Ireland included.

Although, parity number was statistically significant (P<0.0001) when examining calving interval (first parity cows had a higher calving interval when compared with cows in other parity groups), there was no effect (P>0.05) of cow seropositivity for BoHV-1 on either calving interval or indeed on the incidence of calf mortality up to 28 days of age (Table 11).

Table 11. Effect of seroprevalence status and parity on calving interval (CIV) and calf mortality (0-28 days) in cows diagnosed seropositive (Positive) or seronegative (Negative) for BoHV-1.

BoHV-1 Status	Parity	CIV (n = 3468)	Calf Mortality (0-28 days)
Negative	1	379.52 ± 1.84	0.050 ± 0.009
Negative	2-3	368.62 ± 1.49	0.045 ± 0.007
Negative	4-5	367.21 ± 1.44	0.033 ± 0.007
Negative	≥6	369.57 ± 2.12	0.032 ± 0.010
Positive	1	379.53 ± 2.76	0.033 ± 0.013
Positive	2-3	365.80 ± 1.90	0.046 ± 0.009
Positive	4-5	370.01 ± 1.65	0.034 ± 0.007
Positive	≥6	367.11 ± 2.25	0.034 ± 0.010

Bioeconomic modelling

The effects of BoHV-1 on herd fertility, calf performance and calf mortality measures are shown in Table 12. In general, the effects observed on these economically important traits were relatively modest.

Table 12. Effect of BHV-1 seroprevalence on productive and reproductive variables in suckler cow herds (Republic of Ireland only).

	Unit change in seropositive herds
Calving Interval (days)	-0.74
Calf mortality ≤28days (%)	0.1
Calf mortality 28-225 days (%)	0.5
Average daily gain ≤225 days (kg/d)	0.03
Replacement rate[1] (%)	-1.9

[1]Re-appearance effects were quantified as the percentage of cows that were scanned pregnant (at least 30 days after the end of the breeding season) but did not subsequently calve in the following calving season. The percentage change in reappearance was then used to adjust the model parameter replacement rate.

The whole farm system implications of these effects modelled using the GBSM are presented in Table 13. Replacement rate was somewhat greater for seropositive herds and accordingly there was also a modest increase in feed consumed. A further effect of higher replacement rate for the seropositive herd was to reduce beef output; this effect is explained by the lower live weight gain and hence weaning weight of progeny of primiparous cows. Higher calf/weanling mortality further reduced beef output for the seropositive herd.

Table 13. Modelled[1] farm level production effects of herd seroprevalence to BoHV-1.

Farm system	Seronegative herd	Seropositive herd
Area farmed (ha)	40.00	40.00
Mature cows calving	53.9	51.4
Heifers calving	14.2	15.4
Feed budget (t consumed)		
Grazed grass	248.6	249.3
Grass silage	92.5	92.7
Concentrate	13.9	14
Beef output (kg liveweight/ha)	495	480

[1]These data were generated by the Grange Beef Systems Model using data from the BeefCow research project.

In line with the modest effects on animal production traits effects, the economic analysis indicated a small effect of BoHV-1 seroprevalence on cost of production costs and on the net farm margin. Production costs were found to be slightly greater owing to the higher replacement rate (due to lower reappearance rate) of the sero-positive herd. Combined with lower sales for the seropositive herd, the net overall effect was to reduce net margin by approximately 4% across the range of modelled weanling prices outlined in Table 14.

Table 14. Effects[1] of herd seroprevalence status for BoHV-1 on whole farm economic analysis.

Farm costs and margin	Seronegative herd	Seropositive herd
Costs (€ per hectare)		
Concentrate	102	103
Grazing	150	151
Grass silage	194	194
Vet/med/AI	141	142
Other variable costs	47	48
Fixed	380	383
Depreciation	128	129
Total costs	1,142	1,149
Net margin per hectare for a range of weanling prices		
€2.25/kg live weight	243	233
€2.50/kg live weight	354	340
€2.75/kg live weight	464	447
€3.00/kg live weight	575	554

[1]These data were generated by the Grange Beef Systems Model using data from the BeefCow research project.

Overall Summary/Conclusions

- This is one of the largest studies of its kind conducted on the island of Ireland (32 counties) with almost 6,000 cows sampled across 161 spring calving herds. Cows were blood sampled throughout the breeding seasons (April-August) of 2014 and 2015.
- The study represented both small and large herds (herd sizes in the sample ranged 6 – 95 breeding cows) with an average of 35 cows sampled per herd.
- Only 18% of herds sampled indicated that they vaccinate routinely for IBR. However, herd owners did not specify whether their breeding herd was consistently vaccinated. Nonetheless, this is substantially higher than the proportion (1.8%) reported by Cowley et al. (2011) in herds in the Republic of Ireland and also slightly higher than that (11%) reported for herds in Northern Ireland (Cowley et al., 2014).
- A total of 90% of herds sampled were found to be BoHV-1 positive (at least one seropositive case of BoHV-1 in the herd). Previous studies have reported herd prevalences of 74% and77% the Republic of Ireland and Northern Ireland (Cowley et al., 2011, Cowley et al., 2014) respectively.
- The mean animal level seroprevalence of BoHV-1 was 40% and ranged from 19% in herds sampled in Mayo/Galway to 52% in Northern Ireland.

The following points are based on data from herds based in ROI only

- There was no difference (P>0.05) in calving interval or calf mortality (Table 6) in cows diagnosed as BoHV-1 positive versus BoHV-1 negative.
- Prevalence of BoHV-1 increased as parity number increased. Parity number was significant (P<0.0001) when examining calving interval. As expected from a reproductive viewpoint, first parity cows had a higher calving interval when compared with cows in other parity groups, independent of BoHV-1 status.
- Farm level bioeconomic modelling indicated that the impact of lower cow reappearance rate on seropositive herds was to increase production costs due to higher feeding and replacement costs incurred.
- When coupled to higher mortality for seropositive herds, net margin was, on average, 4% lower on seropositive herds across a range of weanling price scenarios modelled.

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4 The impact of a ban on live exports on the Irish cattle sector

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Introduction

The importance of live exports has declined since Ireland joined the EEC in 1973. However, live exports still accounted for over 5 percent of cattle sector output value in 2015 (DAFM, 2016). There is the possibility that the export of live cattle to EU markets could be negatively affected by the ability of EU member states to introduce bans on movement of animals on the grounds of animal health concerns specified in Articles 9 and 10 of Council Directive 64/432/EEC (EEC, 1964).

The future impact of a ban on live exports will depend on i) the magnitude of the expected future live export volumes ii) on the nature of the cattle to be exported and iii) the importance of Irish cattle supply and demand conditions in determining Irish cattle prices.

In the first part of this paper we review the available data on Irish live cattle exports and highlight the developments in the volume and value of the Irish live cattle export trade and the changing composition and destinations of Irish cattle exports.

Would a ban on live exports increase or decrease the value of Irish cattle sector output? What impact would a ban on live exports have on cattle prices in Ireland? What impact would a ban on live exports have on the aggregate income earned by the Irish agricultural sector? In the second part of this paper we attempt to answer these questions by comparing projections of agricultural activity levels, commodity supply and use balance, prices and agricultural sector income to 2025 under a "No Live Exports" (NLE) scenario with a Baseline scenario where no barriers to trade in live cattle are introduced.

In the referendum vote on June 2016 on the UK membership of the EU, UK citizens voted to leave the EU. The UK Government has since confirmed its intention to leave the EU and to also leave the Single Market and EU Customs Union (Prime Minister's Office, 2017). The process by which a Member State leaves the EU is set out in article 50 of the Treaty on EU (TEU) and provides for a two year time table of negotiations between the EU and the exiting member (EU, 2012). The UK government triggered Article 50, and initiated the two year exit process in Spring 2017. This means that unless the remaining MS unanimously agree to extend the exit process (as permitted under Article 50) the UK will exit the EU by Spring 2019.

Given the on-going dependence of the Irish agri-food sector on the UK export market, Brexit (once it happens) will represent an important permanent shock to the competitiveness of the Irish agri-food sector. Irish exports to the UK (and exports from the UK to Ireland) will at the very least face increased transaction costs due to the imposition of customs clearance and other administrative costs once the UK is outside of the EU Single Market. Once the UK has left the EU exports to the UK and imports from the UK into the EU (including Ireland) could also face tariff barriers. The exact nature of the tariff and non-tariff barriers that will be faced once the UK leaves the EU are at this point unclear since negotiations on the UK exit have yet to formally start, while the freedom of the EU to negotiate an agreement on trade in advance of the UK actually leaving the EU is a matter of contention. The UK has stated its desire to conclude a Free Trade Agreement with the EU that would allow it to maintain access to the EU on terms similar to those it currently enjoys as a member of the EU Single Market (Prime Minister's Office, 2017). It remains to be seen whether such an agreement can be concluded in advance of the UK exit and if the remaining EU member states are of a mind to agree such a deep and comprehensive FTA.

The analysis of the impact of a ban on live cattle exports reported in this paper was prepared in advance of the Brexit Referendum and neither the Baseline simulation nor the "No Live Exports" scenario reported have incorporated the impact of Brexit. The UK, as noted below, is the primary outlet for exports of finished and store cattle exports from Ireland and currently takes over 50% of beef exports from Ireland. Brexit will disrupt these very important trade flows and will, as compared to a world where the UK remained a member of the EU, almost certainly lead to a reduction in Irish beef and cattle exports to the UK. Preliminary research (Donnellan and Hanrahan, 2016; Donnellan, Hanrahan and Thorne, 2016) indicates that the impact of Brexit could be particularly severe for the Irish beef sector. Analysis using the FAPRI-Ireland modelling system of the potential impact of Brexit on Irish and EU agriculture is planned for 2017 but is not yet at a stage where it could be used for analysis of the live cattle export ban scenario analysed here.

The approach to evaluating the impact of the no live export scenario with the FAPRI-Ireland model, i.e. of comparing FAPRI-Ireland model projections under a Baseline and alternative policy scenario, is designed to be robust with respect to change to policy assumptions that would be used for both the Baseline and alternative policy simulations. However, given the magnitude and permanent nature of the shock to the terms of trade of the Irish agri-food sector that Brexit could result in the introduction of assumptions concerning trade and other policy changes post Brexit could have an impact on projected magnitude of the negative impact of the no live export scenario on Irish agricultural sector income that are evaluated in this paper.

Irish Live Cattle Exports: Declining value and changing composition

How economically important is the live trade within the Irish cattle industry? Historically, live exports of cattle were a mainstay of the Irish agricultural economy. Figure 1 illustrates that in the early 20th century the vast majority of Irish beef sector exports were "on the hoof". In 1930 almost 900,000 head of cattle were exported live while exports of carcass beef amounted to only 1,300 tonnes. From the 1950s onwards an indigenous meat processing industry developed in Ireland. Over the period prior to accession to the European Economic Community (EEC) the volume of beef exports grew and live exports contracted. Since accession to the EEC in 1973 the importance of carcass beef output and exports have grown while the volume of cattle exported live has contracted.

Figure 2 illustrates the evolution of the annual volume of Irish cattle slaughtered and exported live since 1964. Since 2000 the volume of cattle slaughtered in Ireland has varied between 1.9 and 1.5 million head per annum, while the volume of cattle exported live has varied between 0.07 and 0.33 million.

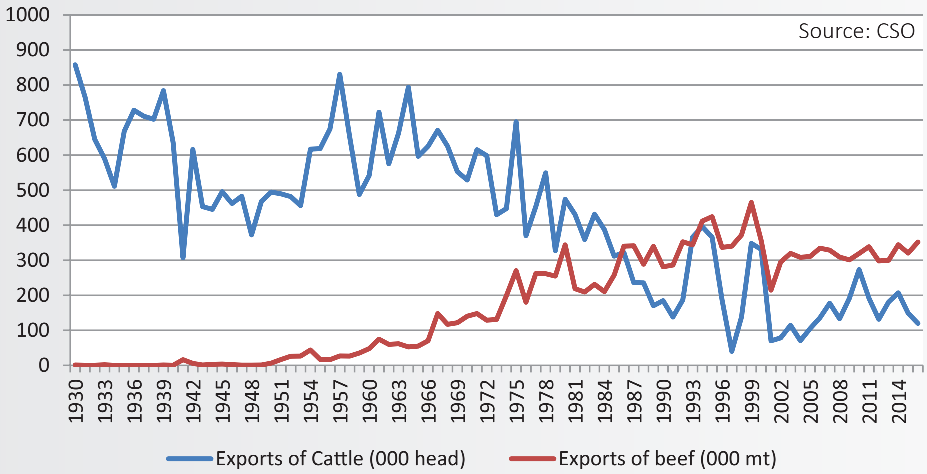

Figure 1. Irish beef sector exports 1930-2016.

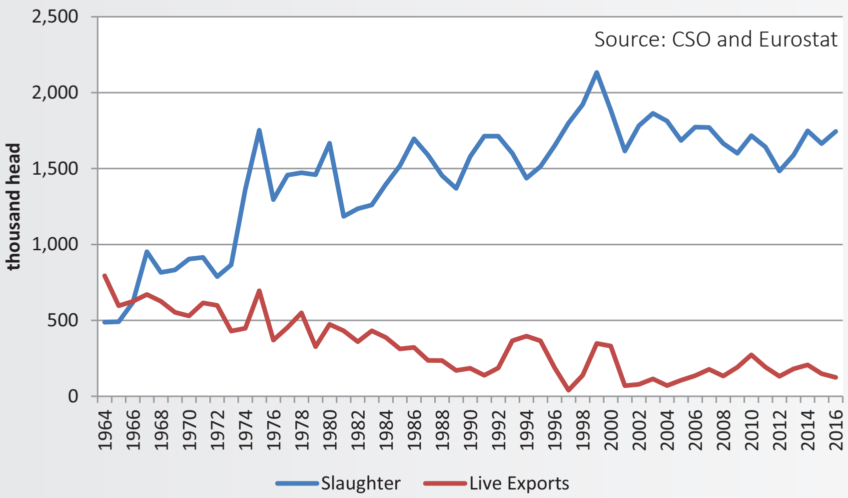

Figure 2. Irish Cattle Disposals 1964-2016.

The increase in the importance of beef export volumes relative to live cattle exports is also reflected in the value of these two exports flows. The nominal value of beef exports has grown by almost 60% between 1990 and 2015, while the value of live exports has declined by over 33% over the same period (see Figure 3). The decline in the value of live exports largely reflects changes in the composition of the live trade as well as a decline in the number of cattle exported. The total volume (thousand heads) of cattle exported in 2015 was almost 20% lower than in 1990. The decline in the value of live exports per head exported over time does not reflect the movement in cattle prices over this period. In nominal terms, prices of cattle of all ages have increased over the period 1990 to 2014. The decline in the unit value of live exports reflects the juvenilisation of Irish live cattle exports and the increased proportion of live cattle exported that are of a dairy breed.

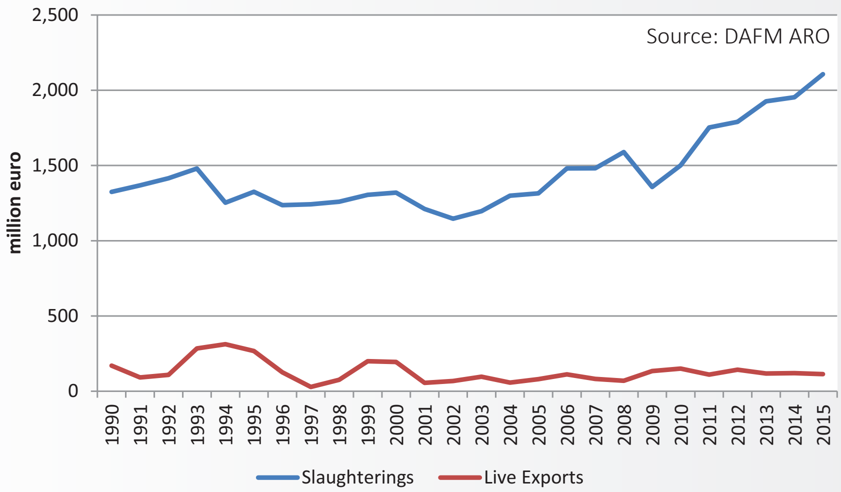

Figure 3. Value of live exports and slaughtering 1990-2015.

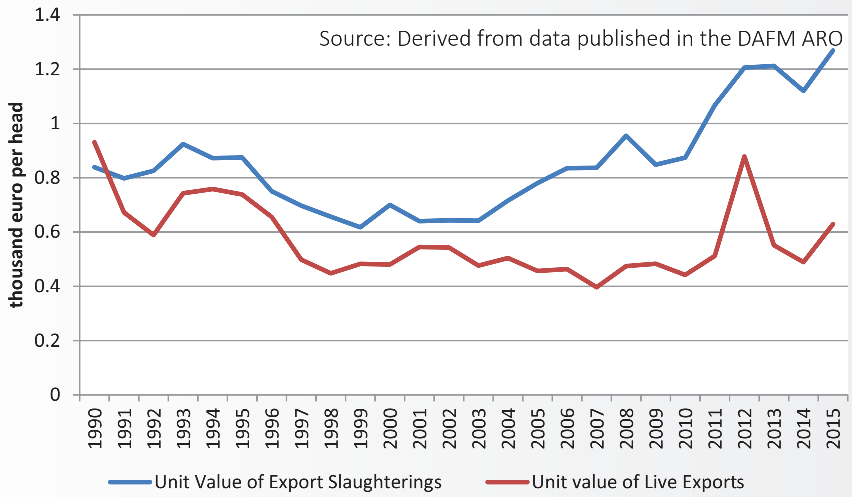

Figure 4. Unit value per head of cattle exported live and per head slaughtered in Ireland.

The decline in the value per head of cattle shipped (with the obvious exception of 2012) reflects a change in the nature of the cattle shipped from Ireland over the period since 1990. Irish live cattle exports have become increasingly dominated by trade in young animals. In 1995 Bord Bia data (see Figure 5) show that almost 70% of the cattle exported were finished animals with exports of calves accounting for approximately 15% of animals shipped. By 2014 the relative importance of finished cattle exports had declined while the importance of exports of calves, weanling and store animals had increased. In 2015 calves accounted for over 52% of all animals shipped from Ireland.

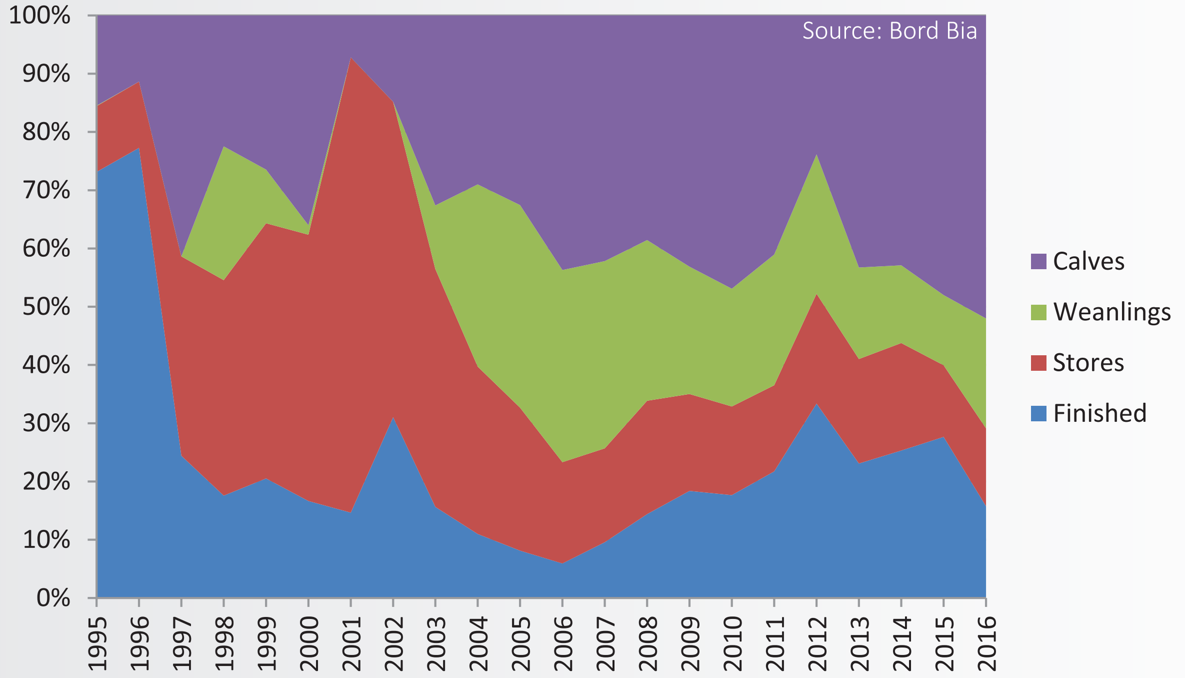

Figure 5. Irish Total Live Export Share by Animal Age Category.

The destinations of calves, weanlings, store cattle and finished cattle exports from Ireland are also different. Calf exports to the Netherlands and Spain accounted for 83% of all calf exports in 2015, while finished cattle exports are almost exclusively to the Northern Ireland and Great Britain. The export destinations of weanlings and store cattle are somewhat more diverse with the UK, Spain and Italy being the predominant destinations.

If a Member State is awarded additional guarantees in respect of IBR, leading to a ban of imports of live cattle from Ireland, the immediate impact in terms of which element of the Irish live trade would be affected would depend on the Member State introducing the ban. A ban on exports to the UK would have a different impact as compared to a ban on exports to the Netherlands given the very distinct natures of the cattle exported to these different markets. The exclusion of Irish live cattle exports to Belgium in 2015 and 2016 is obvious from Figure 6. The concentration of Irish live calf and other live exports on small number of markets constitutes a risk and vulnerability given the possibility of Article 9-based restrictions on such trade.

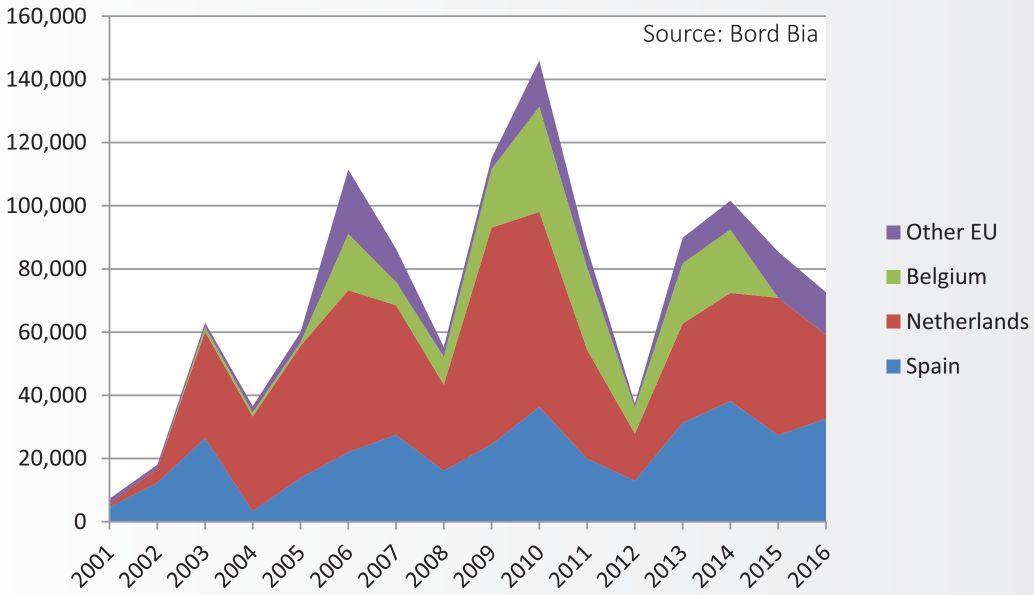

Figure 6. Irish Calf Exports 2001-2016.

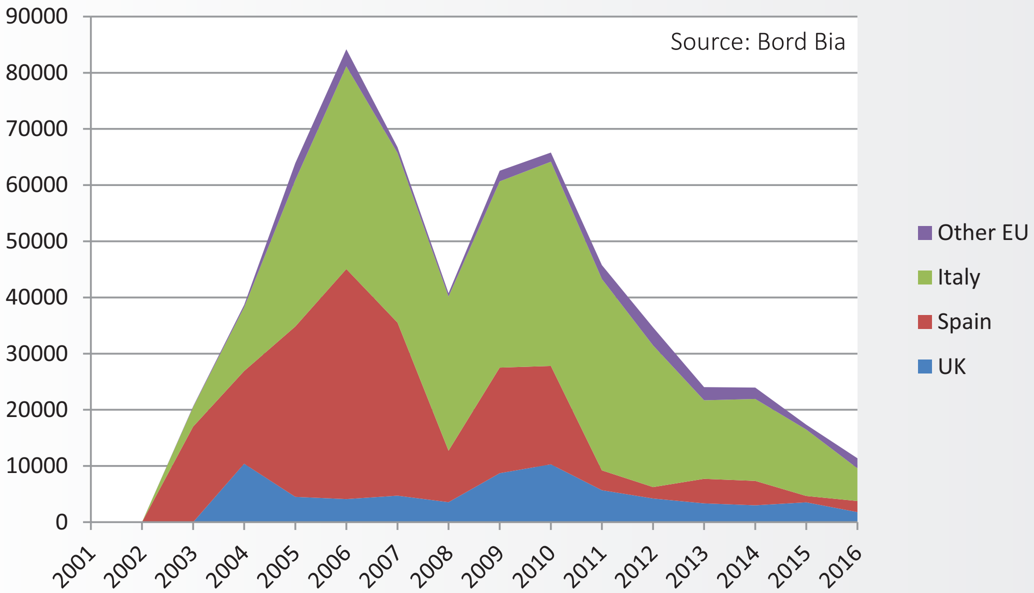

Figure 7. Irish Weanling Exports 2001-2016.

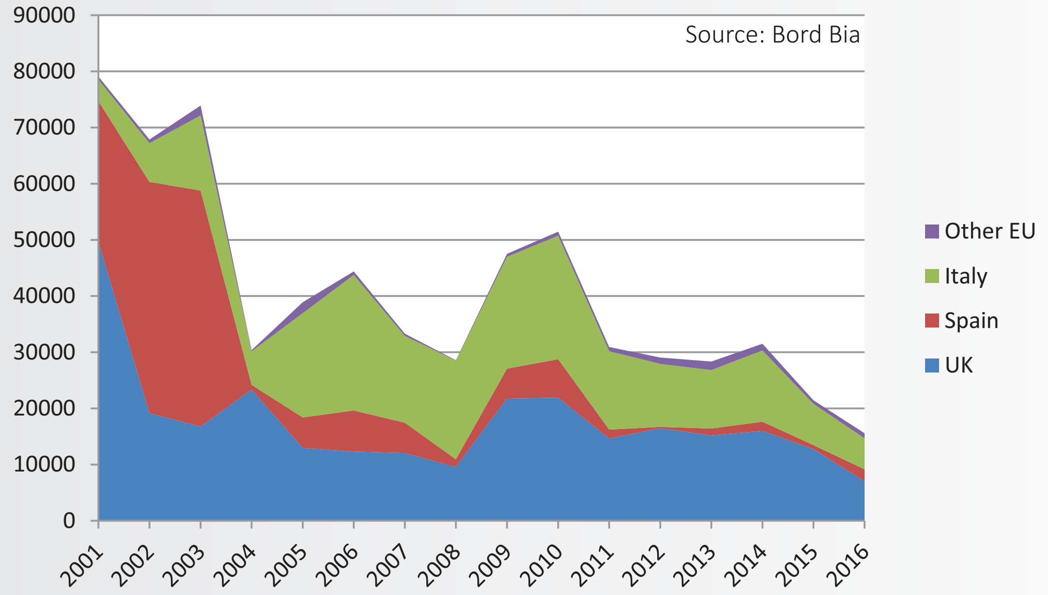

Figure 8. Irish Store Cattle Exports 2001-2016.

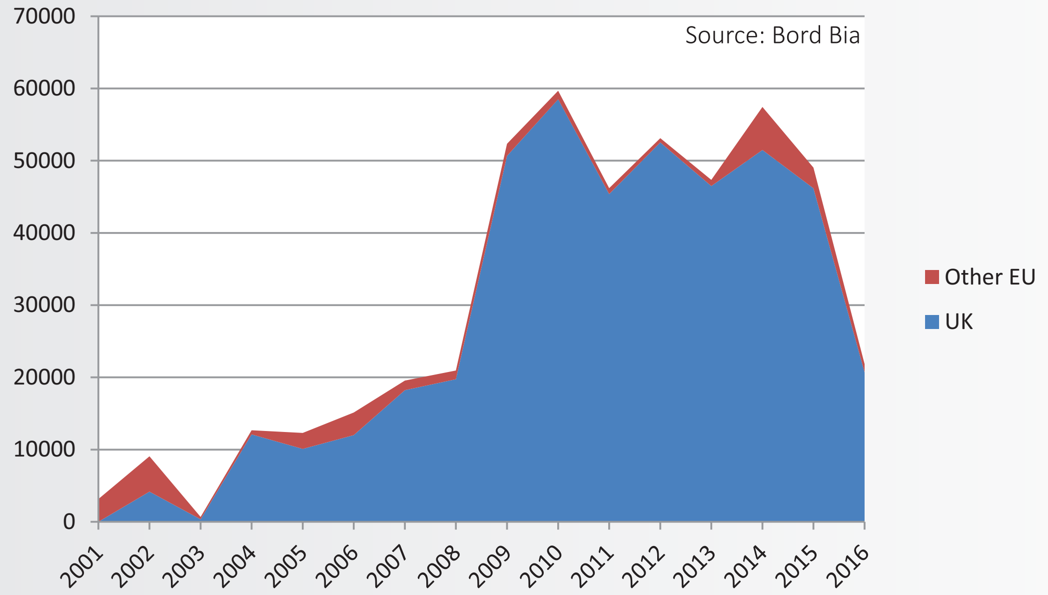

Figure 9. Irish Finished Cattle Exports 2001-2016.

The data within the DAFM CMMS and AIMS databases allow us to look at the breed of cattle (dairy or beef) exported from Ireland, with dairy cattle defined as the progeny of a dairy bull and beef cattle defined as the progeny of a beef bull. Since 2002 the share of animals with a dairy sire and the share of exports accounted for by calves have both increased (see Figures 10 and 11). Irish calf exports are now almost exclusively the male offspring of dairy cattle. Exports of older animals (weanlings, stores and finished cattle) are generally animals with a beef breed sire.

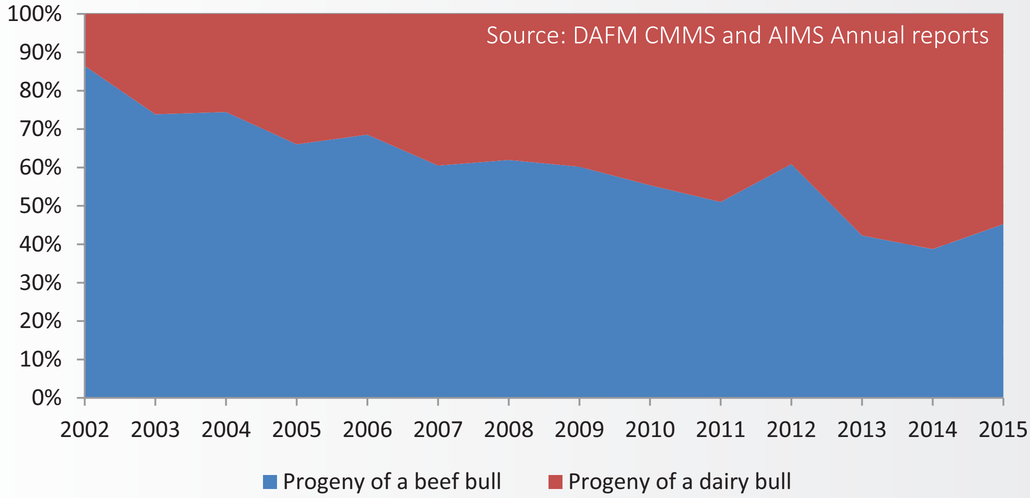

Figure 10. Share of dairy and beef sired animals in total live cattle exports (2002-2015).

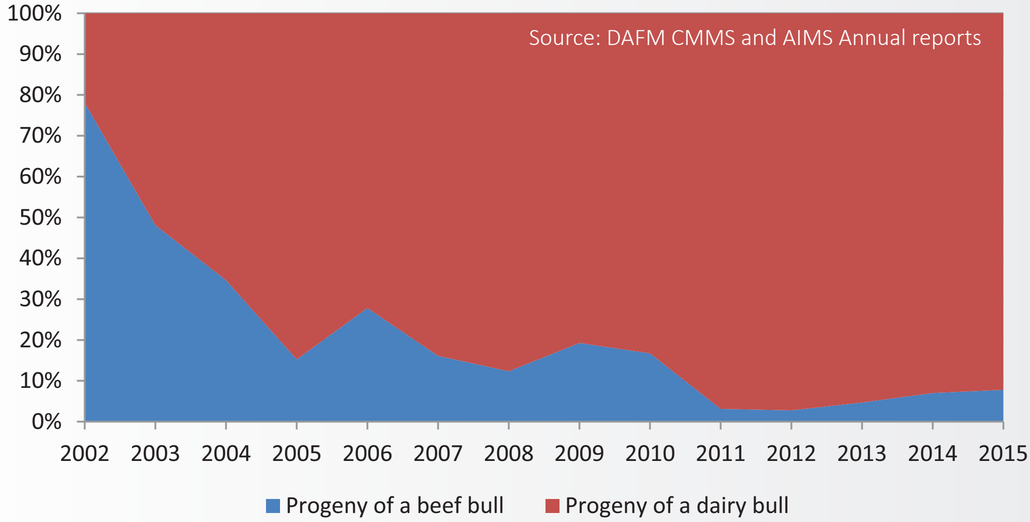

Figure 11. Share of calf exports (Cattle age 0-6 weeks) with dairy and beef sires (2002-2015).

The increase in the volume of dairy calves exported from Ireland is in part driven by the increase in the proportion of Irish calves sired by dairy bulls. The DAFM AIMS data show that the number of calves born to dairy sires has increased from 25 percent of calves born in 2002 to 34 percent of calves born in 2015. However, the growth in Irish exports of calves is also due to changes in the supply and demand for these calves in countries such as the Netherlands. In such countries declining dairy cow inventories have reduced the supply of domestically produced dairy calves to veal production systems. Over the last decade exports of dairy calves from Ireland have grown to satisfy this demand that previously was supplied from the domestic dairy cow herd.

The small share of calves in cattle export value contrasts with the large share of calves in the total number of cattle exported from Ireland. In Figure 12 we present Eurostat trade statistics at the (HS) 4 digit (Live Bovines) and (CN) 8 digit levels of aggregation to illustrate the share of total live export output value accounted for by exports of calves. In Figure 12 the value of all live cattle exports is read from the left hand axis and the value of exports of cattle of less than 80kg live weight is read from the right hand axis. In 2015, despite accounting for over 50% of all animals exported, calf exports (taken as roughly equivalent to the set of animals less than 80 kg in weight) accounted for just a little over 12% of the value of live exports.

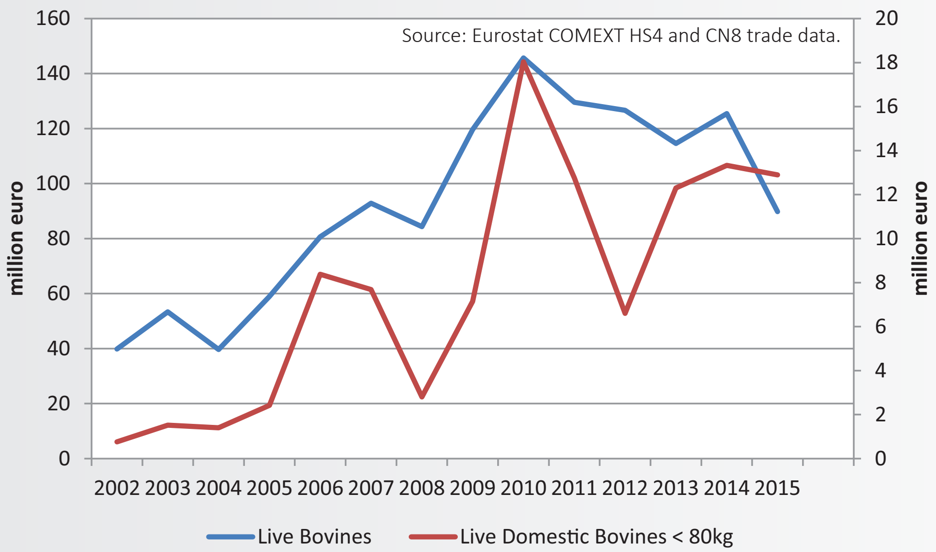

Figure 12. Irish Live Cattle (Left Axis) and Calf (Right Axis) export values.

Irish live cattle exports over the last decade have primarily been to EU markets but prior to that, and in recent years, live exports to non-EU markets have increased in importance. Figure 13 presents data from Bord Bia with live cattle exports to EU and non-EU markets from 1997 to 2016. The volatility of the live export trade is again evident. Non-EU markets, primarily in the Middle East and North Africa have at times accounted for over 15% of the volume of cattle exported. The prospect of increased live exports to Turkey and middle Eastern and North African markets is an important positive aspect of the medium term outlook for EU and Irish cattle market (European Commission, 2016). While these markets are not within the EU and Article 9 based restrictions on live animal trade would not be applicable, the import licences issued by these countries (that are necessary for trade to take place) in general require that animal come farms that are disease free. The presence of an approved IBR control programme in Ireland that would negate the risks of restrictions on Irish live cattle exports to EU markets would also likely also address disease requirements for non-EU markets in the Middle East and North Africa.

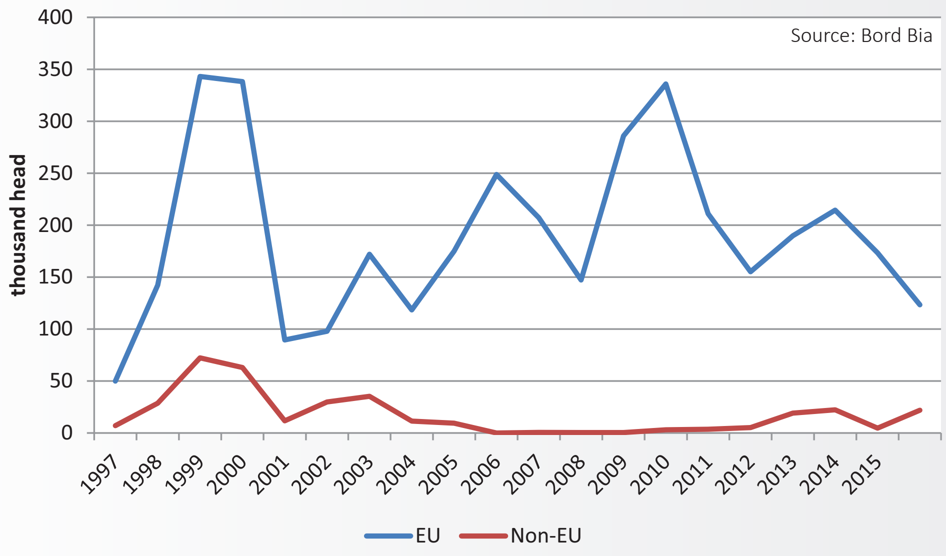

Figure 13. Irish Live Cattle exports to EU and Non-EU markets 1997-2016

In summary, the volume of live exports of cattle from Ireland has declined relative to historical levels as the indigenous Irish meat processing industry developed in the 1960s, 1970s and 1980s. The composition of Irish live cattle exports has also changed as the absolute volume of cattle exported declined. Whereas historically live cattle exports were mostly of animals ready or almost ready for slaughter, increasingly Irish cattle are exported as calves and weanlings. In particular, calf exports have grown in importance. In the last 10 years the share of male calves with a dairy sire in total Irish live cattle exports has increased. In recent years almost all calves shipped (over 90%) are the progeny of a dairy bull. The destinations of Irish cattle exports also differ by age category. For older age categories (store and finished cattle) the UK is either one of the largest destinations or the only destination for the overwhelming majority of animals exported. For younger age categories (calves and weanlings) continental EU markets are more important with Spain and the Netherlands the predominant destinations for Irish calf exports while Italy dominates Ireland's weanling export trade.

Analysis of the impact of a live export ban on the Irish cattle sector

What would be the impact of a ban on live exports on the Irish cattle sector? Given the decline in the importance of live cattle exports, a ban on would not have as big an impact today as it would have had historically. Nevertheless, live exports continue to account for approximately 6 percent of Irish cattle sector output value and 12 percent of Irish cattle disposals. Thus a ban on live exports could be expected to have a non-negligible impact on output values and sectoral income.

To further analyse the nature and magnitude of the impact of a ban on Irish live exports the FAPRI-Ireland aggregate model of the Irish agricultural economy is used (See Donnellan and Hanrahan for more on the FAPRI-Ireland model).

The FAPRI-Ireland model was not developed specifically for the analysis of the impact of animal disease restrictions on trade but it can be useful in providing some insights into the likely magnitude and nature of the impact of such a policy shock. The economic modelling of animal disease outbreaks and the analysis of the policy issues associated with animal diseases and agricultural trade is reviewed in Paarlberg, Lee and Seitzinger (2005). In an Irish context Dillon, Matthews and Thorne (2007) analysed the economic impact of different possible policy responses to an outbreak of FMD, while O'Toole, Matthews and Mulvey (2002) using a CGE model examined the impact of the 2001 FMD crisis on the Irish economy. Binfield, Hennessy and Westhoff (2001) examined the impact of the 2001 BSE crisis on the Irish beef sector.

The analysis of developments in Ireland's live export trade, outlined in the previous section, allows us to place the outcome of the FAPRI-Ireland model-based analysis in context and also highlights areas and issues that cannot be analysed formally by the FAPRI-Ireland model but which are important in assessing the likely impact of an animal disease-related ban on live cattle exports.

When analysing a policy change or shock, such as a ban on the live exports of cattle from Ireland, projections to a medium term horizon (2024) generated using the FAPRI-Ireland model under what is termed the "Baseline" are compared to those under an alternative policy scenario. In this instance the alternative policy considered is one where all exports of live cattle from Ireland are banned over the whole of the model's 10 year projection horizon – the "No Live Exports" (NLE) scenario. The simulated impact of the ban on agricultural activity levels, agricultural output value, agricultural input usage, agricultural output and input prices, and ultimately agricultural sector income is assessed by comparing the projections under the Baseline and the alternative policy scenario – the no live exports (NLE) scenario.

In running the No Live Exports (NLE) scenario all Baseline policy assumptions are maintained but rather than let the FAPRI-Ireland model endogenously project the level of Irish live cattle exports for the period to 2024 the value of this variable is exogenously fixed at 0 for all years from 2016 forward. The ban on live exports is effectively a negative demand shock that is limited to live cattle trade only. An important assumption is that the export and domestic demand for Irish beef is unaffected. The assumption that only demand for live cattle is negatively affected under the NLE scenario limits the magnitude of the impact of the ban on the Irish beef sector. In analyses of the economic impact of animal disease events on agriculture, the nature of the animal disease (does the disease affect human and/or animal health) and the consumer response (if any) plays a major role in determining the economic impact of both the animal disease shock and the policy response (see Juncker, Komorowska and van Tongeren, 2009).

What would we expect to happen to agricultural markets, output and income if Irish live exports of cattle were banned? The first round economic effect of such a ban would be the elimination of the output value associated with the live exports of cattle from Ireland. However, if cattle cannot be exported they would have to be raised and disposed of domestically. The second round economic consequence of a ban on the export of animals would be an increase in the volume of cattle available for slaughter and for feeding for slaughter in Ireland. The increase in the number of animals available for slaughter and for feeding would, in both the short and medium term, lead to an increase in the volume of beef produced in Ireland. However, the increase in the level of agricultural activity would also be associated with increased intermediate costs of production. Alternative production systems could emerge or become more common in the event of a ban on live exports, e.g. veal production systems. However, the economic feasibility of such systems would critically depend on the development of markets capable of absorbing the output produced. In this analysis we assume that the animals that under the Baseline are exported live are raised to slaughter within conventional Irish beef production rather than veal production systems.

Whether the positive impact of additional beef production is sufficient to offset the negative effect on aggregate sectoral output value of the elimination of live exports will depend on whether the presence of additional cattle available for slaughter in Ireland leads to lower finished cattle prices under the NLE scenario as compared to the Baseline and on how much additional beef production results from the ban on live exports. The magnitude of the impact of additional supply (additional cattle for slaughter) on finished cattle prices will depend on a) the size of the increase in the supply of cattle that occurs as a result of the live export ban and b) the sensitivity of Irish finished cattle prices to the volume of cattle available for slaughter in Ireland.

O'Connell (1995, 1997) found a positive statistical relationship between the ratio of the Irish R3 steer price and the EU reference price for cattle and the ratio of live exports to total disposals and contends that this shows that higher live exports lead to higher Irish cattle prices. Hanrahan (1998) found that Irish finished cattle prices (R3 steer prices) were cointegrated with EU cattle prices, and that idiosyncratic movements in Irish prices would not persist through time. This time series analysis, showing that Irish cattle prices are determined by prices on Irish exports markets rather than by the interaction of supply and demand on Irish markets, is reflected in the structure of the FAPRI-Ireland model and similar models that are used for markets and policy analysis.

In the FAPRI-Ireland model Irish cattle prices (and other agricultural commodity prices) are determined by the interaction of supply and demand at the EU market level rather than on the Irish market alone. The specification of the price relationship equation within the FAPRI-Ireland model does, however, allow local supply and demand factors to have a limited influence on the level of Irish cattle prices. The ratio of Irish beef production to Irish beef domestic use is included as a right hand side variable in the finished cattle price equation, so that other things being equal, an increase in Irish production will lower the Irish beef price. However, the cointegrating relationship with EU beef prices remains the dominant factor in determining Irish finished cattle prices.

The prices that determine Irish cattle prices within the FAPRI-Ireland and FAPRI-EU models are those that equilibrate EU beef supply and demand. The magnitude of any reduction in EU prices resulting from a ban on Irish live cattle exports will be contingent on the relative size of Irish and EU beef production. Irish beef production accounted for 7.5% of EU28 beef production in 2016. This means that a small shock to Irish beef production volume, other things equal, would amount to a very small change in aggregate EU production and would be expected to be reflected in only a modest change in EU market prices for cattle.

An increase in Irish beef production based on the retention of animals that would otherwise have been exported live to other EU markets will be reflected in at least a partially offsetting reduction in EU production. This reduction in EU production will mitigate the negative impact of the shock on EU prices

The nature of the cattle retained in Ireland in the event of a ban on live exports is also important in determining the impact on aggregate EU beef production of a ban on live cattle exports from Ireland. If some of the animals that under the Baseline are exported live are destined for veal production systems, male dairy calves for example, then the retention of such animals in Ireland and their slaughter at later ages for beef will increase aggregate EU beef production. In contrast the retention of live cattle in Ireland that are destined for either slaughter or fattening for beef is unlikely to have a significant effect on aggregate EU beef production, with increased Irish production offsetting lower beef production elsewhere.

A third round impact of a ban on live exports of cattle arises from the costs implications of additional agricultural activity. Following a ban on live exports at least some of the animals that would otherwise have been exported live will be fed for slaughter in Ireland. The augmented level of agricultural activity in Ireland that results from the introduction of a ban on live exports is not costless. Additional cattle on feed will lead to additional expenditure on feed and other inputs. Only where all live exports are of finished cattle would it make sense to ignore these costs, and we have noted in earlier parts of this paper that Irish live exports are increasingly of cattle that are not yet ready for slaughter. The raising to slaughter of additional animals will incur additional feed, fertiliser, energy and other costs of production. Other things being equal, the costs of raising animals to slaughter are greater the younger are the animals diverted from live export markets to feeding for slaughter in Ireland.

In summary we should expect that a ban on live export of cattle from Ireland would lead to

a) The elimination of that portion of cattle output value associated with live exports

b) An increase in the volume of cattle slaughtered in Ireland and an increase in the volume of Irish beef production

c) A decrease in the price of finished cattle in Ireland (and possibly on EU markets)

d) Beef sector output value could increase or decrease depending on whether the decrease in cattle prices that arises as a result of a live export ban is sufficient to offset the likely increase in the volume of output of beef that results from a ban on live cattle exports.

e) The higher levels of agricultural activity in Ireland, i.e. higher cattle number being fed for slaughter will lead to higher levels of input expenditure (feed, fertiliser, energy, etc.)

f) Agricultural sector income could increase or decrease depending on whether 1) the value of agricultural output increases and 2) whether the increase in the input expenditure by the agricultural sector due to additional volumes of cattle on feed is sufficient to outweigh the increase in output value.

Model based analysis of the NLE scenario

The FAPRI-Ireland model is a partial equilibrium model of the Irish agricultural sector constructed using annual data on agricultural activity levels, agricultural commodity supply and use balances, levels of input use and input and output prices. The model is used to generate baseline and scenario projections, to a medium term horizon (10 years), of agricultural activity levels, commodity supply and use balances, agricultural input and output prices, and expenditure on inputs, output value and agricultural sector income. The beef sector sub-model is a component of this larger FAPRI-Ireland agricultural sector model and generates projections of ending stocks of total cattle, dairy and beef cows, cattle slaughter, cattle exports and imports, beef production, consumption and trade and cattle prices. With the capacity to simulate the economic accounts for agriculture, the FAPRI-Ireland model can evaluate the impact of a policy change or shock on agricultural output value, expenditure on inputs and total sector income by comparing outcomes under the Baseline with that under an alternative policy scenario such as the No Live Exports (NLE) scenario considered here.

It is important to understand the aspects of the possible impact of a ban on live exports that are not capable of being analysed by the FAPRI-Ireland. In the discussion that follows the presentation of the results from the model based analysis of the NLE scenario, caveats and areas of uncertainty surrounding the impact of a ban on Irish live exports are outlined.

FAPRI-Ireland baseline projections

Donnellan and Hanrahan (2014) outline the FAPRI-Ireland baseline projections for the Irish agricultural sector used in this study. Under the Baseline the agricultural policy setting agreed in the June 2013 CAP reform is assumed to prevail for the whole of the FAPRI-Ireland model's ten year projection period. No changes to international agricultural trade policies or other policies that affect Irish agriculture are assumed to occur.

Under the Baseline, where no restrictions on live cattle exports from Ireland are imposed, Irish live exports are projected to be relatively stable, with the absolute volume of cattle shipped in 2024 close to the volumes shipped in 2014. Under the Baseline dairy cow numbers grow strongly. The end of the milk quota system in 2015 allows the Irish dairy sector to expand strongly, with the ending stock of dairy cows in 2024 projected to be 18% higher than in 2014. Over the Baseline projection period ending stocks of suckler cows are expected to decline, with ending stocks of suckler cows in 2024 projected to be 17% lower than in 2014. The low levels of profitability in beef production and the declining real value of direct income support payments to farmers over time reduces the incentives to hold suckler cows. However, under the Baseline projected increases in dairy cow ending inventories in Ireland are sufficient to offset the negative impact of lower suckler cow numbers on overall cattle inventories. With largely stable cattle inventories under the Baseline, live exports of cattle from Ireland are projected to also be stable.

Table 15. FAPRI-Ireland Baseline Beef Sector Projections.

		2014	2020	2024
Ending stocks of Cattle	000 head	6,176	6,402	6,246
Ending stocks of suckler cows	000 head	1,057	976	872
Ending stocks of Dairy cows	000 head	1,128	1,285	1,329
Cattle Slaughter	000 head	1,779	1,738	1,762
Live exports of cattle	000 head	233	241	233
Beef Production	000 t	596	537	543
Beef exports	000 t	541	494	503
Irish R3 Steer price	€/100 kg cwe	366	373	392
Cattle Output Value	m. euro	2,012	2,004	2,061

Source: FAPRI-Ireland Model 2015

By 2024 under the Baseline with stable volumes of total cattle inventories, disposals of cattle (via both slaughter and live exports) and beef production and exports are also projected to be largely stable. With nominal cattle prices projected to grow over the projection period, the nominal value of Irish cattle sector output is projected to increase, with total cattle sector output value projected to reach over €2.1 billion by 2024.

No live export (NLE) scenario projections

Under the NLE scenario exports of live cattle are exogenously set to zero from 2016 onwards, under the assumption that all live cattle exports from Ireland are banned. As a result of the ban on the disposal of cattle via live exports, ending stocks of cattle in Ireland increase relative to their level under the Baseline; cattle that would otherwise have been shipped out of Ireland are retained and ultimately slaughtered in Ireland. Higher numbers of cattle slaughtered are reflected in an increase in the total volume of beef production in Ireland.

By 2024 under the NLE scenario Irish beef production is projected to increase by over 80 kt (+15%) over the level projected under the Baseline. The additional beef production in Ireland is almost all exported, with Irish beef exports increasing by 90kt. While the projected increase in Irish production is large, given the relative size of Irish and total EU beef production, the shift in EU production is much smaller. The smaller size of the overall change in EU beef production also reflects that fact that lower exports of Irish cattle to other EU markets reduces (marginally), other things being equal, the volume of beef production in EU markets other than Ireland.

With higher Irish beef production, EU meat prices are projected to decline marginally, -0.4% under the NLE scenario as compared to the Baseline level in 2024. The volume of EU beef production increases by less than the increase in Irish production. The smaller increase in EU production is due to the fact that the lower volume of live cattle exports to other EU markets from Ireland under the NLE scenario is reflected in lower beef production volumes on these markets. The small size of Irish beef production relative to overall EU beef production (Ireland in 2014 accounted for 7% of EU beef production) dilutes the impact of the increase in Irish beef production on EU and Irish prices.

With marginally lower EU prices and an increase in the Irish beef self-sufficiency rate, Irish finished cattle prices are projected to decline under the NLE scenario relative to the Baseline. By 2024 under the NLE scenario Irish finished cattle prices are projected to be approximately 1% lower than under the Baseline.

The relatively small magnitude of the projected price decrease that arises as a result of the banning of live cattle exports means that the projected loss of the cattle export value is more than offset by the increase in output value associated with the higher level of beef production projected under the NLE. Total output from the cattle sector is projected to increase by approximately €18 m. The higher output value associated with the increase in beef output more than offsets the loss of revenue associated with the banning of live cattle exports.

The increase in the value of output from the sector of €18 m does not, however, correspond with an equivalent change in value added. As noted earlier the increase in the level of agricultural activity associated with the higher volume of beef production under the NLE scenario is associated with a higher level of expenditure on intermediate inputs – in particular on animal feed. Total intermediate consumption increases under the NLE scenario by almost €70 m when compared with the level under the Baseline. The additional agricultural activity, i.e. the feeding of cattle to slaughter that would otherwise have been exported live reduces the value added by the aggregate Irish agricultural sector. Operating surplus, or agricultural sector income, is projected to be 2% lower under the NLE scenario. The lower income is a result of the higher level of expenditure on intermediate consumption, with these additional costs being more than sufficient to outweigh the additional output value associated with ban on the live export of cattle under the NLE scenario.

Table 16. FAPRI-Ireland No Live Exports (NLE) Scenario Beef Sector Projections.

		2014	2020	2024
Ending stocks of Cattle	000 head	6176	6,593	6,435
Ending stocks of suckler cows	000 head	1,057	973	870
Ending stocks of Dairy cows	000 head	1,128	1,285	1,329
Cattle Slaughter	000 head	1,779	1,966	1,988
Live exports of cattle	000 head	233	0	0
Beef Production	000 t	596	622	628
Beef exports	000 t	541	579	587
Irish R3 Steer price	€/100 kg cwe	366	368	388
Cattle Output Value	million euro	2,012	2,014	2,079

Source: FAPRI-Ireland Model 2015

Table 17. Baseline and NLE 2024 Projections.

		Baseline 2024	NLE Scenario 2024	Absolute Difference	% Difference
Ending stock of Cattle	000 head	6,246	6,435	189	3%
Suckler Cows	000 head	872	870	-2	0%
Dairy Cows	000 head	1,329	1,329	0	0%
Cattle Slaughter	000 head	1,762	1,988	226	13%
Live Exports	000 head	233	0	-233	-100%
Beef Production	000 t	543	628	85	16%
Beef Exports	000 t	503	587	84	17%
Irish R3 Steer Price	€/100 kg cwe	392	388	-4	-1%
Cattle Output Value	m euro	2,061	2,079	18	1%
Intermediate Consumption	m euro	5,818	5,885	67	1%
Operating Surplus	m euro	2,002	1,952	-50	-2%

Source: FAPRI-Ireland Model 2015

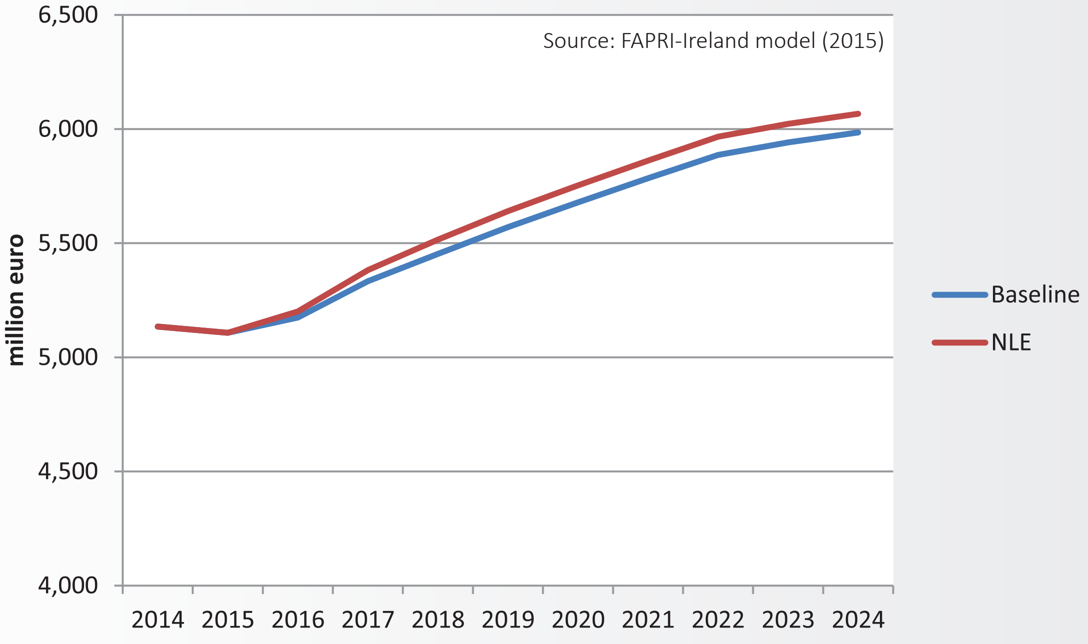

Figure 14. Projected Baseline and NLE Scenario: Input Expenditure.

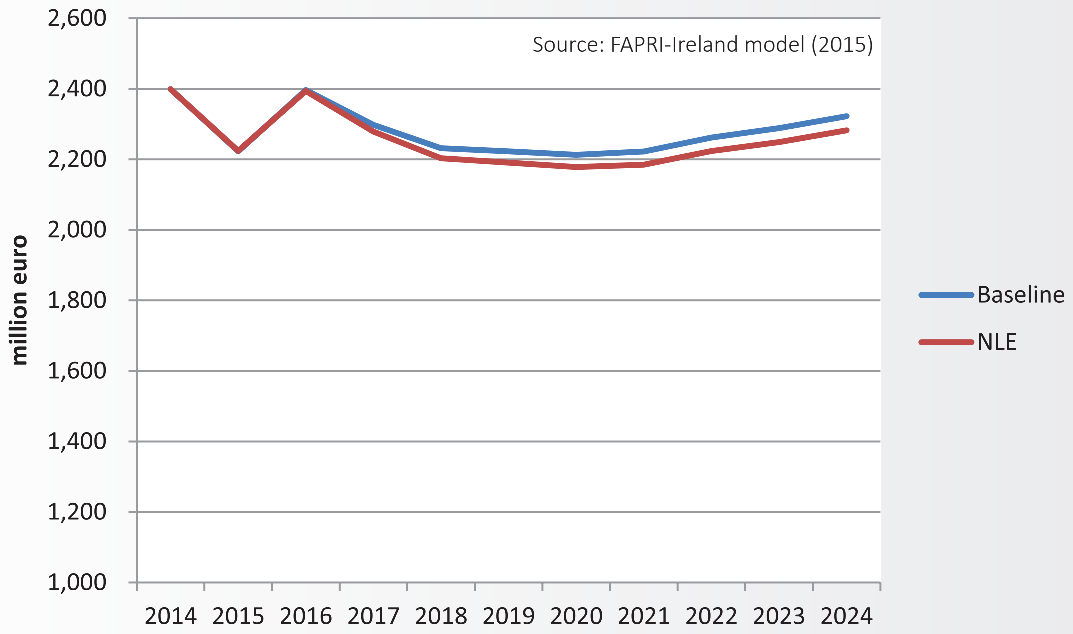

Figure 15. Baseline and NLE Agricultural Sector Income.

Discussion and caveats

As a share of total disposals of cattle, live exports have stabilised in recent years following a large decline in importance during the 1980s and 1990s that coincided with the development and growth of the Irish meat processing industry. The share of output value accounted for by live exports has however continued to decline steadily. This dynamic initially reflected the decline in overall share of live exports in total cattle disposals but in more recent years has been driven by the increasing share of live exports accounted for by younger cattle (calves and weanlings) and cattle of a dairy breed.

The decline in the importance of the live export trade over time and the increase in the importance within that trade of the export of dairy calves means that a ban on live exports, if it were to be introduced/imposed, would be likely to have a relatively small impact on the volume and value of Irish cattle output and be associated with significant increases in expenditure on animals feed and other inputs.

The analysis of the impact of a ban on live cattle exports from Ireland conducted using the FAPRI-Ireland partial equilibrium model suggests that the aggregate economic impact of such a ban on the sector would be relatively modest.

The diversion of animals from live export markets to being raised to slaughter domestically means that the negative impact of a ban on the volume of cattle shipped is likely to be mitigated by higher volume of carcass beef output. The impact on market prices of a ban on live cattle exports is contingent on the impact of the ban on EU markets given that in the medium term Irish cattle prices are determined by the price of beef on Irish beef export markets. While Ireland is the largest net exporter of beef in the EU, Ireland's share of EU production is relatively small (circa 7%). This small production share means that the increase in EU production associated with an increase in Irish production is also likely to small and as a result the negative output price impact is likely to be small.

As noted earlier the FAPRI-Ireland model was not developed to analyse the impact of animal welfare or disease control related trade restrictions (see Paarlberg et al. 2005 for a review of the modelling challenges faced in assessing the economic impact of animal disease). While the FAPRI-Ireland model provides valuable insights into how a trade ban might affect the Irish agricultural sector, as a dynamic partial equilibrium agricultural commodity model, there are important issues that the FAPRI-Ireland model cannot or does not address. These issues, discussed below, are likely to be important in coming to an overall assessment of the likely impact of a ban on Irish live cattle exports.

Brexit

The decision by the UK to leave the EU on foot of the EU referendum that took place in June 2016 has the potential to dramatically alter the economic environment within which the Irish agri-food sector operates. Preliminary analysis by Donnellan and Hanrahan (2016) and Donnellan, Hanrahan and Thorne (2016) indicates that the impact on the Irish agricultural sector could be severe and that the beef sector, given its dependence on the UK market and its dependence on income support payments from the Common Agricultural Policy, could be one of the more severely affected parts of the Irish agri-food industry.

The Baseline and alternative "No Live Exports" scenario analysis using the FAPRI-Ireland model were undertaken in advance of the Brexit referendum and both assume that the UK remains an EU member. Detailed evaluation of the impact of the no live export scenario in a world where the UK is assumed not to be a member of the EU would require the development of a FAPRI-Ireland Baseline that incorporates the Brexit policy change. The on-going absence of clarity on what Brexit will mean, including *inter alia* the clarity on what tariff and non-tariff barriers will be erected between the EU and the UK post-Brexit complicates the process of developing a "Brexit Baseline". This research required to develop such a Baseline is currently underway but is not yet complete.

As noted in the introduction the "method of difference" approach to evaluating the impact of a policy change using the FAPRI-Ireland model is designed to be robust with respect to elements of the Baseline assumptions that don't change between the Baseline and alternative policy scenario. However, the nature of the Brexit decision and the potential consequence for the trading environment within which the Irish agri-food sector operate may affect the magnitude of the costs of restrictions on trade that might arise in the future as a result of IBR. With markets other the UK likely to become more important following Brexit, exclusions from remaining EU or potential non-EU exports markers on the basis of animal disease issues could be expected to be more costly.

Competition

The role of live exports as a competitor for finished cattle with locally operating meat processing firms is frequently cited as the key function of live exports from the perspective of Irish farmers and the Irish agricultural industry (see O'Connell 1995, 1997). In the absence of live exports (and the competitive pressure exerted by those buyers in the live cattle market) it is claimed that Irish meat processors would exploit their oligopsony power and underpay Irish farmers for their cattle.

The FAPRI-Ireland model is based on the assumption that agricultural input and output markets are competitive and that Irish meat processing firms do not behave in an anti-competitive fashion and as a consequence the model is not able to account for anti-competitive behaviour in the agri-food supply chain. However, to date there is no evidence available of such behaviour on the part of the Irish meat processing industry, though the adage that "absence of evidence is not evidence of absence" should be recalled.

If, in the event of a live export ban, the Irish meat industry were to engage in oligopsonic behaviour and succeeded in under paying Irish farmers for their finished cattle, the increase in the cattle sector output value projected under the NLE scenario would be smaller or possibly negative. Either outcome would increase the magnitude of the loss of agricultural sector income associated with the NLE scenario, because the extent to which the increase if domestic cattle supply depresses Irish cattle prices would increase and the simulated positive impact of the NLE on cattle sector output value could be eroded or even reversed. See Panagiotou and Azzam (2010) for an analysis of the implications of imperfect competition in the context of analysis of the impact of trade bans introduced in the wake of the discovery of BSE in the US and Canadian cattle industries.

Distributional impact of a ban on live exports

Not all cattle farmers sell cattle to live exporters. Those immediately affected by a ban on live exports would be those farmers with business models based on the marketing of animals via live export channels – the introduction of a ban would force these farmers to dispose of their animals domestically by selling them to other Irish farmers or meat processors for (probably) lower prices than they would have received from live exporters. For farmers who do not sell animals to live exporters the immediate economic impact of a ban may be negligible or even possibly positive. Those who compete with live exporters for cattle purchases are not only meat processors (the factories) but other farmers. Given that the majority of cattle that are now exported are calves, weanlings or store cattle, farmers who compete with live exporters for these cattle would stand to gain if the export of these animals is prohibited and their market price declines.

The FAPRI-Ireland model, as a sectoral model, does not disaggregate the beef sector into its myriad sub-components, and the farm level winners and losers from a live export ban cannot be identified by the FAPRI-Ireland aggregate model. Information on behaviour and marketing relationships at the farm level such as the destination of cattle sold would be required to identify farmers that potentially stand to lose or gain from the introduction of a ban on live exports.

Changing age composition of live exports

The FAPRI-Ireland model does not disaggregate live export flows into exports of calves, weanlings, store and finished cattle. As we have seen the composition of Irish live exports has changed over time and can be expected to continue to change into the future. Under the Baseline projections presented in this paper the composition of live exports in 2015 is assumed to be unchanged over the projection period. Plausible arguments can be made for why, with an expanding dairy cow herd and contracting suckler herd, the Baseline share of calves in Irish live cattle exports would be expected to increase.

If the age composition of Irish live exports becomes more juvenile this would a) reduce the magnitude of the output revenue loss associated with inability to export animals since these animals are less valuable and b) would increase, other things being equal, the magnitude of the increase in beef produced under the NLE scenario. However, offsetting the higher output value associated with the raising to beef of calves that would otherwise be exported as live animals is the higher level of expenditure on inputs associated with the increase in such agricultural activity.

Given the existing low levels of profit from raising dairy calves to beef it seems likely that the magnitude of loss of sectoral income would be higher if the composition of live exports became even more juvenile. Again the FAPRI-Ireland model projection of the costs of the NLE scenario would likely understate the magnitude of the losses to the agricultural sector associated with a NLE ban if the future composition of Irish live exports is more juvenile than is currently the case.

Changing breed composition of live exports

The FAPRI-Ireland model does not disaggregate live exports by the breed type of cattle exported. For the same reasons one could expect live exports to become more juvenile following the ending of the milk quota system one might also expect Irish live exports to become increasingly dominated by dairy cattle types as the share of dairy cows in the total stock of breeding cattle increases. Other things being equal, this would mean that the value of live exports foregone would be considerably lower – since these animals are of lower value than beef type cattle when exported as live animals. The additional beef output volume resulting from the diversion of these animals to being raised for slaughter would also be reduced since animals with predominantly dairy genetics have on average lower slaughter weights than “beef” cattle.

If in the future live exports become dominated by dairy cattle then the negative impact of a NLE scenario could be greater than projected by the FAPRI-Ireland model. It should be noted that the output value and beef production simulations under the NLE scenario accounts for the negative impact on average cattle slaughter weight of the increased dairy composition of the Irish cattle breeding herd.

Changing destinations of live cattle exports

At times in the past non-EU markets have been very important destinations for Irish cattle exports, this was particularly the case in the early 1990s when exports to markets such as Egypt, with the aid of export refunds, accounted for over 20% of all live exports. Currently prospects for increases in live exports to non-EU markets such as Turkey (and other Middle East and North African markets) have improved. In 2016 Bord Bia data indicate that live exports to such markets accounted for over 17% of total Irish live cattle exports. While Article 9 or 10-based restrictions on live animal trade with other EU member states is the principal motivation for the NLE scenario, animal disease based restrictions could also affect trade with non-EU markets. Most non-EU imports of livestock require licences that require that the animals imported are from disease free farms. Thus live exports to non-EU markets are as likely to be affected by animal disease status as trade with other EU member states.

The FAPRI-Ireland model is non-spatial and cannot provide projections on the geographic destination of future Irish cattle live exports. Thus it cannot provide projections on the shares of live exports that in the future go to non-EU markets. However, given the conditions associated with live animal import licenses issued by countries such as Turkey, which require that animals are from disease-free farms, the scenarios examined here –the no live export scenario – is relevant to both EU and non-EU live cattle trade.

Wider economy impact of a ban on live exports

The FAPRI-Ireland model is a partial equilibrium model of the agricultural economy and as such takes no account of the wider economic impact of a ban on live cattle exports. As noted in O'Connell (1997) the export of live cattle provides employment and added value to the Irish economy. Its banning would have a negative impact on associated upstream and downstream economic activities. However, if animals that would otherwise be exported are raised for slaughter it is possible that the positive benefits of upstream and downstream economic activity associated with both the farming and processing of these additional animals, could outweigh the negative impact of the lower economic activity associated with the live export industry.

The formal evaluation of the impact of a live export ban on the whole economy would require the use of an input output model or computable general equilibrium (CGE) modelling framework –see O'Toole, Matthews and Mulvey (2002) for an analysis of the economic impact of the 2001 FMD crisis on the Irish economy while Miller et al. (2014) provide an analysis of the wider economy impact of the achievement of the Food Harvest 2020 targets.

Conclusions

The importance of live exports to the Irish agricultural sector and the cattle sector in particular has declined. In 2015 live exports accounted for just under 10% of the volume of cattle disposals (live exports and slaughter) and slightly more than 5% of the value of Irish cattle disposals (DAFM, 2016). The composition of these exports has changed over time with Irish live exports increasingly comprised of relatively low value dairy breed calves rather than higher value (per head) finished and store cattle of a beef breed.

The FAPRI-Ireland model was used to evaluate the impact of a "no live export scenario" compared to the 2015 FAPRI-Ireland Baseline. The projections indicate that a ban on live exports would have only modest sector level impacts. The loss of value and volume of agricultural output associated with loss of live exports offset are offset by additional beef output volume that arises from the slaughter of animals in Ireland that under the Baseline would have been exported on the hoof. Additional levels of agricultural activity under the NLE scenario and associated higher levels of input expenditure mean that agricultural sector income (operating surplus) is projected to be 2% (€50m) lower than under the Baseline.

There are a number of caveats to the result presented in this study. The uncertainty relating to the potential impact of Brexit is perhaps the most important caveat. At this point in time, given that is it is not possible to provide definitive analysis of the impact of Brexit, it has been necessary to assume for analytical purposes that Brexit is not happening. Other caveats outlined relate to the role of live exports in ensuring effective competition in the Irish cattle supply chain and the impact of changes to the breed and age composition of live exports in the future. Other things being equal, the younger the cattle exported live and the greater the proportion of cattle exported under the Baseline that are of a dairy breed, the greater the cost of the NLE scenario in terms of sectoral income losses. The FAPRI-Ireland model as a sectoral model is not able to provide insights on the distribution of losses within the cattle sector. The analysis does not take any account of the biophysical costs of IBR in the Irish dairy cattle and beef cattle herds that are analysed in the papers by Shalloo and Sayers (2017) and Parr et al. (2017) that form the first two parts of this study and any such costs would be additional to those estimated to arise as a result of restrictions on trade in live cattle.

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5 Overall Study Conclusions

The three studies presented here (Shalloo and Sayers 2017, Parr et al., 2017 and Hanrahan and Donnellan, 2017) analyse the nature and magnitude of the farm level costs associated with IBR on Irish dairy and single suckling farms and the potential additional economic costs that could arise if other EU Member States were to impose a ban on imports of live cattle from Ireland under the provisions set out in Articles 9 and 10 of Council Directive 64/432/EEC (EEC, 1964).

The BoHV-1 (IBR) status of a dairy herd is found to have a significant effect on the performance and profitability characteristics of Irish dairy farms. Using the Moorepark Dairy System Model, and three different milk prices regimes (24.0 cpl, 29.0 cpl and 34.0 cpl), profitability was reduced by an average of €60 per cow per year when herds were classified as seropositive for BoHV-1. At a milk price of 29 cent per litre this equated to a 22% reduction in profit.

It is estimated that IBR is costing the Irish dairy industry €62 million annually in terms of foregone profit as compared to a situation where IBR was not present. This aggregate estimate of dairy farm costs of IBR is based on the estimate of foregone income per cow of €60 per year, a national dairy cow population of 1.296 million cows and an 80% herd level prevalence of IBR.

In contrast to the significant biophysical effects of BoHV-1 status on dairy herd performance and profitability, the biophysical and farm level economic effects of BoHV-1 status on suckler cow herds taking progeny to weaning were more modest.

The modest biophysical effect of BoHV-1 seropositivity (with output per hectare was found to be 3% lower for seropositive herds) was reflected in similarly modest impacts on farm level profitability as simulated by the Grange Beef Systems Model (GBSM). Net margin per farm was found to be 4% with lower for the seropositive herd using the GBSM. The negative impact on incomes of lower physical output per hectare was augmented by the higher costs per hectare on seropositive herds.

Due to the significant heterogeneity amongst Irish suckler cow production systems it is not possible to aggregate from the GBSM estimate of the impact of IBR on profit per hectare on suckler herds where progeny are sold as weanlings to a national farm level cost for all Irish suckler cow production. However the magnitude of the aggregated economy wide farm level cost of IBR on suckler farms is likely to be significantly lower than that associated with IBR on Irish dairy farms.

The average Cattle Rearing farm in the Teagasc NFS consisted of just over 35 hectares (Hennessy and Moran, 2016). If the loss in margin per hectare from BoHV-1 seropositivity on all cattle rearing farms were assumed to be the same as those on suckler farms where progeny are sold as weanlings then the average cost per farm would range from €350 per farm to €735 per farm. No evaluation has yet been undertaken of the biophysical losses associated with BoHV-1 on Irish cattle finishing farms and the economic value of these losses would be in addition to those arising on cattle rearing farms.

In certain circumstances restrictions on trade in live cattle (and other animals) can be introduced by EU member states on animal health and disease grounds (Articles 9 and 10 of Council Directive 64/432/EEC). It is possible that markets that currently import Irish cattle (or that are on the land route to markets that import Irish cattle) could ban imports of Irish cattle on the grounds of the presence of IBR in the Irish cattle population. What would the economic impact of such a ban be? The FAPRI-Ireland model based simulations of a no live export (NLE) scenario indicate that a ban on live exports of cattle would lead to a loss in agricultural sector income of approximately €50 m per annum by 2024, this is equivalent to 2% of projected Irish agricultural sector income.

Under the NLE scenario, cattle that under the Baseline would have been exported live are raised to slaughter in Ireland. This change in the nature of Irish cattle disposals (more slaughter and less live exports) leads to an increase in the volume of Irish beef output. Irish cattle sector output value is also higher in the no live cattle export scenario than under the Baseline despite a small reduction in Irish cattle prices. However, additional cattle fattening activities under the NLE scenario are also associated with additional expenditure on intermediate inputs (feed, fertiliser etc.). The projected increase in input expenditure is sufficient to more than offset the higher cattle output value projected and this is projected to leave aggregate agricultural sector income 2% lower under the no live export scenario than under the Baseline.

As noted earlier the farm level costs associated with BoHV-1 are additional to those that could arise as a result of the restrictions on live cattle exports that could be imposed because of the absence in Ireland of an IBR control/eradication programme. The sum of both biophysical based economic costs of BoHV-1 prevalence on Irish cattle and dairy farms and the potential loss in agricultural sector income associated with restrictions on live cattle exports is likely to be in excess €100 m per annum.

6 Annex: Update on FAPRI-Ireland analysis of the economic impact of a ban on live cattle exports

Dr Kevin Hanrahan
Rural Economy Development Programme, Teagasc, February 2020.

Introduction

Since the IBR report (Hanrahan and Donnellan, 2017) was completed in 2017 exports of live cattle form Ireland have continued to increase in volume (heads of animals shipped). The simulated economic impact of a no live exports scenario where live exports are effectively banned depends on the projected baseline (business as usual) simulation of the volume of live exports in the absence of any restriction on live exports.

In this note we present updated impact analysis of a "no live exports (NLE)" scenario. Due to the heightened uncertainty relating to the impact of Brexit on future trade relationships between the EU and the UK we present impact analysis of the NLE scenario with reference to two alternative Brexit outcomes: one where the transition arrangement whereby the UK remains within the Single Market is assumed to persist over the medium term (a "soft" Brexit) which we term reference Scenario 1 and one where from 2021 the UK and the EU trade on what are sometimes called WTO terms with the UK applying the "temporary tariff schedule" it announced in 2019 (HMG 2019) over the medium term (a "hard" Brexit), this we term reference Scenario 2.

All scenario impact analysis is relative to a baseline where the analysed NLE scenario does not apply. The impact of a NLE scenario in the future is relative to an alternative state of the world in that uncertain future, not relative to the known past. In the results presented all impacts are presented for the year 2030 relative to a defined alternative/counter-factual reference or baseline scenario (Scenario 1 or Scenario 2). The Hard Brexit NLE scenario is compared to the Hard Brexit Baseline and the Soft Brexit NLE scenario is compared to the Soft Brexit Baseline.

Why the FAPRI-Ireland baseline projections change each year

Each year the FAPRI-Ireland baseline projections are revised and updated to reflect emerging and changed market conditions and to incorporate the additional information that is yielded by an additional year's worth of "real" data. There are also on-going revisions to the FAPRI-Ireland model's structure to reflect new policy analysis demands and concerns. These two sources of change to the model will by construction cause change to the model's projections of the future to also change.

The development of the external policy environment and related analytical demands (principally Brexit) have led to changes in the structure of the FAPRI-Ireland model so as to allow the model to be used to analyse this critical policy issue. These changes in the model's structure, even with identical historical data, would lead to changes in the model's behaviour in terms of its simulations of the future.

As discussed at more length below there have also been significant changes in the volume of agricultural activity in Ireland and in particular in the volume of live exports since the publication of Hanrahan and Donnellan (2017) that also need to be reflected in the model's projections.

External exogenous datasets (projections) used within the model are also updated periodically – these exogenous data include macroeconomic aggregates such as projected rates of general price inflation, exchange rate values, levels of national income (GDP) as well as data on agricultural and trade policy variables such as world agricultural commodity prices and policy variables such as tariff rates and rates of subsidy that have changed.

Projections such as those produced using the FAPRI-Ireland model, are equivalent to projections from agencies such as the OECD and FAO (OECD/FAO, 2019) and the European Commission (EC, 2019) with respect to agricultural commodity market developments and from agencies such as the ESRI (McQuinn, O'Toole and Allen-Coghlan, 2019) with respect to the future evolution of the Irish macroeconomy.

FAPRI-Ireland model projections, or "conditional forecasts", are based (conditional) on assumptions concerning future developments in agricultural and trade policy and other exogenous forces that are not modelled. They are not forecasts. The important distinction between projections and forecasts should be borne in mind by the reader.

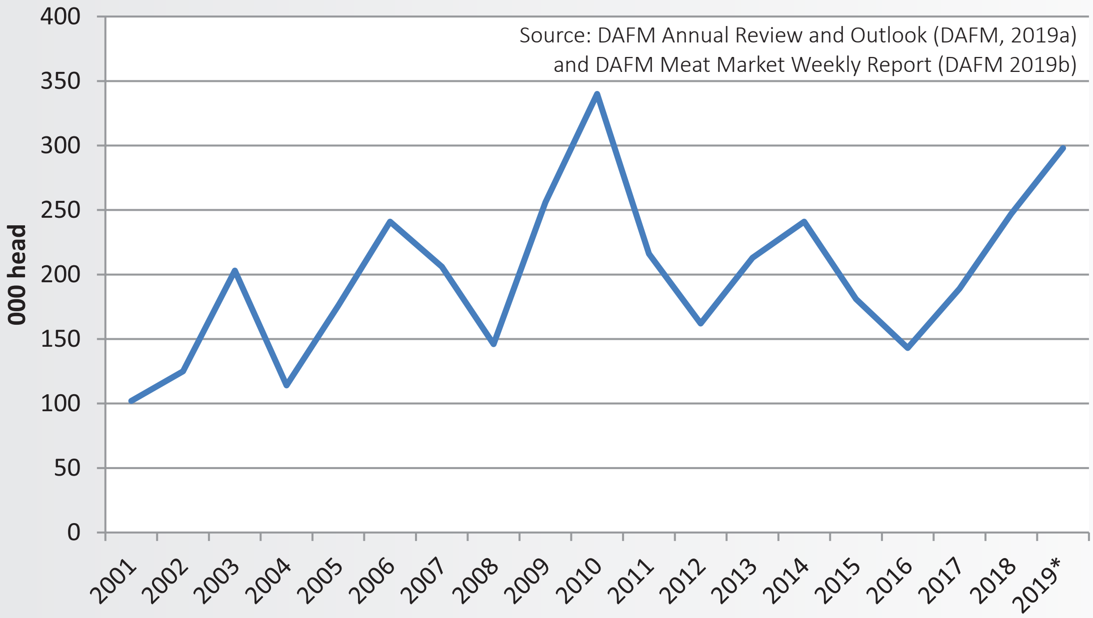

Figure 16. Irish Live Cattle Exports (heads) 2001-2019.

Live exports

The FAPRI-Ireland model generates projections of future agricultural activity levels, agricultural commodity supply and use balances and the Irish economic accounts for agriculture, conditional on the most up to date data on endogenous data on agricultural activity, agricultural commodity supply and use levels, agricultural input and output prices, and projections of exogenous agricultural policy, trade policy and macroeconomic data.

As with most things, where you will get to in the future is at least in part (and often largely) determined by where you start from, what economists and others term path dependency. The path of the projected future for all of the agricultural activity and agricultural commodity supply and use variables and prices that are endogenous to the FAPRI-Ireland model begins with observations on the reality of market outcomes and agricultural activity levels as reported by the Department of Agriculture, Food and the Marine (DAFM), the Central Statistics Office (CSO) and Eurostat.

In 2018 Irish live exports of cattle numbered over 240 thousand head. The early estimates of the cumulative level of live cattle exports in 2019 (DAFM Weekly Meat Market Reports) indicate that in 2019 over 298 thousand head of cattle were exported live (DAFM 2019). Figure 16 presents these official DAFM data and provisional data for the year to the end of December 2019. The very strong growth in the volume of live exports since 2016 is clear.

The change in the composition of Irish live exports noted in Hanrahan and Donnellan (2017) has continued with the share of total live exports accounted for by calf exports continuing to grow. In 2019 based on DAFM data on live exports by age cohort and the Bord Bia commentary concerning growth in year on year volumes by animal age categories in 2019, the proportion of total cattle exports (heads) accounted for by exports of calves reached almost 71%.

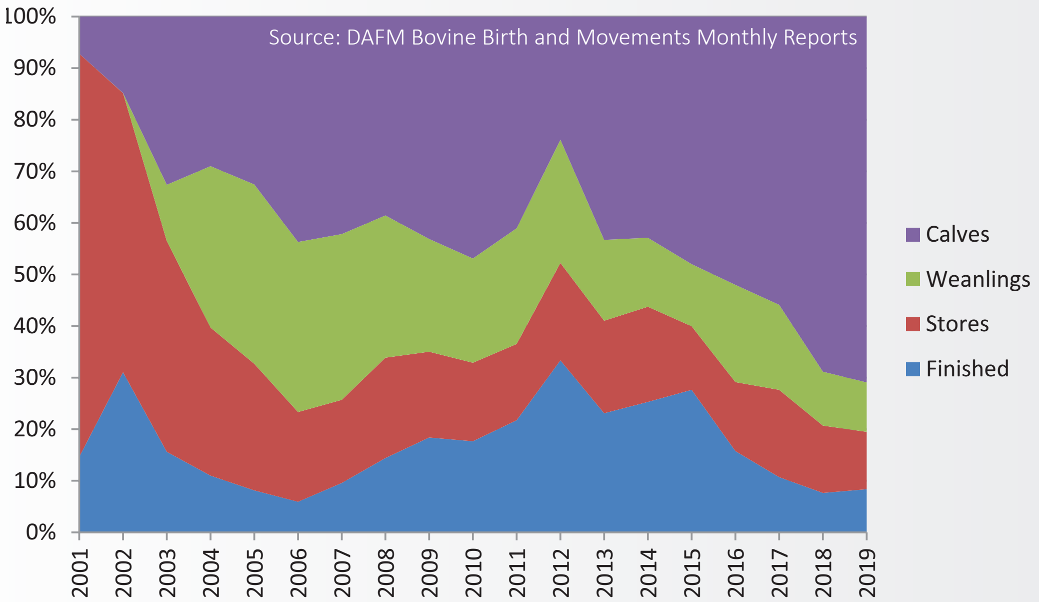

Figure 17. Irish Live Cattle Exports by animal type.

The value of live cattle exports has grown since 2016 but the rate of growth in the value of these exports has lagged that observed in total cattle numbers (volume) exported. This reflects the increasing calf composition of Irish live cattle exports. In 2018 the share of calf exports in total live cattle exports when measured by heads shipped was just under 69% while the share of total value of cattle exported accounted for by calf exports was 23%.

2019 FAPRI-Ireland simulations: Reference and no live exports scenario simulations

A key consideration in modelling the economic consequences of a disruption to Irish live cattle exports (the No Live Export Scenario) is the projected volume of the physical flows under the reference or Baseline scenario(s). This and the baseline projections for Irish cattle and other agricultural prices are important determinants of changes to the costs and revenues associated with the diversion of animals that otherwise are exported to live to other uses within Ireland.

The development of Irish agriculture in the future will be contingent on a very large set of policy and market forces. A critical source of policy uncertainty currently faced by the Irish agri-food sector relates to the nature of the trade relationship between the UK and the EU over the medium term. Just what will Brexit mean?

While Brexit in the formal legal sense has now happened, there remains fundamental uncertainty concerning the nature of the EU-UK trade relationship over the medium term. The nature of the future relationship is the subject of negotiations between the EU and the UK that will commence during 2020 following the adoption by the EU Council of a negotiating mandate to be followed by the European Commission and an equivalent process in the UK. The transition period agreed in the Withdrawal Agreement, which ends on December 31 2020, can be extended at the request of the UK. However, the UK Government to date has ruled out any extension and repeatedly expressed their desire to diverge or at least retain the freedom to diverge from EU regulatory norms from Jan 1 2021.

Whether or not a deep and comprehensive trade relationship between the EU and the UK that only minimally raises barriers to trade between the EU and UK can be agreed with the next 11 months remains uncertain. What is certain is that there will be at the very least new Customs and regulatory procedures that will apply to trade between the UK and the EU Single Market from January 1 2021.

The possibility remains that in addition to non-tariff barriers that would emerge even with a FTA between the EU and the UK, there could also be tariff barriers to trade between the EU and the UK if no agreement is reached between the UK and the EU during 2020 and the UK Government sticks with its stated commitments not to seek an extension to the transition arrangements as set out in the EU-UK Withdrawal Agreement. The exact nature of any future tariff barriers is at this point unknown.

If there are significant new tariff or non-tariff barriers to trade between Ireland and the UK post-Brexit then Irish cattle prices will be significantly lower than would be the case if EU-UK trade relationships remain close to their current pre-Brexit settings.

At least some of the economic impact of the scenario wherein live exports are banned (NLE) derives from the price at which cattle are transacted and this will be conditional on the nature of the future (unknown) additional Brexit related trade frictions between Ireland (and the wider EU) and the UK. This future price level, and the relative value of Irish cattle prices to EU prices, also drives the attractiveness of the live export channel as a market outlet for cattle relative to domestic slaughter.

This continuing uncertainty relating to the nature of the trade relationship between the EU and the UK and the high importance of the UK as a market for Irish agri-food exports means that baseline assumptions concerning the nature of the trade relationship importantly affect the simulated impact of a shock such as a ban on the live export of cattle from Ireland.

To assess the importance of this dimension of policy uncertainty we have evaluated the NLE scenario in two contexts – one where the reference scenario or baseline is one where EU-UK trade relations continue to be effectively equivalent to continued UK membership of the Single Market (reference Scenario 1) and one where EU-UK trade relations move after the transition period end in 2020 to so-called WTO terms (reference Scenario 2).

Under reference Scenario 1 (a "soft Brexit") the EU-UK trade relationship remains unchanged as compared to the status quo ante when the UK was an EU and Single Market member. We assume that the outcome of the future relationship negotiations is effectively equivalent to the UK remaining as a Single Market Member (the transitional rules persisting over the medium term). This outcome is increasingly seen as unlikely but is a useful alternative state of the world with which to assess the impact of other (perhaps more likely) policy outcomes where the UK-EU trade relationship is inferior to the current transitional arrangements.

The details of the trade policy relationship between the UK and the EU in the event that a deep and comprehensive FTA is not agreed during 2020 are also unknown. The EU would, under WTO rules, have to apply its MFN schedule to the UK – that is treat it as a "third country". The schedule of tariffs that the UK would apply in these circumstance is currently unknown. During 2019 the UK government published what it (at the time) termed a temporary tariff schedule that would apply in the event of a so-called No Deal Brexit. This schedule may or may not be the MFN schedule which the UK applies form 2021. The UK Government currently has a public consultation on the nature of its future tariff regime (HMG, 2020). In our reference Scenario 2 we assume that the 2019 "Temporary No Deal" tariff regime is applied by the UK for the period to 2030 and we then evaluate the impact of the No Live Export (NLE) scenario relative to this alternative hard Brexit reference scenario (HMG, 2019).

Under all scenarios modelled no changes are made to CAP policies within the EU and the UK is assumed to fund the continuation of a CAP like agricultural policy measures (direct payments etc.) over the projection period within the UK. We know that UK and EU agricultural policy will change over the medium terms but given the uncertainty concerning the outcomes of these two agricultural policy reform processes we abstract away from this dimension of policy uncertainty.

Under both the first reference scenario (the "soft Brexit" Scenario 1) where EU-UK trade relations for the period to 2030 are characterised by the transition arrangement s that will apply during 2020 and the second reference scenario (the "hard Brexit" Scenario 2) where EU-UK trade relations are characterised by the application of EU and UK MFN tariff schedules we take no account of the non-tariff barriers (NTB) to trade between the EU and the UK that will emerge once the UK has left the Single Market.

Analysis of the impact of NTB on Irish agri-food exports and on the economic performance of the Irish agri-food sector using the FAPRI-Ireland model is an area of ongoing research. Even with a deep and comprehensive FTA between the EU and the UK, new NTB will emerge at the end of the agreed transition period to the trade between the EU and the UK due to the exit of the UK from the Single Market. Other things being equal, these NTB would be expected to have a negative impact on both the volume and value of trade between the EU and the UK. For most of the key Irish agricultural commodities the price impact of NTB would be expected to be negative relative to a Baseline of continued UK membership of the Single Market and the impact of new NTB on the volume of agri-food trade between the EU and the UK would also be expected to be negative. For those commodities, such as lamb, where the UK is a large exporter to the EU market Brexit, even if EU-UK trade relations are characterised by zero tariffs and zero quota, NTB may lead to reduced UK exports and this may lead to concomitant increases in EU prices. Whether the value of Irish sheep meat exports increase as a result of the NTB faced will depend on whether the losses arising from the deterioration in access to the UK market (lower volumes) are offset by any increase in prices that results from the reduced access to the EU market currently enjoyed by UK exporters.

Under both the Scenario 1 (soft Brexit) and Scenario 2 (Hard Brexit) scenarios we introduce a "no Live Export" scenario that is equivalent to that analysed in 2017 (Hanrahan and Donnellan). The NLE scenario run off of Scenario 1 (the Soft Brexit reference scenario) we term Scenario 3 (NLE Soft Brexit) and the NLE scenario run off of Scenario 2 (the Hard Brexit Scenario) we term Scenario 4 (NLE Hard Brexit). The impact of the live exports scenario modelled differs between Scenario 3 and 4 because the projected cattle price level and the projected volume of live exports are different in the relevant reference run scenarios.

Impact of the no live export Scenario (S3) relative to the soft Brexit reference run (Scenario 1)

Over the projection period under Scenario 1 dairy commodity prices and farm gate milk prices are projected to remain relatively stable and the current and expected continued profitability of milk production in Ireland is reflected in continued growth in dairy cow numbers. The increase in the flow of calves from this breeding stock is projected to more than offset the projected decline in the volume of calves produced from a declining suckler cow inventory. By 2030 under Scenario 1 Irish dairy cow numbers are projected to grow to 1.56 million while the suckler cow inventory is projected to decline to 0.73 m head. Irish live cattle exports are projected to grow over the period to 2030 to close to 340,000 head.

Under the No live cattle Exports (NLE) scenario exports of cattle from Ireland are, by assumption zero, from 2021 onwards. Cattle that under the reference scenario would have been exported are under the NLE scenario (scenario 3) instead diverted for use in Ireland. The total size of the Irish cattle inventory under the NLE scenario is by 2030 approximately 300 thousand cattle higher than under the reference scenario (Scenario 1).

The higher total cattle inventories are almost exclusively due to the higher numbers of cattle retained within the Irish agricultural economy that would otherwise have been exported. This higher volume of animals available for slaughter is reflected in higher total cattle slaughter and total beef production. Irish cattle slaughter in 2030 under the NLE scenario (Scenario 3) is projected to be over 17% higher than under the Reference Scenario (Soft Brexit Scenario 1), while beef production is projected to be over 20% higher.

Under the no live export scenario the proportion of the total cattle kill accounted for by culled cows declines as the share of prime cattle increases due to the ban on live cattle exports. This is reflected in a projected increase in the average cattle slaughter weight of 2.7%.

By 2030 as a result of the higher Irish cattle inventories and total supply of beef in Ireland, Irish finished cattle prices are projected to decline by 3% relative to the reference scenario. Due to the decline in the price of cattle, and the loss of the value of live cattle exports, despite the increase in the volume of beef produced, the total value of cattle output is projected to decline compared to the reference scenario. Total cattle output value in 2030 under the no live export scenario (Scenario 3) is projected to be marginally lower than under the reference scenario (Scenario 1).

The marginally lower output value associated with the NLE is not reflected in an increase in the projected operating surplus of agricultural sector income. Increased agricultural activity levels under the NLE are reflected in increased expenditure on intermediate expenditure as compared with the reference scenario. Animals that under the reference scenario were exported live are retained in Ireland and while their presence leads to higher output value their presence leads to increased expenditure on feed, fertiliser, veterinary services and other elements of Irish agriculture's intermediate consumption. By 2030 intermediate consumption under the NLE scenario is projected to be over 90 m euro higher than under the Soft Brexit (Scenario 1).

The marginal decline in cattle output value that arises under the NLE scenario when combined with the higher expenditure on inputs (intermediate consumption) combine to leave Irish agricultural sector income lower under the NLE scenario than under the reference or Baseline scenario (Scenario 1). By 2030 Irish agricultural sector income under the No Live exports scenario is projected to be almost €140m per annum lower than under the reference (soft Brexit) scenario (Scenario 1).

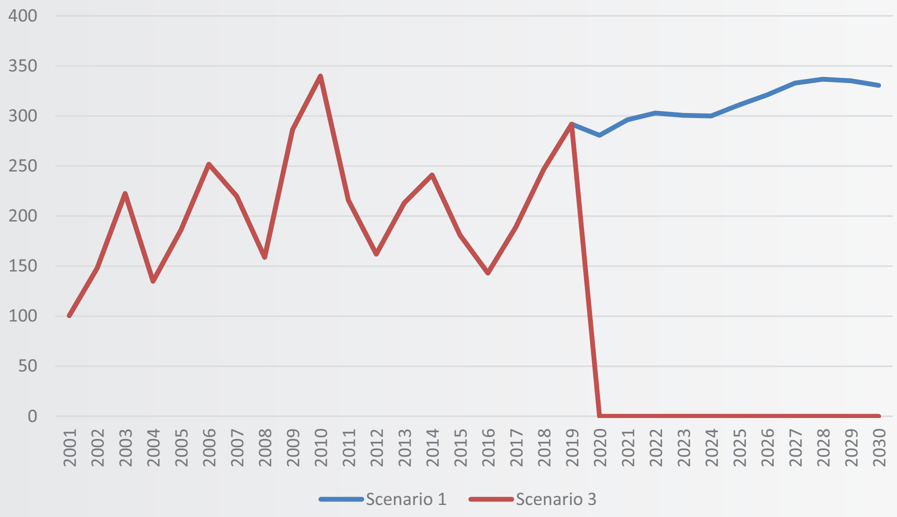

Figure 18. Baseline (Soft Brexit – Scenario 1) and No Live Cattle (NLE) Scenario 3: **Cattle Exports.**

Source: FAPRI-Ireland Model 2019

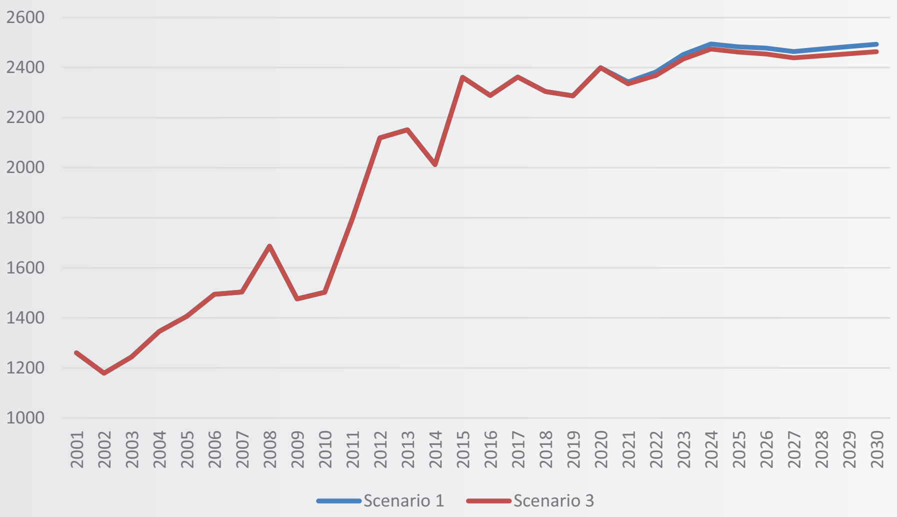

Figure 19. Baseline (Soft Brexit – Scenario 1) and No Live Cattle (NLE) Scenario 3: **Cattle Output Value.**

Source: FAPRI-Ireland Model 2019

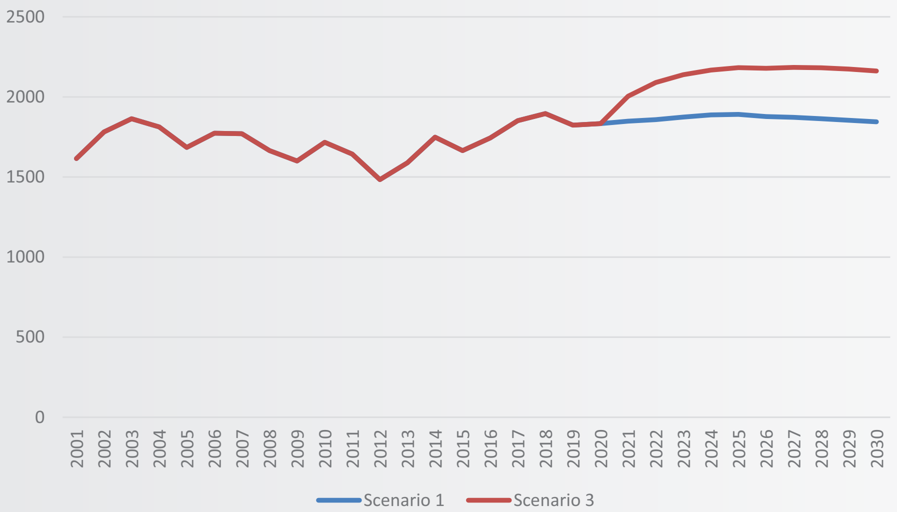

Figure 20. Baseline (Soft Brexit – Scenario 1) and No Live Cattle (NLE) Scenario 3: **Cattle Slaughter.**

Source: FAPRI-Ireland Model 2019

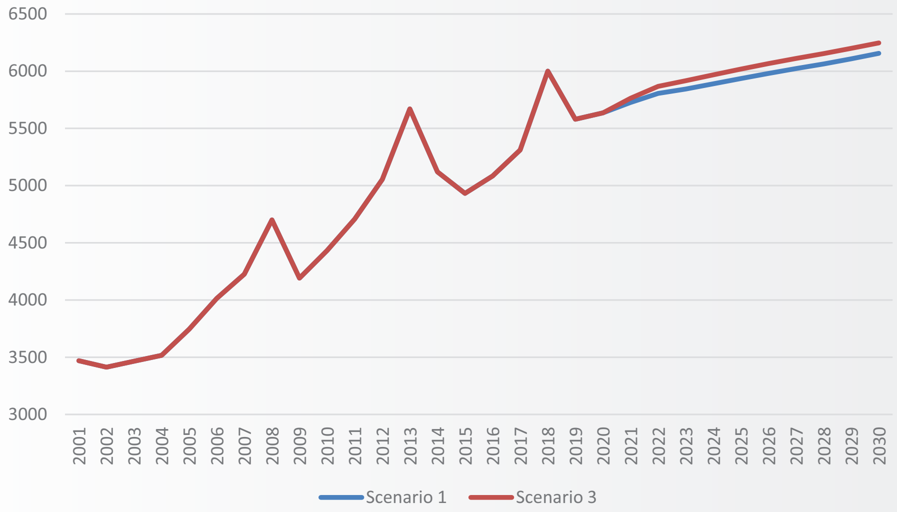

Figure 21. Baseline (Soft Brexit – Scenario 1) and No Live Cattle (NLE) Scenario 1: **Intermediate Consumption.**

Source: FAPRI-Ireland Model 2019

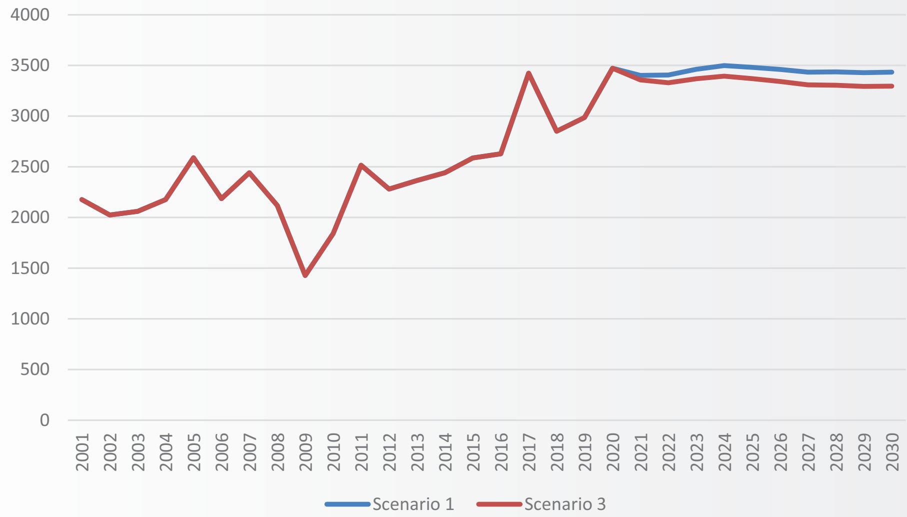

Figure 22. Baseline (Soft Brexit – Scenario 1) and No Live Cattle (NLE) Scenario 1: **Operating Surplus.**

Source: FAPRI-Ireland Model 2019

Table 1. FAPRI-Ireland Baseline (Scenario 1) Beef Sector Projections.

		2018	2025	2030
Ending stocks of Cattle	000 head	6,593	6,708	6,558
Ending stocks of suckler cows	000 head	982	833	730
Ending stocks of Dairy cows	000 head	1,369	1,536	1,561
Cattle Slaughter	000 head	1,896	1,891	1,845
Live exports of cattle	000 head	247	311	331
Beef Production	000 t	623	607	592
Beef exports	000 t	572	559	546
Irish R3 Steer price	€/100 kg cwe	385	403	415
Cattle Output Value	m. euro	2,261	2,483	2,493

Source: FAPRI-Ireland Model 2019

Table 2. FAPRI-Ireland No Live Exports (NLE Scenario 3) Scenario Beef Sector Projections.

		2018	2025	2030
Ending stocks of Cattle	000 head	6,593	6,963	6,827
Ending stocks of suckler cows	000 head	982	827	719
Ending stocks of Dairy cows	000 head	1,369	1,536	1,561
Cattle Slaughter	000 head	1,896	2,183	2,162
Live exports of cattle	000 head	247	0	0
Beef Production	000 t	623	718	712
Beef exports	000 t	572	665	661
Irish R3 Steer price	€/100 kg cwe	385	392	402
Cattle Output Value	million euro	2,261	2,462	2,463

Source: FAPRI-Ireland Model 2019

Table 3. Baseline (Scenario 1) and NLE (Scenario 3) 2030 Projections.

		Baseline 2030	NLE Scenario 2030	Absolute Difference	% Difference
Ending stock of Cattle	000 head	6,558	6,827	269	4%
Suckler Cows	000 head	730	719	-11	-2%
Dairy Cows	000 head	1,561	1,561	0	0%
Cattle Slaughter	000 head	1,845	2,162	317	17%
Live Exports	000 head	331	0	-331	-100%
Beef Production	000 t	592	712	120	20%
Beef Exports	000 t	546	661	114	21%
Irish R3 Steer Price	€/100 kg cwe	415	402	-13	-3%
Cattle Output Value	m euro	2,493	2,463	-30	-1%
Intermediate Consumption	m euro	6,156	6,247	91	1%
Operating Surplus	m euro	3,435	3,296	-138	-4%

Source: FAPRI-Ireland Model 2019

Impact of the no live export Scenario (S4) relative to the hard Brexit reference run (Scenario 2)

As noted earlier the terms of the future trade relationship between the EU (including Ireland) and the UK are the subject of ongoing negotiations between the EU and the UK. Teagasc have since 2016 undertaken research in support of the Irish Government that has analysed the economic impact of Brexit on Irish agriculture and on the incomes of Irish farmers. In these analyses Baseline scenarios where the UK either remains a member of the EU or effectively remains a member of the EU Single Market after formally exiting the EU have been compared with different Brexit policy scenarios. The latest of such policy scenario analysis was presented to Government in early 2019. This scenario analysis highlighted the large negative impact on Irish agricultural sector incomes of a so-called Hard Brexit where after the end of the current transition period EU-UK trade relations are not governed by the terms of a to be agree preferential or free trade agreement (FTA) but rather are characterised by the application of what is sometime referred to as “WTO rules”. This scenario involves the application of the EU MFN tariff schedule to imports into the EU from the UK and the application of the “temporary NO Deal” tariff schedule announced by the UK Government in March 2019 (as subsequently updated and modified in October 2019). Note that none of the Teagasc analysis to date (Donnellan and Hanrahan, 2017, Hanrahan, Donnellan and Thorne, 2019) has incorporated the impact of so-called non-tariff barriers (NTB) to trade that will apply in addition to any new tariffs that might (or might not) apply to EU-UK trade after the end of the transition period agreed in the EU-UK Withdrawal Agreement.

In this paper we are not seeking to fully outline all of the details of Teagasc Brexit analysis, rather we use the Hard Brexit Scenario analysed as an alternative Baseline or reference simulation and examine the impact of a No Live Export scenario under which live exports of cattle from Ireland are banned from 2021 onwards. As noted in the introduction two key projections drive the economic impact of the NLE scenario. The first is the projected level of live exports in the reference or Baseline run and the second is the price of cattle projected in the reference run. Because both the level of live exports projected over the medium term and the level of market prices for cattle projected over the medium terms differ significantly between the Soft Brexit Baseline (Scenario 1) and the Hard Brexit Scenario (Scenario 2). Consequently the simulated impact of the NLE scenario is different when run against a reference run where EU-UK trade relations are governed by so-called WTO rules.

Under the Hard Brexit Baseline (Scenario 2) Irish live exports are projected to be dramatically higher than under the soft Brexit Scenario (Scenario 1). Under Scenario 2, the imposition of tariffs on Irish exports to the UK and the loss of preferential access to the UK market after the end of the transition period agreed under the terms of the EU-UK Withdrawal Agreement leads to a dramatic decline in Irish exports to the UK and this market access shock is reflected in a large decline in Irish cattle prices. Most importantly the decline in cattle prices in Ireland increases the difference between Irish and continental EU cattle prices. This decline in Irish cattle prices relative to those prevailing in the EU as a whole increases the competitiveness of Irish live cattle exports which under the Hard Brexit Scenario are projected to be over 40% higher than under the Soft Brexit scenario (Scenario 1). This much higher level of live cattle exports means that the economic impact of an effective ban on this trade flow, as under the NLE scenario (Scenario 4) would be expected to be reflected in a larger economic impact of the NLE under a Hard Brexit Scenario as compared to the same NLE scenario when assessed against a Soft Brexit Reference Scenario. The one complicating factor is that the Cattle price level under a Hard Brexit is much lower and this means that any output value impacts may also be attenuated as compared to the impact analysis where the reference run is Scenario 1.

Under the Hard Brexit reference run (scenario 2) total cattle inventories decline due to a slower rate of growth in inventories of dairy cows, a large decline in the inventory of suckler cows and a strong increase in the level of live exports as compared both to recently observed levels of live exports and relative to the level of live exports of cattle projected under Scenario 1 (the soft Brexit scenario). The decline in the ending stock of suckler cows and the large increase in the live exports of cattle are both driven by the large decline in Irish cattle prices. Under the Hard Brexit scenario, Irish finished cattle prices in 2030 are approximately 20% lower than the projected level under the soft Brexit reference run.

Under the NLE scenario (Scenario 4) we introduce the ban on live cattle exports policy shock and simulate its impact relative to the Hard Brexit reference scenario (S2). The magnitude of the shock is larger because the reference run projection for live cattle exports is higher. The positive impact of the diversion of close to half a million head of cattle that would otherwise be exported live has a large impact on the volume of cattle slaughtered and beef production as compared to the Hard Brexit reference simulation. By 2030 under the NLE Irish ending cattle inventories are 7% higher than under Scenario 2, while beef production is 36% higher than under the reference run. The large increase in cattle supply in Ireland and in Irish beef production is reflected in a decline in the market price of cattle, which is 2% lower than under the Hard Brexit reference run. The relatively small scale of price impact reflects the continued dominance of EU market price factors in the determination of Irish cattle prices, Irish price levels decline dramatically due to Brexit but their evolution over time continue to be largely due to EU market price developments.

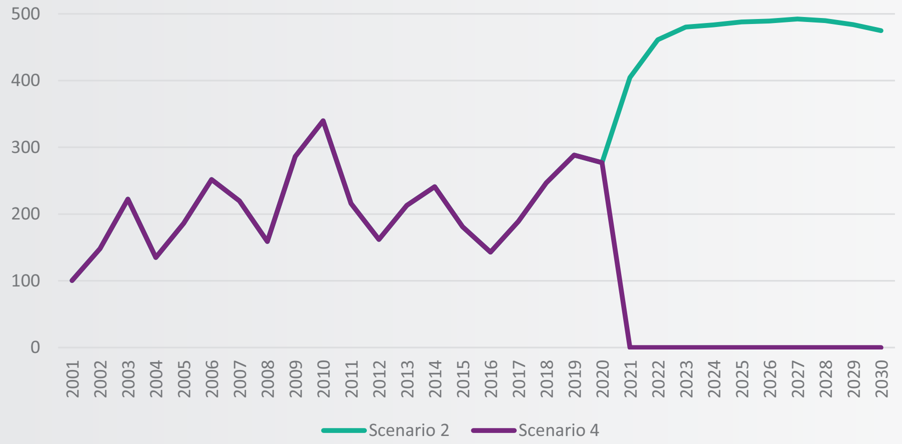

Figure 23. Baseline (Hard Brexit – Scenario 2) and No Live Cattle (NLE) Scenario 4: **Cattle Exports.**

Source: FAPRI-Ireland Model 2019

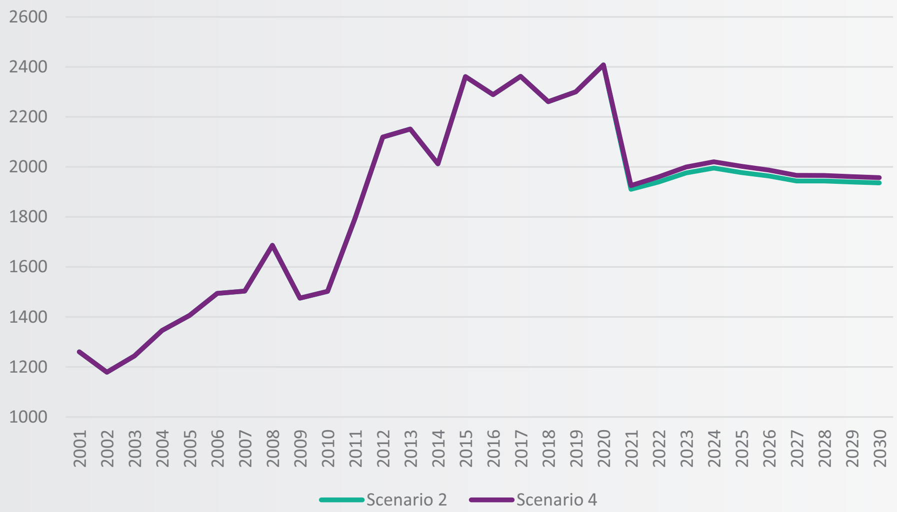

Figure 24. Baseline (Hard Brexit – Scenario 2) and No Live Cattle (NLE) Scenario 4: **Cattle Output Value.**

Source: FAPRI-Ireland Model 2019

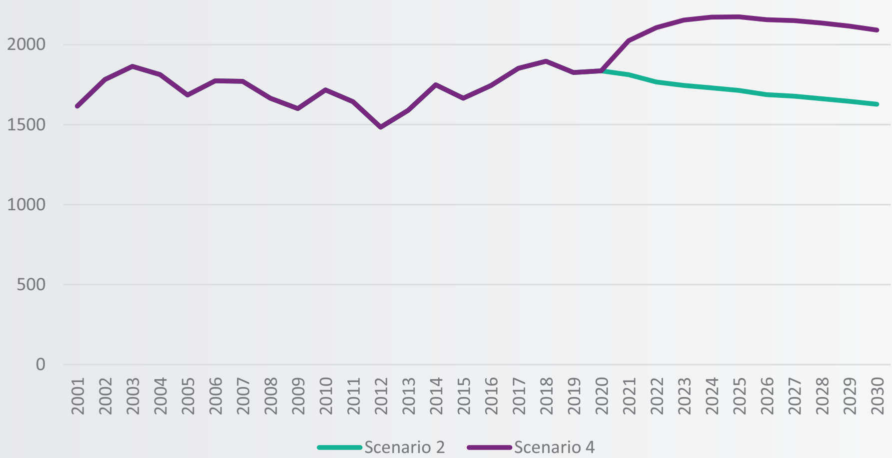

Figure 25. Baseline (Hard Brexit – Scenario 2) and No Live Cattle (NLE) Scenario 4: **Cattle Slaughter.**

Source: FAPRI-Ireland Model 2019

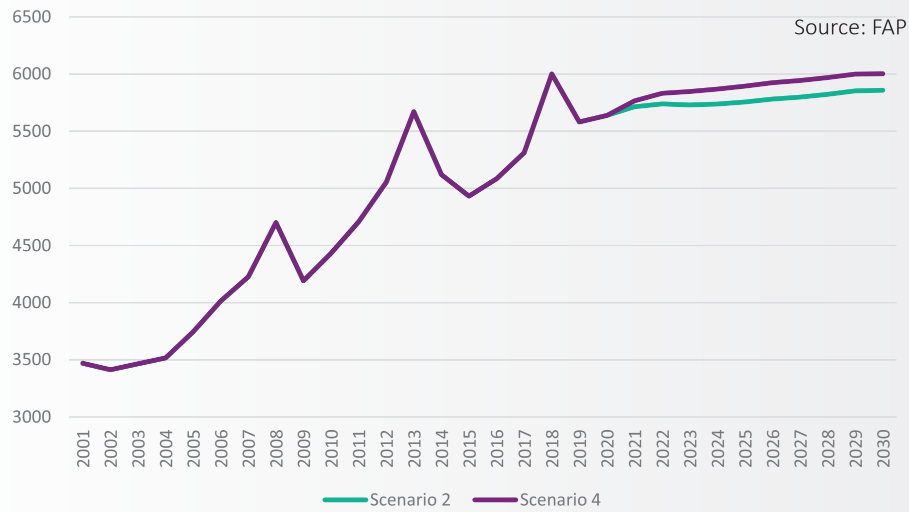

Figure 26. Baseline (Hard Brexit – Scenario 2) and No Live Cattle (NLE) Scenario 4: **Intermediate Consumption.**

Source: FAPRI-Ireland Model 2019

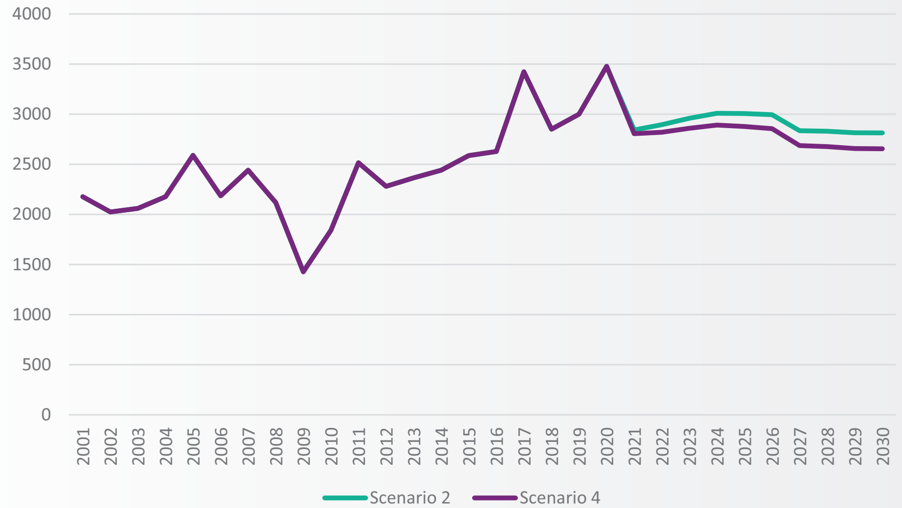

Figure 27. Baseline (Hard Brexit – Scenario 2) and No Live Cattle (NLE) Scenario 4: **Operating Surplus.**

Source: FAPRI-Ireland Model 2019

Overall the value of cattle output value under the NLE scenario (Scenario 4) is marginally higher than under the Reference simulation (Scenario 4). The Large increase in beef output as a result of the diversion of 475k cattle from the live export outlet to domestic beef production is sufficient to offset the loss of the value of live exports. However, the large increase in cattle inventories is reflected in an increase in the total volume of beef feed used, which increases by close to 20%. The impact of this increase in total volume of beef feed used on total agricultural sector expenditure on animal feed is diluted by the stable level of feed used by other agricultural sectors (poultry, pigs, sheep and dairy). Total input expenditure increases by 2% by 2030 under the NLE scenario (Scenario 4) as compared to the reference Hard Brexit Scenario (Scenario 2), by 2030 as a result of higher cattle inventories under the NLE total input expenditure by Irish agriculture is projected to be €144m higher than under the Hard Brexit reference scenario.

The marginally higher cattle output value under the NLE scenario partially offsets the higher costs of production associated with the retention in Ireland of cattle that would otherwise have been exported as live cattle. Overall Sector income (Operating surplus) is projected by 2030 to be €160 m lower than under the reference scenario. Because Agricultural sector income is lower under the Hard Brexit Reference scenario the percentage decline in agricultural sector income under the NLE is also larger than that simulated under the Soft Brexit Reference scenario. By 2030 under Scenario 4 (NLE) Agricultural sector income is projected to be 6%.

Table 4. FAPRI-Ireland Baseline (Hard Brexit **Scenario 2**) Beef Sector Projections.

		2018	2025	2030
Ending stocks of Cattle	000 head	6,593	6,419	6,130
Ending stocks of suckler cows	000 head	982	788	665
Ending stocks of Dairy cows	000 head	1,369	1,505	1,492
Cattle Slaughter	000 head	1,896	1,714	1,627
Live exports of cattle	000 head	247	488	475
Beef Production	000 t	623	536	512
Beef exports	000 t	572	458	429
Irish R3 Steer price	€/100 kg cwe	385	325	333
Cattle Output Value	m. euro	2,261	1,978	1,936

Source: FAPRI-Ireland Model 2019

Table 5. FAPRI-Ireland No Live Exports (NLE **Scenario 4**) Scenario Beef Sector Projections.

		2018	2025	2030
Ending stocks of Cattle	000 head	6,593	6,832	6,541
Ending stocks of suckler cows	000 head	982	784	658
Ending stocks of Dairy cows	000 head	1,369	1,505	1,492
Cattle Slaughter	000 head	1,896	2,173	2,091
Live exports of cattle	000 head	247	-	-
Beef Production	000 t	623	711	688
Beef exports	000 t	572	629	602
Irish R3 Steer price	€/100 kg cwe	385	318	325
Cattle Output Value	million euro	2,261	2,003	1,957

Source: FAPRI-Ireland Model 2019

Table 6. Baseline (Hard Brexit **Scenario 2**) and NLE **(Scenario 4)** 2030 Projections.

		Baseline 2030	NLE Scenario 2030	Absolute Difference	% Difference
Ending stock of Cattle	000 head	6,130	6,541	411	7%
Suckler Cows	000 head	665	658	-7	-1%
Dairy Cows	000 head	1,492	1,492	0	0%
Cattle Slaughter	000 head	1,627	2,091	464	29%
Live Exports	000 head	475	-0	-475	-100%
Beef Production	000 t	512	688	176	34%
Beef Exports	000 t	429	602	173	40%
Irish R3 Steer Price	€/100 kg cwe	333	325	-8	-2%
Cattle Output Value	m euro	1,936	1,957	21	1%
Intermediate Consumption	m euro	5,859	6,003	144	2%
Operating Surplus	m euro	2,814	2,655	-160	-6%

Source: FAPRI-Ireland Model 2019

Conclusions

The original analysis in Hanrahan and Donnellan found that under the NLE scenario that the loss of operating surplus that resulted from the introduction of a ban on the live export of cattle was circa €50m per annum or 2% of agricultural sector income (Operating Surplus). The discussion in Hanrahan and Donnellan stressed that this estimate of the costs of a ban on live cattle exports came with caveats and was contingent on the future level of live cattle exports amongst other factors. There has been a dramatic increase in the volume of cattle exported live from Ireland since 2015. The total volume (head) of cattle exported in 2019 is estimated to be almost 65% higher than that observed in 2015. This dramatically higher volume of live exports means that the impact of any disruption to live cattle trade is likely to have a larger economic impact, other things equal, than if the volume exported live was lower. The analysis presented here confirms this intuition.

Over the medium term the volume of live cattle exports is projected to grow from recently observed high levels due to ongoing growth in the Irish cattle breeding herd. The rate of growth in live cattle exports is higher under a hard Brexit scenario than under a reference scenario where EU-UK trade relations are close to the status quo ante. Under a hard Brexit the large decline in the level of Irish cattle prices compared to those in continental EU markets increases the attractiveness of live cattle imports from Ireland and leads to growth in this element of cattle output.

Under a soft Brexit policy setting the NLE scenario reduces agricultural sector income by €138 m per annum (4%) by 2030, while under a Hard Brexit policy setting the introduction of a ban on live cattle exports reduces the level of agricultural sector income by €160m (6%).

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