

Labour Productivity in the Dairy Sector

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'Examination of agri-food supply chain structures and
performance to enhance competitiveness'

Siyi Feng and Myles Patton

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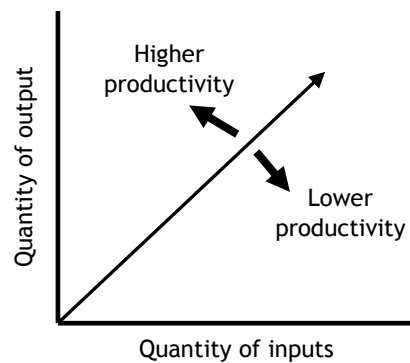
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1. Introduction

The dairy sector plays a central role in Northern Irish Agriculture, accounting for 26 per cent of the value of agricultural gross output in 2016. In addition, it accounts for approximately 50 per cent of total cows and therefore makes a significant contribution to the beef sector which accounted for a further 24 per cent of the value of gross output in 2016. However, the local dairy sector is faced with a number of important challenges that may affect its future performance. This includes increased exposure to world markets following successive CAP reforms which have diminished the role of market management tools and the gap between and world prices has been reduced. It is likely that the Northern Irish dairy sector will be exposed to greater international competition in the future as the UK seeks to negotiate Free Trade Deals across the globe in the post-Brexit era. More locally, countries such as Ireland, have benefited from the abolition of milk quotas in 2015, which previously acted to constrain milk production. Milk quotas were less of a constraining factor in Northern Ireland due to the more flexible system implemented in the UK (trading could occur across regions) and the fact that the national quota was not exceeded in the latter years of the quota system.

These market and policy developments will affect the future competitiveness of the Northern Irish dairy sector. As a result, it is important to benchmark the competitiveness of the local dairy sector in order to gain a better understanding of the performance of Northern Ireland compared to other regions/countries and identify trends overtime. A key indicator of competitiveness is productivity as this measures the efficiency by which farms or sectors transform inputs into outputs. Specifically, productivity is defined as the ratio of outputs to inputs. As shown in Figure 1, a more productive farm or country has a higher ratio of output to input compared to a less productive farm/country.

Figure 1: Comparison of productivity



In particular, this study focuses on labour productivity. With regards to dairy farms, this is measured using ‘*Output of milk per hour of labour input*’. This indicator is useful as it can be computed using the FADN database and thus comparisons can be made for different regions/countries across the EU. In addition, labour productivity is readily interpretable and can be decomposed into two sub-components, namely ‘*Milk yield*’ and ‘*Labour requirement per hour of labour input*’:

$$\begin{aligned} \text{Annual milk production/Labour input} &= \text{Milk yield} * \text{Dairy cow} / \text{Labour input} \\ &= \text{Milk yield} * (1 / (\text{Labour input} / \text{Dairy cow})) \end{aligned}$$

The milk yield component is mainly indicative of changes in biological innovations, e.g. due to genetics or changes in feed composition, while the labour requirement component mainly reflects technological innovations, such as the labour requirements of milking machines (Jansik *et al.*, 2014).

With regards to the processing sector, dairy labour productivity is measured in terms of gross turnover and value added. The productivity of the Northern Irish dairy processing sector is compared to the other food processing sector such as meat. By normalising gross turnover and value added to labour requirements it is possible to obtain a clearer picture to what extent changes in these indicators have occurred through more inputs or productivity.

It should be noted that an improvement in productivity does not necessarily translate into higher profits, at least in the short-run (Kimura and Sauer, 2015). In addition, some caution needs to be shown in interpreting changes in labour productivity as different labour productivities may be a result of differences in technology (e.g. high or low capital intensity) and may not necessarily reflect whether inputs are used in an efficient way (Jansik *et al.*, 2014).

2. Results

2.1 Labour Productivity in the Dairy Farm Sector

‘*Annual milk production per hour of labour*’ was computed for (i) geographical regions within the UK and (ii) EU Member States, using the FADN database for the period 2004 to 2015. In terms of the geographical regions, the UK is sub-divided into Northern Ireland, Scotland, Wales, England-North, England-East and England-West. With regards to the EU Member States, data were collected for all 28 members but some figures were incomplete for the entire period and as a result these Members are omitted from the analysis below¹.

UK Regions

‘*Annual milk production per hour of labour*’ during the period 2004 to 2015 in different regions across the UK is shown in Figure 1a; see also Table A1 in the appendix for detailed figures and percentage changes. Northern Ireland is bottom in ranking in terms of this indicator at the start of the period (2004), slightly below England-East. Although milk yield

¹ Romania, Bulgaria and Croatia are excluded due to data availability as they were not Member States for the entire period, while not all the data is available for small countries such as Cyprus and Malta.

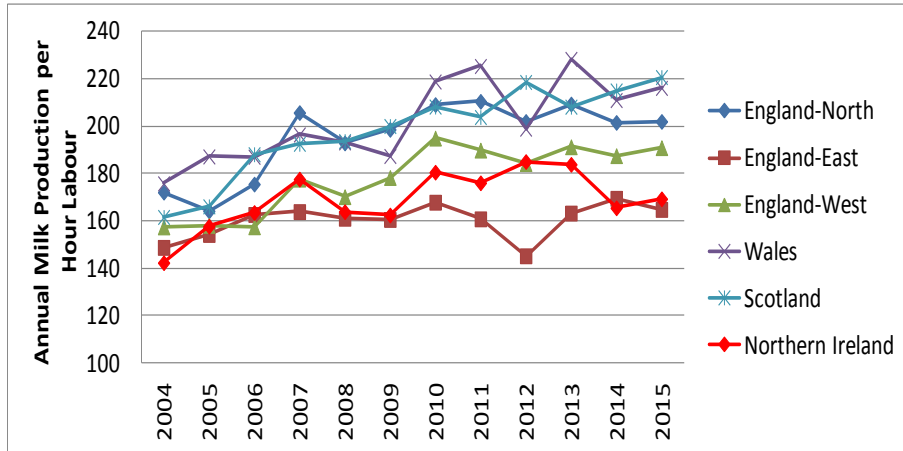
(Figure 1c) is significantly higher in England-East, this is largely offset by higher labour requirements per dairy cow (Figure 1d); i.e. dairy farming is more labour intensive in England-East. Labour productivity in Northern Ireland improves relative to England-East between 2010 and 2013, but deteriorates in 2014 and 2015, and only remains marginally above England-East at the end of the period (2015). The decline in Northern Irish labour productivity in 2014/15 reflects an increase in labour requirements.

Apart from 2014/15, labour requirements per dairy cow are relatively similar in Northern Ireland, England-North and England-West. However, in contrast to England-East, England-North is higher in terms of labour productivity throughout, and likewise for England-West from 2007 onwards, due to higher milk yields.

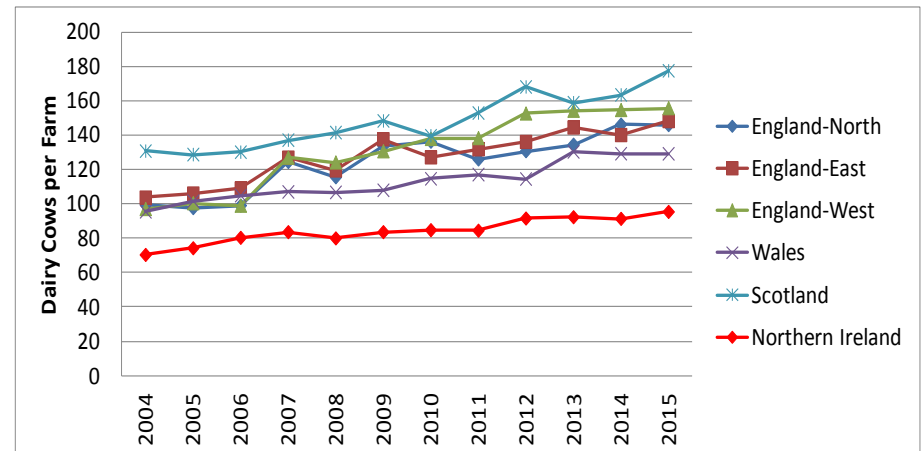
Wales is ranked highly in terms of labour productivity throughout, while Scotland shows a marked improvement, moving from 3rd in 2004 to 1st in 2015. Within both regions, labour requirements per dairy cow exhibit significant downward trends, particularly in Scotland.

Figure 1: Dairy Farm Labour Productivity in the UK and Associated Graphs

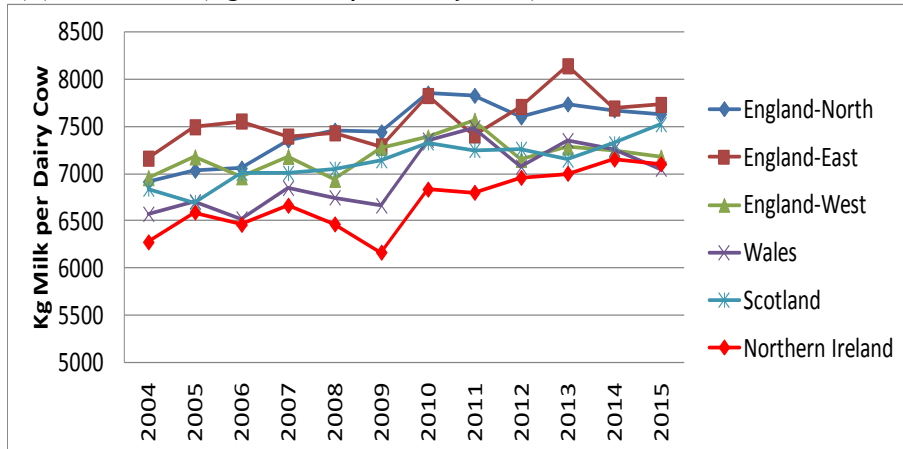
(a) Labour Productivity (Annual milk production (kg) per hour labour)



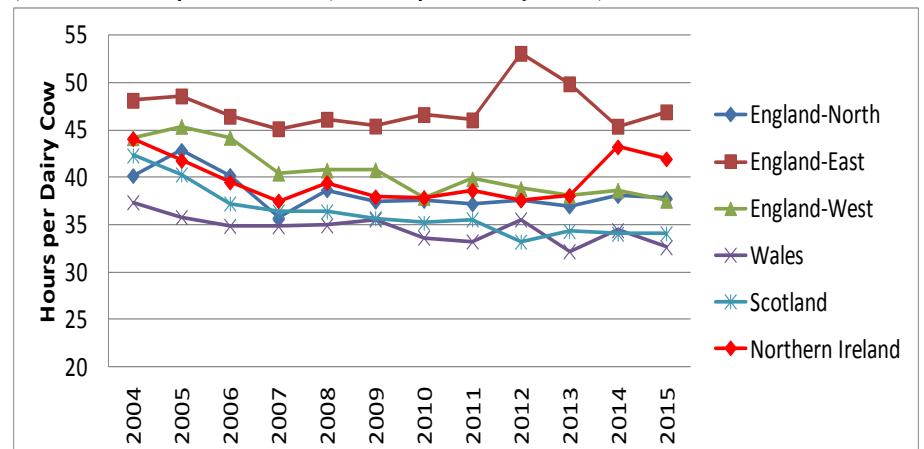
(b) Dairy Cows per Farm



(c) Milk Yield (Kg of milk per dairy cow)



(d) Labour Requirements (Hours per dairy cow)



The results generally suggest that the labour requirement component is more important in explaining improvements in labour productivity than milk yields. The three geographical regions that showed the greatest improvement in labour productivity in percentage terms between 2004 and 2015 (Scotland, Wales and England-West) exhibited the largest fall in labour requirements. Of these countries, Wales and England-West, experienced the smallest percentage increase in milk yields. In contrast, although Northern Ireland experienced the largest increase in milk yields in the latter years (2010 and 2015), labour productivity fell by the most in this region during this period due to an increase in labour requirements.

To further place labour productivity in context, the evolution of labour productivity relative to milk yield between 2004 and 2015 is shown in Figure 2. The direction of the line between 2004 and 2015 demonstrates the combined impact of changes in milk yield and labour productivity. Generally, the movement between the two reference points is north-easterly, reflecting large or small increases in both milk yield and labour productivity. In the extreme cases, if the line is vertical it indicates there no is change in milk yield and only labour productivity changes, while if the line is horizontal it indicates only milk yield has changed and there is no change in labour productivity. All the UK regions show a north-easterly direction between 2004 and 2015. However, compared to other regions, the direction of the line for Northern Ireland is closest to a horizontal line. This demonstrates that the Northern Irish dairy sector is performing well in terms of milk yield growth, but less so in terms of labour productivity. This issue is further demonstrated in Figure 3 in which the changes in labour productivity are normalised against the changes in milk yield. It is apparent that within most regions labour productivity grew faster than milk yield in percentage terms (elasticity greater than 1). England-West has the highest labour productivity growth relative to milk yield growth, followed by Scotland. Northern Ireland is ranked 3rd in 2010 but drops to last in 2015.

Figure 2: Change in Milk Yield and Labour Productivity in the UK (2004 to 2015)

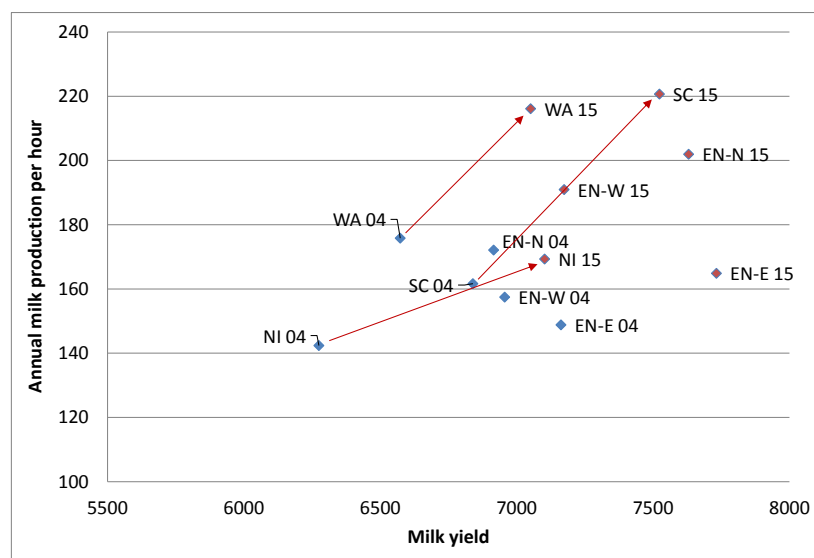
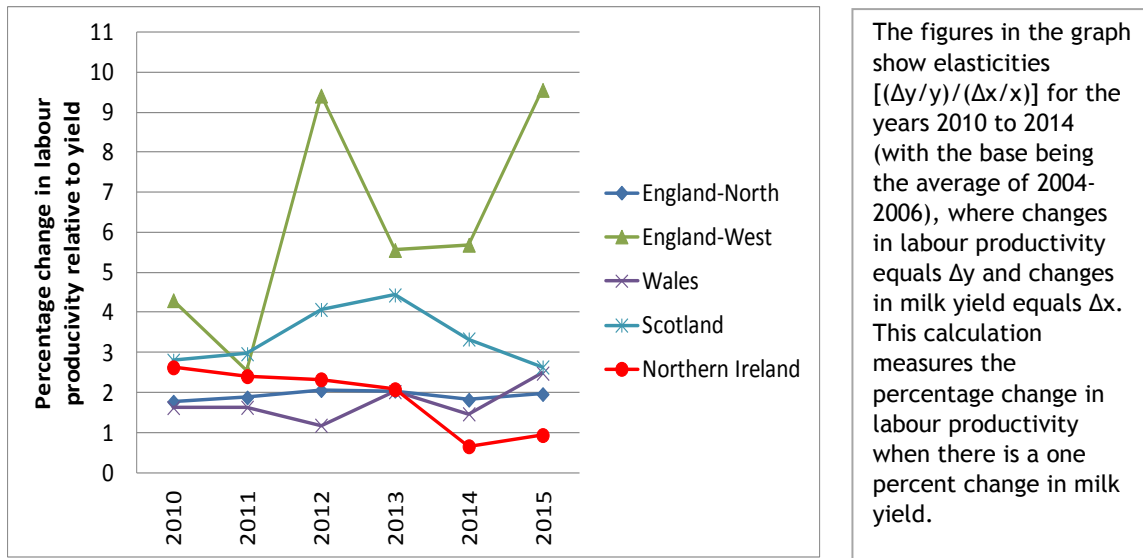


Figure 3: Changes in labour productivity normalised against the changes in milk yield for UK regions



Given the variability in the farming sector, it is not surprising that this elasticity fluctuates from year-to-year. However, Northern Ireland is the only region in which the elasticity decreases throughout the period 2010 to 2015; *i.e.* with the same percentage in milk yield growth, labour productivity grows slower and slower. Milk yield is one of the main indicators used to measure farm performance and there has traditionally been a focus by producers in attaining growth in this indicator, e.g. through genetic improvements (Jansik *et al.*, 2015). However, in order to remain competitive in the long-run care needs to be taken to ensure that growth in yield is not accompanied by deteriorating labour productivity.

In parallel with the general increase in labour productivity across different geographical regions in the UK there has been an expansion in farm size (Figure 1b). Farm size (measured in terms of dairy cows per farm) increased in each UK geographical region between 2004 and 2015 and the differentials in absolute terms have largely been maintained. This suggestive relationship between farm size and labour productivity is even more apparent at the Member State level and is expanded upon in the next section.

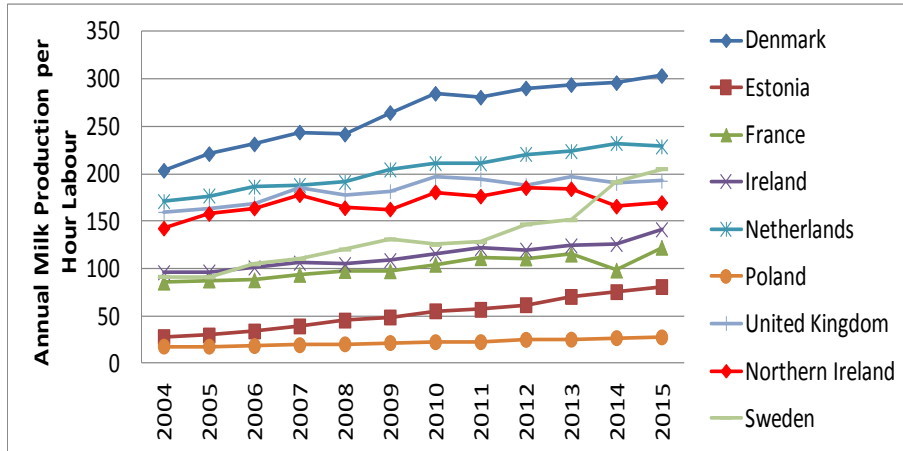
EU Member States

It is apparent from Figure 4a and Table A1 in the appendix that there is considerable variation in dairy labour productivity across the EU. At the end of the reference period (2015), one hour of labour produced 303 kg of milk in Denmark compared to 18kg in Lithuania. Northern Ireland lies in the middle of this range, with one of labour producing 169 kg of milk.

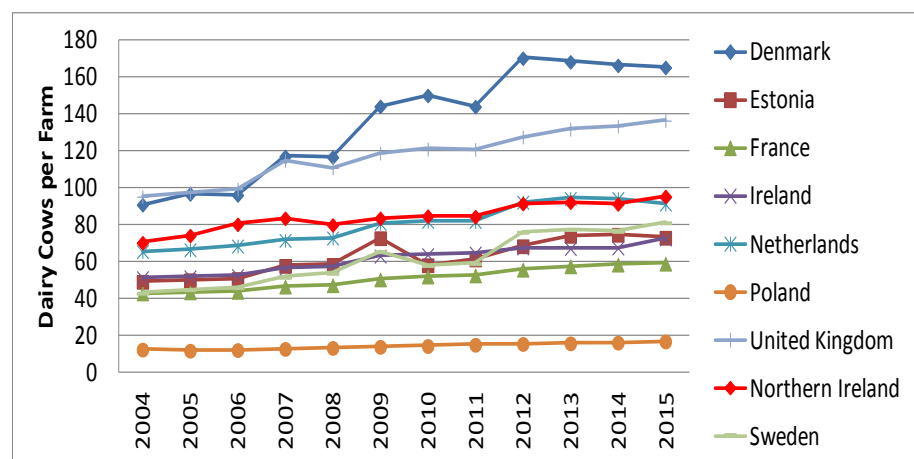
In general, productivity is markedly lower in eastern European countries that only entered the EU in 2003. Nevertheless, it is clear that some of these eastern European countries have progressed very quickly during the reference period, with Estonia in particular performing strongly, exhibiting an average annual labour productivity growth rate of 17.2 per cent. This compares to an annual average growth rate of 1.7 per cent in

Figure 4: Dairy Farm Labour Productivity in EU Member States and Associated Graphs

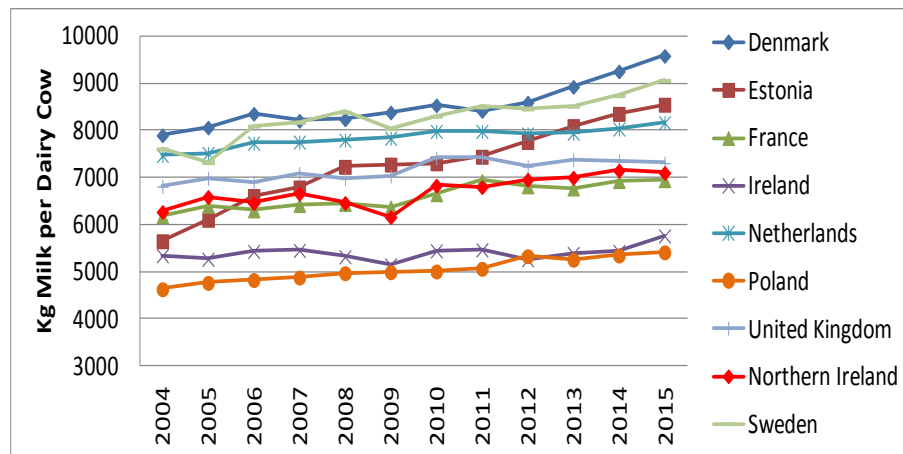
(a) Labour Productivity (Annual milk production (kg) per hour labour)



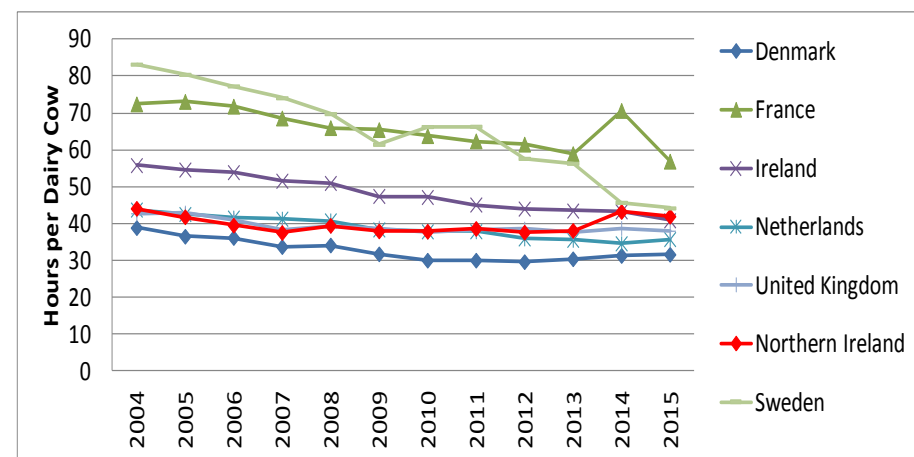
(b) Dairy Cows per Farm



(c) Milk Yield (Kg of milk per dairy cow)



(d) Labour Requirements (Hours per dairy cow)



NB: Estonia and Poland are excluded from graph (d) as values in 2004 significantly exceed other countries (>200 hours per dairy cow).

Northern Ireland. In fact, Northern Ireland displays the second lowest growth rate in labour productivity across the EU, including both old and new Member States².

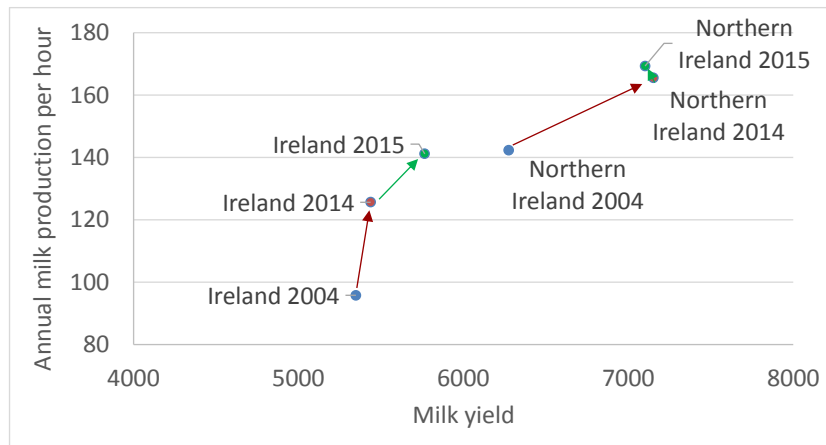
It is instructive to compare the various indicators underlying labour productivity, i.e. milk yield and labour requirements, and farm size. In 2015, Denmark has the largest farm size, highest milk yield and lowest labour input. This partly reflects the high level of investment in technology that has occurred in Denmark, which has reduced labour requirements. However, it needs to be borne in mind that Danish farms have high debt burdens and hence, there are question marks regarding the sustainability of this level of investment (Jansik *et al.*, 2015).

Northern Ireland lies in between Denmark and Sweden for most of the indicators, except for milk yield. Note, however, the labour requirement (hours) per dairy cow in Sweden has declined very rapidly, albeit the starting point is high. Similarly, the labour requirements were high at the beginning of the reference period for many of the new entrant Member States, but these have shown a sharp fall, e.g. an Estonian dairy cow required 106 hours in 2015 compared to 202 in 2004. Northern Ireland is close to the Netherlands in terms of both farm size and labour requirements (hours) per dairy cow. However, the Netherlands has higher milk yield, which translates into higher annual milk production per hour of labour input. The Irish farm size and milk yield indicators are lower compared to Northern Ireland. However, the labour requirement gap between Ireland and Northern Ireland has closed in recent years.

The evolution of labour productivity (annual milk production per hour of labour input) and milk yield between 2005, 2014 and 2015 for Northern Ireland and Ireland is shown in Figure 5. In Ireland, the direction of travel between 2004 and 2014 is almost vertical since milk production was restricted by the milk quota during this period. The milk quota system was abolished in 2015 and there was an associated increase in milk yields due to latent production potential. As a result, the direction of travel for Ireland between 2014 and 2015 is north easterly and it is anticipated that there will be further labour productivity improvements as milk yield is expected to increase further in the near future.

² While Malta displays a lower labour productivity growth rate, these figures appear unreliable as the labour requirement increases from 68 hours per dairy cow in 2004 to 1458 in 2015.

Figure 5: Changes in labour productivity normalised against the changes in milk yield for EU Member States



With regards to farm structure, the growth in labour productivity across the EU has generally occurred in tandem with increases in farm size; see indicator for dairy cows per farm (Figure 4b). This accords with expectations as changes in farm structure impact both milk yield and labour requirements (Jansik *et al.*, 2015). Larger farms tend to be more commercially oriented, with a greater focus on improving milk yields. In addition, as farm size increases, capital substitution drives down labour requirements.

2.2 Labour Productivity in the Dairy Processing Sector

Turning to the processing sectors, the gross turnover and value added in real terms (normalised to 2010) per direct full time equivalence are shown in Figures 6 and 7. The results for gross turnover indicate that the ‘Milk and Milk Products’ sector displayed strong growth during the reference period (53%, see Table 1). The growth was particularly strong between 2006 and 2014. Similarly, the ‘Eggs’, ‘Animal by-products’, ‘Pigmeat’ and ‘Poultry’ sectors showed strong growth using this indicator during the reference period. However, while these other sectors also increased significantly during the reference period in terms of value added per direct full time equivalence, the dairy sector displayed limited growth (12%). In fact, value added normalised to labour fell for the dairy sector between 2008 and 2014. This suggests that the growth in gross turnover for the dairy sector was due to global market prices rather than gains in the processing sector.

The ‘Beef and Sheepmeat’ sector also performed poorly in terms of value added normalised to labour, falling by 6 per cent between 2000 and 2015. Although non-normalised value-added in the ‘Beef and Sheepmeat’ sector increased significantly during this period, this was more than offset by an increase in labour requirements. In contrast, the number of employees in the ‘Milk and Milk Products’ sector declined during this period, which at least helped to offset the non-normalised fall observed in gross turnover for the milk sector.

Figure 6: Gross turnover in real terms (normalised to 2010) per direct full time employee equivalence by sub-sector

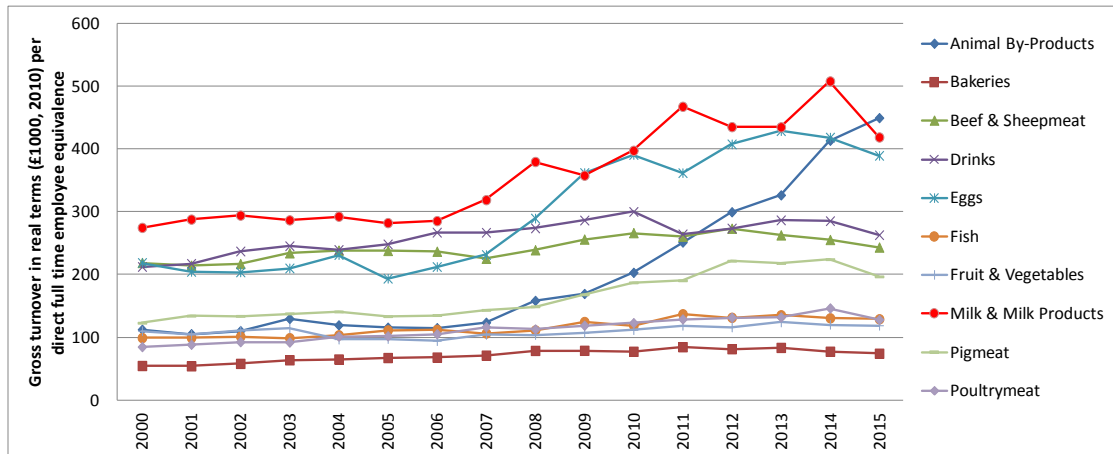


Figure 7: Value added in real terms (normalised to 2010) per direct full time employee equivalence by sub-sector

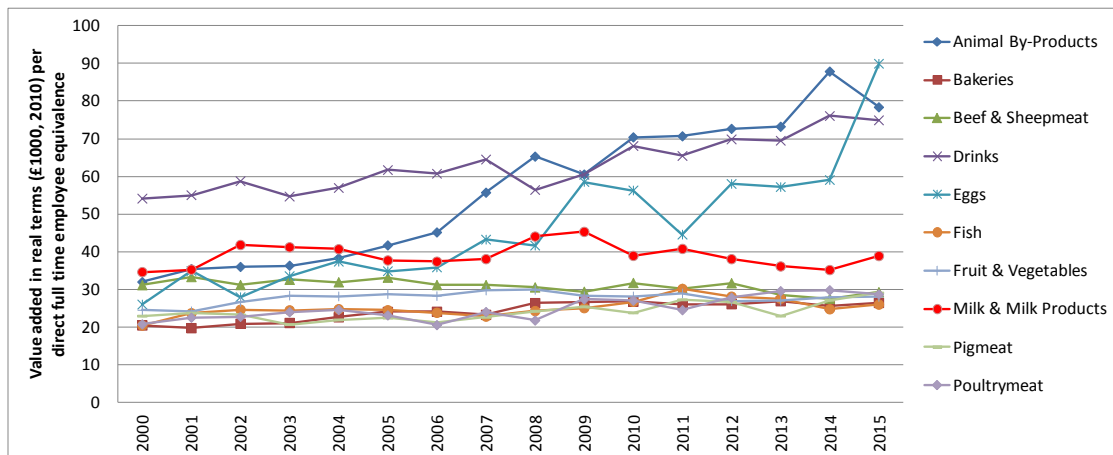


Table 1: Comparison of gross turnover and value added per direct full time employee; Percentage change between 2000 and 2015

	Gross turnover in real terms per direct full time employee	Value added in real terms per direct full time employee equivalence
Animal By-Products	301%	145%
Bakeries	36%	29%
Beef & Sheepmeat	11%	-6%
Drinks	24%	39%
Eggs	78%	246%
Fish	30%	27%
Fruit & Vegetables	8%	14%
Milk & Milk Products	53%	12%
Pigmeat	60%	27%
Poultrymeat	51%	38%

3. Conclusions

The results in this briefing report highlight that there has been limited improvements in labour productivity in both the dairy farming and processing sectors in Northern Ireland in recent years. With regards to the farming sector, the small improvements in this indicator have generally been due to higher milk yields. In contrast, the gains due to declining labour requirements have been small (less than 0.5% per annum). This contrasts with considerably larger falls elsewhere within the EU. Similarly, based on the value added indicator it is evident that the dairy processing sector in Northern Ireland has performed weakly compared to other sectors. Overall, the results imply that the dairy sector in Northern Ireland is operating at the extensive rather than the intensive margin; *i.e.* more output is generated through more labour input, rather than gains in productivity.

Appendix

Table A1: Labour Productivity (Annual milk production (kg) per hour labour)

	Level			Annual growth		
	2004	2010	2015	2004 to 2010	2010 to 2015	2004 to 2015
EU Member States						
Belgium	99	126	160	4.5%	5.4%	5.5%
Czech Republic	26	32	38	4.1%	3.8%	4.4%
Denmark	203	284	303	6.6%	1.3%	4.5%
Germany	90	111	133	4.0%	3.9%	4.4%
Spain	67	93	120	6.6%	5.8%	7.3%
Estonia	28	55	81	16.2%	9.3%	17.2%
France	85	104	122	3.7%	3.4%	3.9%
Hungary	36	44	49	3.7%	2.2%	3.3%
Ireland	96	116	141	3.4%	4.4%	4.3%
Italy	76	81	119	1.1%	9.5%	5.2%
Lithuania	14	19	18	6.4%	-1.2%	2.8%
Luxembourg	92	124	159	5.8%	5.8%	6.7%
Latvia	15	22	27	9.1%	4.3%	7.9%
Malta	73	82	4	2.2%	-18.9%	-8.5%
Netherlands	171	211	229	3.9%	1.7%	3.1%
Austria	28	34	37	3.8%	1.5%	2.9%
Poland	18	23	28	4.3%	4.5%	4.9%
Portugal	45	60	78	5.3%	6.2%	6.6%
Finland	46	70	84	8.8%	3.8%	7.4%
Sweden	92	125	205	6.2%	12.7%	11.3%
Slovakia	13	23	26	12.2%	2.6%	8.7%
Slovenia	17	24	26	6.7%	1.8%	4.8%
United Kingdom	159	196	192	3.8%	-0.4%	1.9%
UK Regions						
England-North	172	209	202	3.6%	-0.7%	1.6%
England-East	149	168	165	2.1%	-0.4%	1.0%
England-West	157	195	191	4.0%	-0.4%	1.9%
Wales	176	219	216	4.1%	-0.2%	2.1%
Scotland	162	208	221	4.8%	1.2%	3.3%
Northern Ireland	142	181	169	4.5%	-1.2%	1.7%

Table A2: Dairy Cows per Farm

	Level			Annual growth		
	2004	2010	2015	2004 to 2010	2010 to 2015	2004 to 2015
EU Member States						
Belgium	48	59	70	3.5%	3.9%	4.0%
Czech Republic	79	92	117	2.9%	5.3%	4.4%
Denmark	91	150	165	10.9%	2.0%	7.4%
Germany	44	53	63	3.7%	3.5%	4.0%
Spain	29	43	53	7.7%	4.4%	7.1%
Estonia	49	58	73	3.0%	5.1%	4.4%
France	43	52	59	3.6%	2.7%	3.4%
Hungary	30	41	44	5.7%	1.3%	3.9%
Ireland	51	64	72	4.0%	2.7%	3.7%
Italy	45	46	52	0.4%	2.6%	1.5%
Lithuania	8	12	10	6.5%	-3.0%	1.6%
Luxembourg	42	53	68	4.7%	5.5%	5.7%
Latvia	13	15	16	2.9%	1.7%	2.5%
Malta	63	61	57	-0.6%	-1.3%	-0.9%
Netherlands	65	82	91	4.2%	2.3%	3.6%
Austria	14	16	18	2.2%	2.5%	2.5%
Poland	12	14	17	2.6%	3.4%	3.2%
Portugal	23	27	32	3.1%	3.6%	3.6%
Finland	21	30	34	7.0%	2.7%	5.6%
Sweden	43	58	81	5.8%	8.0%	8.1%
Slovakia	167	184	190	1.7%	0.7%	1.3%
Slovenia	13	17	16	5.6%	-1.5%	2.1%
United Kingdom	95	121	136	4.5%	2.5%	3.9%
UK Regions						
England-North	99	136	146	6.1%	1.4%	4.2%
England-East	104	127	148	3.8%	3.3%	3.9%
England-West	97	138	156	7.0%	2.6%	5.5%
Wales	95	115	129	3.4%	2.5%	3.2%
Scotland	131	140	177	1.1%	5.4%	3.3%
Northern Ireland	70	85	95	3.4%	2.5%	3.2%

Table A3: Milk Yield (Kg of milk per dairy cow)

	Level			Annual growth		
	2004	2010	2015	2004 to 2010	2010 to 2015	2004 to 2015
EU Member States						
Belgium	5,910	6,880	7,368	2.7%	1.4%	2.2%
Czech Republic	5,701	6,285	7,157	1.7%	2.8%	2.3%
Denmark	7,899	8,537	9,585	1.3%	2.5%	1.9%
Germany	6,674	7,423	7,590	1.9%	0.4%	1.2%
Spain	5,814	6,730	7,436	2.6%	2.1%	2.5%
Estonia	5,653	7,307	8,549	4.9%	3.4%	4.7%
France	6,183	6,651	6,949	1.3%	0.9%	1.1%
Hungary	5,941	6,685	6,819	2.1%	0.4%	1.3%
Ireland	5,348	5,450	5,766	0.3%	1.2%	0.7%
Italy	6,267	6,072	7,606	-0.5%	5.1%	1.9%
Lithuania	4,476	5,271	5,342	3.0%	0.3%	1.8%
Luxembourg	6,681	7,225	7,532	1.4%	0.8%	1.2%
Latvia	4,527	5,438	5,913	3.4%	1.7%	2.8%
Malta	4,920	6,157	6,543	4.2%	1.3%	3.0%
Netherlands	7,473	7,984	8,169	1.1%	0.5%	0.8%
Austria	6,059	6,284	6,612	0.6%	1.0%	0.8%
Poland	4,635	5,012	5,417	1.4%	1.6%	1.5%
Portugal	6,173	6,980	7,573	2.2%	1.7%	2.1%
Finland	8,165	8,590	8,863	0.9%	0.6%	0.8%
Sweden	7,611	8,306	9,064	1.5%	1.8%	1.7%
Slovakia	4,829	5,573	6,202	2.6%	2.3%	2.6%
Slovenia	5,122	5,309	5,158	0.6%	-0.6%	0.1%
United Kingdom	6,812	7,416	7,311	1.5%	-0.3%	0.7%
UK Regions						
England-North	6,916	7,853	7,631	2.3%	-0.6%	0.9%
England-East	7,162	7,827	7,732	1.5%	-0.2%	0.7%
England-West	6,956	7,386	7,174	1.0%	-0.6%	0.3%
Wales	6,573	7,358	7,052	2.0%	-0.8%	0.7%
Scotland	6,840	7,330	7,523	1.2%	0.5%	0.9%
Northern Ireland	6,275	6,834	7,102	1.5%	0.8%	1.2%

Table A4: Labour Requirements (Hours per dairy cow)

	Level			Annual growth		
	2004	2010	2015	2004 to 2010	2010 to 2015	2004 to 2015
EU Member States						
Belgium	59	55	46	-1.4%	-3.1%	-2.1%
Czech Republic	222	196	188	-1.9%	-0.8%	-1.4%
Denmark	39	30	32	-3.8%	1.1%	-1.7%
Germany	74	67	57	-1.7%	-2.9%	-2.1%
Spain	87	72	62	-2.9%	-2.8%	-2.6%
Estonia	202	132	106	-5.7%	-4.0%	-4.3%
France	72	64	57	-2.0%	-2.2%	-2.0%
Hungary	165	152	139	-1.3%	-1.6%	-1.4%
Ireland	56	47	41	-2.6%	-2.7%	-2.4%
Italy	83	75	64	-1.5%	-3.0%	-2.1%
Lithuania	324	275	296	-2.5%	1.5%	-0.8%
Luxembourg	73	59	47	-3.3%	-3.8%	-3.2%
Latvia	311	242	217	-3.7%	-2.1%	-2.8%
Malta	68	75	1488	1.8%	377.6%	190.8%
Netherlands	44	38	36	-2.2%	-1.1%	-1.7%
Austria	217	184	179	-2.6%	-0.5%	-1.6%
Poland	258	222	196	-2.4%	-2.3%	-2.2%
Portugal	136	117	97	-2.4%	-3.4%	-2.6%
Finland	177	122	106	-5.2%	-2.7%	-3.7%
Sweden	83	66	44	-3.4%	-6.7%	-4.3%
Slovakia	365	243	240	-5.6%	-0.3%	-3.1%
Slovenia	300	222	197	-4.3%	-2.2%	-3.1%
United Kingdom	43	38	38	-1.9%	0.1%	-1.0%
UK Regions						
England-North	40	38	38	-1.1%	0.1%	-0.5%
England-East	48	47	47	-0.5%	0.1%	-0.2%
England-West	44	38	38	-2.4%	-0.2%	-1.4%
Wales	37	34	33	-1.7%	-0.6%	-1.2%
Scotland	42	35	34	-2.8%	-0.6%	-1.8%
Northern Ireland	44	38	42	-2.4%	2.2%	-0.4%