Irish Journal of Agricultural and Food Research **53:** 149–169, 2014

The employment effects of Food Harvest 2020 in Ireland

Ana Corina Miller[1,3†], Alan Matthews[2,3], Trevor Donnellan[4] and Cathal O'Donoghue[4]
[1]*Agri-Food and Bioscience Institute, Belfast, Northern Ireland*
[2]*Department of Economics, Trinity College Dublin, Ireland*
[3]*Institute for International Integration Studies, Trinity College Dublin, Ireland*
[4]*Rural Economy Development Programme, Teagasc, Athenry, Co. Galway, Ireland*

This paper examines the job creation potential of the four main sectoral growth targets in the Food Harvest 2020 (FH2020) development plan for Irish agriculture, namely the growth targets for milk, beef, sheep and pigs. As well as the direct employment that would be created from an increase in activity in the agriculture sector, there would be a knock-on benefit for the rest of the economy arising out of the linkages between agriculture and other economic sectors, as well as the spending of those additionally employed on goods and services produced in the economy. Commonly this is described as the multiplier impact. Two scenarios are simulated using different assumptions to assess how employment will respond to increased output. The first scenario shows the effects of the four shocks calculated using average or direct employment coefficients. The second scenario calculates the effects using marginal employment coefficients estimated using an econometric model of the output-employment relationship. Our results are sensitive to the choice of coefficients used to simulate the employment potential of the FH2020 targets. Based on our preferred scenario using marginal employment coefficients, we estimate that achieving the FH2020 targets will create at least an additional 16,500 jobs in the Irish economy.

Keywords: agriculture; employment elasticity; Ireland; social accounting matrix analysis

†Corresponding author: Ana Corina Miller;
E-mail: Corina.Miller@afbini.gov.uk

Introduction

The current economic crisis has had a greater negative impact on the Irish economy compared to many other European Union (EU) Member States. Between 2007 and 2010, Gross National Product (GNP) per head fell by 14.7% while there was a similar fall in Gross National Income (GNI) per head. This brought GNP and GNI per head back to their 2000 levels. Prior to the economic crisis, Ireland's unemployment rate was around 4% while in August 2013 it was over 13% (CSO 2013) with a peak of 14% reached in 2011 (NESC 2011). Government policy recognises that Ireland's economic recovery must be export-led, and recent export performance in goods and services has been encouraging particularly in pharmaceuticals, medical equipment, food, computer services and business services. Nonetheless, growth in exports does not necessarily translate, at least in the short run, into growth in jobs, in part because many of the export sectors have relatively low linkages with the rest of the economy. The agri-food sector is an exception in that previous research indicates it has both high forward and backward linkages with other sectors in the economy (Riordan 2008).

The Irish Government has set ambitious targets for growth in this sector in its Food Harvest 2020 (FH2020) report (DAFF 2010b). These include: (i) an increase in the value of primary output in the agriculture, fisheries and forestry sector of 33% compared to the 2007–2009 average; (ii) an increase in the output of the agri-food, fisheries and wood products processing sector of 40% compared to 2008; (iii) and an increase in exports of 42% compared to the 2007–2009 average (DAFF 2010b). The FH2020 objective is to achieve these growth targets by 2020.

This paper investigates the economic effects of the FH2020 targets for growth in the Irish agriculture sector relative to the size of the sector in the period 2007–2009. The agri-food sector is predominantly rural-based and growth in this sector is particularly important for the rural economy, but it is also important for the economy more widely given the recessionary effects elsewhere in the economy. However, the extent to which achieving these targets would contribute to additional employment is an empirical question which requires further analysis. We undertake this analysis using a model which is representative of the economy in 2005, since this is the most recent date for which all the required data are available.

The calculation of input-output multipliers to capture the direct and indirect effects of changes in final demand began in Ireland with the early work of Copeland and Henry (1975). Multiplier analysis has been widely applied to assess the economic importance of particular industries in Ireland (Norton 1982; O'Hagan and Mooney 1983; Fáilte Ireland National Tourism Development Authority 2008; Clancy and Scheer 2012; Morrissey and O'Donoghue 2013, among others). Indeed, the widespread use of multipliers to expand our understanding of the economic importance of a sector in consultancy studies and by lobby groups seeking to stress the importance of their industry to the economy and to justify receiving special incentives, has brought multiplier analysis into a state of disrepute. During the brief period of full employment in the Irish economy in the mid-2000s the assumption of unemployed resources necessary to justify the use of multiplier estimates to influence investment allocation clearly did not apply. The criticism attached to multiplier analysis is only partially justified, however. Multiplier estimates properly interpreted can give important insights into the structure of

the economy and the 'embeddedness' of different sectors. It is also a useful tool in helping to trace the total impacts of changes in the structure of the economy. For example, O'Doherty and Tol (2007) developed an environmental input-output model to estimate the short-run response of emissions and resource use to changes in consumption and production patterns in Ireland.

The relationship between economic growth and employment, or the employment intensity of growth, has been the focus of many researchers over time [for a small selection, see Islam and Nazara 2000; Kapsos 2005; Wang (2010)]. Other researchers have investigated the employment effects of changes in trade flows, using input-output models to capture not only the direct employment effects of changes in exports and imports, but also their indirect and induced effects (Wood 1994). Research (Driver, Kilpatrick and Naisbitt 1985; 1988) has found that using direct employment coefficients (defined as the average employment intensity of a unit of output) together with an input-output model overestimates the employment effects of changes in final demand compared with marginal employment coefficients (defined as the employment intensity of an incremental unit of output).

In this paper both average and marginal employment coefficients are estimated and used with a social accounting matrix multiplier analysis to simulate the impact of meeting the FH2020 agriculture targets on employment in the Irish economy. This analysis focuses on the four main agricultural sector output growth targets in FH2020, namely the growth targets for milk, beef, sheep and pigs. Two sets of results are presented: a higher-end estimate of 40,591 jobs and a lower-end estimate of 16,385 jobs could be created if the FH2020 targets are met. This range of estimates is a function of using both average and marginal employment coefficients, respectively, to assess the employment consequences of growth in line with the FH2020 targets. The employment potential identified from the analysis with marginal employment coefficients, of around 16,500 jobs, should be seen as the plausible outcome if the FH2020 targets are met. We argue that the employment growth estimates based on marginal employment coefficients provide a better estimate of the likely outcome than those based on average employment coefficients.

The rest of the paper is organised as follows. The methodology, data and shocks implemented in the model are presented in section 2, the scenarios and results are discussed in section 3 and section 4 concludes.

Methodology, Data and Shocks

This paper uses a 2005 social accounting matrix (SAM) for Ireland with a particular focus on the agri-food sector and a multiplier analysis to assess the impact of the FH2020 targets on the wider economy. The AgriFood-SAM (Miller *et al.* 2011) has 12 primary agricultural sectors and 10 food processing sectors, plus another 53 manufacturing and services sectors. The SAM can be manipulated to examine the impact of an expansion of a particular sector on the wider economy and it then becomes a model capable of examining the impact of an initiative such as FH2020. Using the disaggregated AgriFood-SAM and a multiplier analysis, employment changes are simulated as a result of the achievement of the FH2020 targets.

The advantage of using a SAM is that it not only captures the initial output effects of achieving the FH2020 targets but also the total effects of those changes. The

total effects are defined as the direct, indirect and induced effects of the increase in agricultural output found from a model (the AgriFood-SAM) that is closed with respect to households (Miller *et al*. 2011). The indirect effects capture the additional domestic output needed to provide the inputs to support the increase in primary agricultural output. The induced effects account for the impact of household spending due to increased household income. Concentrating on just the direct effects of meeting the FH2020 targets alone would substantially underestimate the likely employment impacts of increasing agricultural output.

Shocks

The FH2020 targets examined are a mixture of sectoral value growth targets (beef, sheep and pigs) and a specific sectoral volume growth target (for milk) to be achieved by 2020 compared with the average level of 2007 to 2009 production. The four main targets set in the FH2020 are as follows: (i) 50% increase in the volume of milk production; (ii) 20% increase in cattle output value; (iii) 20% increase in sheep/lamb output value; and (iv) 50% increase in pig output value.

In order to implement those shocks in the SAM multiplier model the results from the Food and Agricultural Policy Research Institute (FAPRI)-Ireland 2012 partial equilibrium model (Donnellan and Hanrahan 2012) are used to simulate the sectoral activity level associated with the achievement of the targets in FH2020 (details of this model are provided in Binfield *et al.* 2003, 2007, 2009). This simulation interprets the value and volume targets set out in FH2020 so that volume shocks for four of the main agricultural sectors can be defined for this paper. The FAPRI FH2020 simulation assumes that the main targets in FH2020 are met.

Table 1 provides the shocks implemented in the model. The FH2020 shocks target the output levels of the primary agricultural commodities. In a SAM multiplier model the exogenous (shock) variable is final demand, hence the FH2020 shocks are translated into the changes in final demand in the relevant processing sectors consistent with the targeted output increases in primary agriculture (i.e., the change in cattle output is modelled as a change in the final demand for beef products). We assume that all of the additional primary production is processed and not exported in raw or live form, which is a reasonable assumption in current Irish circumstances. To obtain a 50% increase in milk output (€800 million) requires a final demand shock of €1,369 million transmitted through an increase in dairy processing output; a €250 million increase in cattle output requires a final demand increase of €442 million in beef processing; a €16 million decrease in sheep output requires a final demand decrease of €39 million in sheep processing; and a €90

Table 1. The volume shocks implemented in the model to proxy the impact of achievement of the Food Harvest 2020 targets

Sector	Volume shock 2020 relative to 2007–2009 (%)	Value shock (euro millions)	Final demand shock (euro millions)
Milk output	+50	+800	+1,369
Cattle output	+9	+250	+442
Sheep output	–7	–16	–39
Pig output	+30	+90	+374

Source: Authors' calculation.

million increase in pigs output requires a final demand increase of €374 million in pig processing.

The assumed fall in the volume of sheep production requires some further comment. There has been a significant increase in the price of sheep meat in recent years, and the FAPRI-Ireland projections of sheep prices in 2020 are considerably higher than the 2007–2009 base year level. This means that the FH2020 value expansion target of 20% for sheep can be achieved with a sheep volume in 2020 that is lower than that which existed in 2007–2009. Hence, the shock implemented in the model, which is consistent with the achievement of the FH2020 growth target for sheep, represents a contraction relative to the volume of production in 2007–2009. This assumption is not meant to be a projection of future sheep output, but is made to ensure that our volume changes are consistent with the output value targets in FH2020.

Average employment coefficients

In order to calculate the changes in employment in the agricultural and food sectors resulting from the FH2020 shocks applied, the initial employment figures for those sectors are calculated. The base year for the AgriFood-SAM for Ireland is 2005. We use the latest output and employment figures for 2008 where possible to simulate the impact of the FH2020 targets on employment, or otherwise the figures for 2005. The annual detailed enterprise statistics 1995–2008 dataset provided by Eurostat (2009) is used to obtain the number of employees and output in the food processing sectors for 2008 alongside the Census of Industrial Production (CSO 2011a). For the agricultural sectors the Annual Review and Outlook for Agriculture, Fisheries and Food (DAFF 2010a) and the Management Data for Farm Planning (Teagasc 2005) are used to allocate the 2008 employment numbers for agriculture between the 12 agricultural sectors. The Output, Input and Income in Agriculture (CSO 2010) is the source for the output for the 12 agricultural sectors for 2008. A detailed presentation of the method is provided in Miller *et al.* 2011).

The average, or direct, employment coefficients are calculated as the ratio of employment to output for each individual sector in the AgriFood-SAM. Table 2 contains the average employment coefficients, employment numbers and the output for the 22 agricultural and food sectors for 2008. For the remaining 53 sectors, the most recent employment and output data refer to 2005. The output and employment numbers for the 53 non-agrifood sectors are taken from the 2005 Input-Output Tables (CSO 2009) and from the Census of Industrial Production (CSO 2011a), respectively. Table A1 in the Appendix provides the average employment coefficients for all sectors in the economy for 2005, plus the 22 agriculture and food sectors for 2008.

Marginal employment coefficients

Typically, multipliers are a measure of the average knock-on (multiplier) impact of the expansion or contraction of a sector. In general, multipliers tend to be more valid for modelling the impact of small increases in production and become less reliable as the scale of the change in the economic activity being modelled becomes larger. This is because the assumption behind the multiplier analysis of unemployed resources becomes more tenuous the more a sector expands. More of the needed new inputs have to be imported into the economy and/or outputs from other sectors must be shifted from exports and kept in the economy for use as inputs,

Table 2. Average (direct) employment coefficients in the agri-food sectors in 2008

NACE code	Sectors	Employment numbers	Total output million euro	Workers per million euro of domestic output
1	Milk	30,740	1,956	15.72
	Cattle	68,337	3,282	20.82
	Sheep	4,710	208	22.69
	Pig	1,178	344	3.42
	Poultry	1,073	193	5.57
	Horses	1,556	212	7.34
	Cereals	4,888	273	17.94
	Fruit and vegetable	306	280	1.09
	Sugar	0	0	0.00
	Potatoes	684	75	9.08
	Other crops	244	71	3.46
	Fodder crops	1,082	979	1.11
	Total	114,800	7,872	
15	Beef meat	7,762	2,456	3.16
	Pig meat	3,326	1,038	3.21
	Poultry meat	1,802	582	3.09
	Sheep meat	970	300	3.24
	Fish and other fishing products	1,793	360	4.98
	Fruit and vegetable	1,658	245	6.78
	Dairy products	4,995	3,288	1.52
	Animal feed	1,770	982	1.80
	Other food products	11,286	8,984	1.26
	Beverages	5,130	3,023	1.70
	Total	40,492	21,258	

Source: Authors' calculations based on the Eurostat annual detailed enterprise statistics 1995–2008 dataset (2009), Census of Industrial Production 1994–2008 dataset (CSO 2011a), Teagasc NFS (2010) and Annual Review and Outlook for Agriculture, Fisheries and FoodDAFF (2010a).
Note: 2008 is the most recent year for which data are available on both employment numbers and output for all 12 primary agricultural and 10 food processing sectors. The AgriFood-SAM used in this model is based on 2005 data when there was still sugar production in Ireland. Sugar production ceased in Ireland as a result of the reform of the EU Common Market Organisation for sugar in 2005. The presence of a sugar sector in the model does not significantly influence the results as sugar has little input into any of the four sectors shocked in the model.

thus dampening the multiplier effect (Miller and Blair 2009, p. 246).

Related to this issue is that multiplier analysis usually assumes fixed proportion production functions. In other words, if milk output grows by 50% then the level of input usage is also assumed to grow by 50%. Similarly, output, employment and income are assumed to increase in the same proportions. The reality is likely to be different, for a number of reasons. For example, the growth in Irish milk production is envisaged to involve production efficiencies which mean that each unit of milk requires fewer purchased inputs and less labour on the farm (a larger number of cows is managed per farm worker). There are also likely to be economies of scale at processing level. At the margin, sectoral employment would be expected to increase at a lower rate than the increase in output, given that a portion of the employment in the sector is not directly tied to production levels, e.g., supervisory and managerial roles. Increased output may be associated with

new capital investment which will often be more productive (i.e., less labour-intensive) than the capital currently in use because it embodies technical change. Under employment, where the labour currently allocated to production at farm level is less than is required for the actual level of production, must also be considered since it is a feature of some parts of Irish agriculture. For all these reasons, if expansion in the output of a sector takes place it is unlikely to lead to a corresponding increase in the numbers employed. It is more likely to result in an increase in output per worker, in violation of the fixed proportions assumption implicit in the use of average employment coefficients. The marginal employment impact of the expansion of a sector will thus tend to be smaller than the average, so using the average (direct) employment coefficients will overstate the knock-on employment impact in this context.

Employment elasticities are a useful measure with which to capture the marginal relationship between output and employment growth (Islam and Nazara 2000; Kapsos 2005). We estimate employment elasticities for most of the sectors in the AgriFood-SAM using a fixed effects model with an unbalanced panel. In some cases, the output and employment data are only available for more aggregated sectors than those in the AgriFood-SAM (e.g., NACE 02 and 03, NACE 10 to 14, NACE 60 to 64). For these sectors, the group elasticities are assumed also to apply to the individual sectors within each group. In the case of the sectors NACE 23 and 36, 37, 41, 65, 66, 67, 75, 80, 85, 90, 91 and 95 no data are available, hence, marginal elasticities cannot be estimated. For these sectors, we assume zero marginal employment coefficients in the simulations in the second scenario, taking a deliberately conservative view of the employment impacts using this approach.

The data used come from the Census of Industrial Production 1994–2008 (CSO 2011a), the Economic Accounts for Agriculture 1994–2008 (CSO 2011b) and the Compendium of Irish Agricultural Statistics 2008, (DAFF 2009). Data are only available for some sectors for fewer than the 14 years period hence an unbalanced panel covering the period 1995–2008 is constructed and used to estimate marginal employment elasticities for each sector. A feature of the data is that employment has generally declined across sectors despite increased output. This reflects ongoing technical change in each sector and needs to be accounted for in the estimation procedure.

The fixed effects model described by equation (1) is used to estimate the employment elasticity for each sector for the period 1995–2008 using annual data measured in constant 2006 commodity-specific prices.

$$\Delta\, lnE_{it} = \alpha_0 + \sum_{i=1}^{57} \beta_i \Delta lnY_{it-1} + \delta S_i + \epsilon_{it} \qquad (1)$$

Where $\Delta lnE_{it} = lnE_{it} - lnE_{it-1}$ is the change in sectoral employment, $\Delta lnY_{it-1} = lnY_{it-1} - lnY_{it-2}$ is the lagged change in sectoral output and S is a sector dummy, subscript i and t denotes the sector and time, respectively. This fixed effects model controls for time invariant sector specific unobserved heterogeneity. Potential reverse causality is controlled for by using the lag of the output variable in the model. After unit root testing using the Augmented Dickey-Fuller (ADF) test, the first differences for employment and lagged output are used in the regression. Estimating the elasticities using first differences is equivalent

to estimating the employment-output relationship in levels including a time trend to control for productivity change. Thus, the use of improved technologies or a change in the capital-labour intensity in the production process is taken into account. The elasticity for each sector is calculated by adding δ to β_i. Marginal employment coefficients are calculated using the mean values of employment and output for each sector i using the following equation:

$$\varepsilon_i = \frac{\frac{\Delta E_i}{E_i}}{\frac{\Delta Y_i}{Y_i}} \quad (2)$$

Where E_i is the sectoral employment and Y_i is the sectoral output. Note that these marginal employment coefficients represent the effect of an incremental unit of output on employment holding technology constant. Continued technical progress and increased labour productivity will result in fewer jobs per unit of output, regardless whether output is increasing or not. The complete regression results for this specification are presented in Table A2.

Table 3 presents the marginal employment coefficients estimated for the 22 agriculture and food sectors in the AgriFood-SAM (details of the full set of marginal coefficients for all sectors are available on request from the authors). The size of the estimated marginal employment coefficients is small, so it can be inferred that the increase in output is mainly due to factors such as capital investment, economies of scale or technological change rather than increases in the labour input. Increases in cattle and sheep production are more labour-intensive than increases in pig or poultry production, with dairy farming falling in between. However, at the processing level, increases in dairy throughput generate more jobs per million euro of additional output than increases in meat throughput. Within the meat sector, increases in pig meat and poultry meat processing are more successful at creating jobs than increases in throughput of sheep and particularly beef, indicating that on average these sectors are more labour-intensive at the margin than is the beef sector.

The results using both average and marginal employment coefficients are now used to estimate the job potential of the FH2020 growth targets and their impacts on each sector represented in the 2005 AgriFood-SAM for Ireland.

Scenarios and Results

Employment effects of changes in agricultural output

Two scenarios are simulated using different assumptions to see how employment might respond to increased agricultural output. Scenario 1 shows the effects of meeting the four sectoral FH2020 targets using average employment coefficients. These are based on 2008 employment coefficients for the 22 agricultural and food processing sectors and 2005 employment coefficients for the remaining sectors in the economy. Scenario 2 shows the effects of meeting the four targets using the econometrically-estimated marginal employment coefficients in Section 2.

Table 4 shows the results based on Scenario 1. The total output changes arising from the FH2020 targets and the associated final demand changes are presented in columns 2 to 9 of Table 4. Column 10 shows the average jobs coefficients calculated as the ratio of the numbers of workers to output in each sector, which are the same figures presented in Table 1. Columns 11 to 14 give the total change

Table 3. Employment elasticity and marginal employment coefficients for agriculture and food sectors

Sectors	Employment elasticity	Marginal coefficient (per million euro output)
	(1995–2008)	
(1)	(2)	(3)
Milk	0.238	6.018
Cattle	0.258	11.279
Sheep	0.244	10.664
Pigs	0.256	4.615
Poultry	0.258	4.653
Horses	0.269	1.204
Cereals	0.277	1.242
Fruit & veg.	0.229	1.729
Sugar	0.257	1.938
Potatoes	0.229	2.917
Other crops	0.300	3.821
Fodder crops	0.256	3.870
Beef meat	0.256	0.086
Pig meat	0.289	0.619
Poultry meat	0.294	0.630
Sheep meat	0.262	0.289
Fish and fishing products	0.235	0.259
Fruit and vegetable	0.263	2.954
Dairy products	0.230	2.587
Animal feed	0.229	1.937
Other food products	0.249	2.103
Beverages	0.254	1.933

Source: Authors' calculation. Employment elasticities and significance levels are reported in Appendix, Table A2.

in employment given the final demand shock by multiplying the average employment coefficient by the change in output for each sector. The rightmost column presents the sum of the additional employment generated in each sector. For example, an expansion in milk output by 50% will lead to an increase in the numbers engaged in milk production at farm level by 12,575 workers. This will also have an indirect effect through the increase in the numbers of workers in the dairy food processing sector by 2,110 workers plus 8,367 workers in the other sectors of the economy. Similarly, the table shows the direct and indirect effects (including the effects induced by additional household spending) if the targets for cattle, sheep and pig production are met. In total, assuming that employment would expand proportionately to output, the FH2020 targets would generate an additional 38,000 jobs in this scenario. Over half of these additional jobs would be created as a result of the expansion in milk production.

Table 5 reports the results of Scenario 2, using the econometrically-estimated marginal employment coefficients in Table 3. There is a significant difference between the results of Scenario 1 and Scenario 2. For example, a 50% increase in milk output generates 4,814 jobs in the primary sectors and indirectly generates 2,922 jobs through the dairy processing sector and

Table 4. Scenario 1. Employment effect of the Food Harvest 2020 targets using average employment coefficients

Sectors (1)	Output changes arising from FH2020 targets								Average employment coefficient per €1 million domestic output (10)	Total employment change				Total changes (15)
	50% increase in milk output volume (2)	Change in output (€m) (3)	9% increase in cattle output volume (4)	Change in output (€m) (5)	7% decrease in sheep output volume (6)	Change in output (€m) (7)	30% increase in pigs output volume (8)	Change in output (€m) (9)		50% increase in milk output volume (11)	9% increase in cattle output volume (12)	7% decrease in sheep output volume (13)	30% Increase in pigs output volume (14)	
Milk		800.00		30.48		–0.21		1.45	15.72	12,575	479	–3	23	13,074
Cattle		4.89		250.00		–0.14		0.99	20.82	102	5,206	–3	21	5,325
Sheep		0.88		0.42		–16.00		0.14	22.69	20	10	–363	3	–330
Pigs		1.14		0.59		–0.03		90.00	3.42	4	2	0	308	314
Poultry		0.97		0.52		–0.03		0.17	5.57	5	3	0	1	9
Horses		0.31		0.13		–0.07		0.09	7.34	2	1	–1	1	3
Cereals		18.71		18.16		–0.49		9.98	17.94	336	326	–9	179	832
Fruit & vegetable		5.16		3.71		–0.16		1.22	1.09	6	4	0	1	11
Sugar		2.03		0.88		–0.04		0.27	0.00	0	0	0	0	0
Potatoes		1.36		0.73		–0.04		0.22	9.08	12	7	0	2	21
Other crops		8.66		15.56		–0.16		0.11	3.46	30	54	–1	0	84
Fodder crops		29.63		44.40		–1.22		17.21	1.11	33	49	–1	19	100
Beef meat.		7.26	441.78	3.77		–0.20		1.31	3.16	23	1,408	–1	4	1,434
Pig meat.		6.30		3.23		–0.17	374.33	1.01	3.21	20	10	–1	1,203	1,233
Poultry meat		3.67		1.90		–0.10		0.60	3.09	11	6	0	2	19
Sheep meat		1.76		0.91	–38.57	–0.05		0.29	3.24	6	3	–125	1	–115
Fish &fishing products		2.68		1.32		–0.07		0.42	4.98	13	7	0	2	22
Fruit & vegetable		4.50		2.39		–0.13		0.71	6.78	31	16	–1	5	51
Dairy products	1,369.13	20.10		10.73		–0.58		3.96	1.52	2,110	16	–1	6	2,132
Animal Feed		88.00		57.49		–3.15		34.80	1.80	159	104	–6	63	319
Other food products		101.76		43.34		–2.15		12.45	1.26	128	54	–3	16	195
Beverages		11.10		6.47		–0.45		2.07	1.70	19	11	–1	4	33
Other sectors		1,384.99		741.68		–45.74		450.83		7,408	3,822	–253	2,690	13,667
Total all sectors		2,506		1,239		–71		630		23,052	11,597	–772	4,552	38,430

Source: Authors' calculations.

Note: The reported changes in output in each sector are the result of the direct, indirect and induced impacts of the initial changes in final demand arising from the FH2020 targets.

another 2,411 in other sectors of the economy. Overall, a total of 10,147 jobs are created in the economy in this scenario if the FH2020 milk output target is met. Taking account also of the other sectoral targets, we estimate that a total of 16,000 additional jobs would be created in the Irish economy if all the FH2020 targets were met.

Thus, depending on the assumption made regarding the employment intensity of additional output, one can conclude that meeting the FH2020 targets would create between 16,045 and 38,430 additional jobs. For the reasons enumerated previously, our preferred estimate is the lower figure, because it takes into account the observed relationship between employment and output increases in the past. Increased output is almost never associated with a proportionate increase in employment, either because it requires capital investment which embodies more productive and less labour-intensive technologies, or because there are economies of scale in labour use, or because there is currently underemployment at farm level which allows additional output to be produced without requiring the employment of additional workers. However, we recognise that the empirically-estimated relationship from the past may not necessarily hold in the future, and the scenario results using the average employment coefficients can be interpreted as an upper bound on the likely employment effects of meeting the FH2020 targets.

Employment effects of higher prices

In addition to the effect of the change in employment due to the change in the volume of final demand, we would expect to see a change in employment also due to the change in prices. The SAM multiplier model is a fixed price model and does not account for the change in prices forecast by the FAPRI model. In other words, if final demand is projected to increase by 10% and this is all due to a change in price, then the model cannot capture the employment effects on the economy, as this is not an increase in output volume. However, an increase in prices of the four main commodities for which growth targets are set in FH2020 is translated into an increase in farm household income and the additional impact of this increase in household expenditure on employment can also be simulated.

To capture the re-spending of higher household incomes due to the exogenous commodity price increase, the price changes for the four primary agricultural sectors and some of the inputs provided by the FAPRI-Ireland model (Table 6) are used to calculate the change in farm income arising from the changes in the values of each output and input in the 2005 AgriFood-SAM. The output value share is reduced for each of the four primary agricultural sectors by the value of output sold on the domestic market, as this is only a reshuffling of domestic expenditure with no net employment increase. This approach allows the calculation of the change in farm income arising only from a change in prices of exported output and inputs. The expenditure generated by the assumed change in farm income (allowing for household savings and taxes) is then allocated over the 53 sectors in the economy in accordance with the expenditure shares in the 2005 AgriFood-SAM, and used as a second set of shocks to final demand.

Table 7 presents the results of the extra income re-spent in the economy as an effect of the projected increased prices in primary agricultural products. The results for the two scenarios, described earlier, are presented. An increase in farm household income of €374 million could generate

Table 5. Scenario 2. Employment effect of the Food Harvest 2020 targets using marginal employment coefficients

Sectors (1)	Output changes arising from FH2020 targets								Marginal employment coefficient per €1 million domestic output (10)	Total employment change				Total changes (15)
	50% increase in milk output volume (2)	Change in output (€m) (3)	9% increase in cattle output volume (4)	Change in output (€m) (5)	7% decrease in sheep output volume (6)	Change in output (€m) (7)	30% increase in pigs output volume (8)	Change in output (€m) (9)		50% increase in milk output volume (11)	9% increase in cattle output volume (12)	7% decrease in sheep output volume (13)	30% increase in pigs output volume (14)	
Milk		800.00		30.48		–0.21		1.45	6.018	4,814	183	–1	9	5,005
Cattle		4.89		250.00		–0.14		0.99	11.279	55	2,820	–2	11	2,884
Sheep		0.88		0.42		–16.00		0.14	10.664	9	5	–171	2	–155
Pigs		1.14		0.59		–0.03		90.00	4.615	5	3	0	415	423
Poultry		0.97		0.52		–0.03		0.17	4.653	5	2	0	1	8
Horses		0.31		0.13		–0.07		0.09	1.204	0	0	0	0	1
Cereals		18.71		18.16		–0.49		9.98	1.242	23	23	–1	12	58
Fruit & vegetable		5.16		3.71		–0.16		1.22	1.729	9	6	0	2	17
Sugar		2.03		0.88		–0.04		0.27	1.938	4	2	0	1	6
Potatoes		1.36		0.73		–0.04		0.22	2.917	4	2	0	1	7
Other crops		8.66		15.56		–0.16		0.11	3.821	33	59	–1	0	92
Fodder crops		29.63		44.40		–1.22		17.21	3.870	115	172	–5	67	348
Beef meat		7.26	441.78	3.77		–0.20		1.31	0.630	5	281	0	1	286
Pig meat		6.30		3.23		–0.17	374.33	1.01	0.289	2	1	0	108	111
Poultry meat		3.67		1.90		–0.10		0.60	0.259	1	0	0	0	2
Sheep meat		1.76		0.91	–38.57	–0.05		0.29	2.954	5	3	–114	1	–105
Fish& fishing products		2.68		1.32		–0.07		0.42	2.587	7	3	0	1	11
Fruit & vegetable		4.50		2.39		–0.13		0.71	1.937	9	5	0	1	14
Dairy products	1,369.13	20.10		10.73		–0.58		3.96	2.103	2,922	23	–1	8	2,952
Animal feed		88.00		57.49		–3.15		34.80	1.933	170	111	–6	67	342
Other food		101.76		43.34		–2.15		12.45	1.711	174	74	–4	21	266
Beverages		11.10		6.47		–0.45		2.07	0.887	10	6	0	2	17
Other sectors		1,384.99		741.68		–45.74		450.83		1,766	904	–66	851	3,455
Total all sectors		2,506		1,239		–71		630		10,147	4,687	–372	1,583	16,045

Source: Authors' calculations.

Note: The reported changes in output in each sector are the result of the direct, indirect and induced impacts of the initial changes in final demand arising from the FH2020 targets.

Table 6. Input and output price changes, Food and Agricultural Policy Research Institute (FAPRI) model

Sectors	FAPRI price change outputs (%)	Export value shock (€ millions)	Sectors	FAPRI price change inputs (%)
Milk	+16	+217	Animal feed	–2
Cattle	+22	+325	Chemical	+19
Sheep	+42	+70	Energy	+46
Pigs	+2	+2		
Additional farm export income		€374		

Source: Authors' calculation and Donnellan and Hanrahan (2012).
The FAPRI model provides estimates for the price change for the four main agricultural products and three of the inputs used in agriculture.

2,161 jobs in the economy in Scenario 1, compared with 313 jobs in Scenario 2. Thus, using average employment coefficient, the total job creation which might be generated by meeting the FH2020 targets would amount to 40,591 jobs. If, more plausibly, we base the simulation on the econometrically-estimated marginal employment coefficients, in addition to the 16,045 jobs associated with increased output, another 313 jobs will be created in the economy due to the change in prices, for a total of 16,358 jobs if the FH2020 targets are met.

Conclusion

This paper uses a SAM multiplier analysis to investigate the employment impact of the four main targets for increases in agricultural output set in the FH2020 report. We simulate results for two scenarios based on estimated average and marginal employment responses to meeting the output targets. We take into account both the greater volume of output as well as the gains in farm income due to higher projected prices in 2020. The multiplier analysis takes into account not only the potential additional employment at farm level, but also in the processing and other sectors in the economy through indirect linkage and induced effects. The results reveal a wide range in terms of the jobs impact and show the importance of the assumptions made with regard to the employment intensity of the additional output arising as a result of the achievement of the FH2020 agricultural output growth targets.

In the first scenario using average employment coefficients, the model simulates the creation of just over 40,000 additional jobs. For reasons mentioned earlier, we believe this is a substantial overestimate of the likely employment impact of the FH2020 targets. In the second scenario, we project the employment impacts using marginal employment coefficients based on the historical relationship between employment growth and output increases holding technology constant. The total employment impact of the FH2020 targets in this scenario would amount to 16,500 additional jobs. In our view, this lower estimate is the more realistic one although we recognise that the empirically-estimated relationship from the past may not necessarily hold in the future. The scenario results using the average employment coefficients can be interpreted as an upper bound on the likely employment effects of meeting the FH2020 targets.

Multiplier analysis assumes that prices are static and that resources are freely available to produce the additional supply. These assumptions imply that if a sector expands, the additional demand it generates for labour and inputs does not

Table 7. Employment effect of the Food Harvest 2020 targets assuming increased prices for agricultural sector output

Sector	Income change	Scenario 1		Scenario 2		Sector	Income change	Scenario 1		Scenario 2	
		Average employment coefficient per €1 million domestic output	Change in employment	Marginal employment coefficient per €1 million domestic output	Change in employment			Average employment coefficient per €1 million domestic output	Change in employment	Marginal employment coefficient per €1 million domestic output	Change in employment
A_AMIK	0	15.72	0	6.018	0	A_MEMA	1	6	8	3	3
A_ACATL	0	20.82	0	11.279	0	A_MAEQ	2	5	13	1	1
A_ASHP	0	22.69	0	10.664	0	A_OFMA	1	1	1	1	0
A_APIG	0	3.42	0	4.615	0	A_ELMA	1	4	6	1	1
A_APOL	1	5.57	3	4.653	3	A_RATV	2	2	4	1	2
A_AHOR	0	7.34	0	1.204	0	A_MEDI	0	4	2	1	0
A_ACER	0	17.94	0	1.242	0	A_MOTO	31	6	175	0	0
A_AFRVE	4	1.09	5	1.729	7	A_OTTR	0	8	3	1	0
A_ASUG	0	0.00	0	1.938	0	A_RECY	0	5	0	0	0
A_APOT	1	9.08	13	2.917	4	A_ELGA	6	2	13	0	3
A_AOTCR	0	3.46	0	3.821	0	A_WATE	0	9	1	1	0
A_AFOCR	0	1.11	0	3.870	0	A_CONS	0	6	1	5	1
A_FORE	0	4.96	1	3.372	1	A_TRAD	2	14	35	5	12
A_FISH	1	4.67	6	0.088	0	A_WHSL	1	8	5	5	3
A_CPUM	3	3.45	10	0.086	0	A_RETS	1	21	12	7	4
A_MING	0	3.65	0	0.619	0	A_HORE	48	14	649	0	0
A_MBEF	4	3.16	11	0.630	2	A_LATR	5	8	34	0	0
A_MPIG	4	3.21	14	0.289	1	A_WATR	0	11	1	0	0
A_MPOL	2	3.09	6	0.259	0	A_AITR	1	1	2	2	3
A_MSHP	1	3.24	5	2.954	4	A_OTTRS	8	4	35	2	17
A_MFSH	1	4.98	5	2.587	2	A_POTL	15	4	62	2	31
A_MFRVE	4	6.78	25	1.937	7	A_FISE	10	2	19	1	7
A_MDARY	8	1.52	12	2.103	17	A_INSE	17	3	43	1	17
A_MANFE	0	1.80	0	1.933	0	A_OFISE	1	3	3	0	0
A_MOTFO	24	1.26	31	1.711	42	A_REES	17	1	22	0	0
A_MBEV	3	1.70	6	0.887	3	A_RESE	3	2	6	0	0
A_TABA	6	1.72	11	0.606	4	A_COSE	0	2	0	0	0
A_TEXT	3	9.19	23	0.657	2	A_RESH	0	5	0	0	0
A_FURS	17	7.62	127	1.248	21	A_OTBU	1	8	10	3	4
A_LETH	3	7.47	25	1.059	3	A_PUAD	0	9	3	2	1

Table 7. (Continued)

Sector	Income change	Scenario 1		Scenario 2		Sector	Income change	Scenario 1		Scenario 2	
		Average employment coefficient per €1 million domestic output	Change in employment	Marginal employment coefficient per €1 million domestic output	Change in employment			Average employment coefficient per €1 million domestic output	Change in employment	Marginal employment coefficient per €1 million domestic output	Change in employment
A_PAPE	3	5.69	15	0.000	0	A_HEAS	11	12	134	0	0
A_PRME	7	1.10	8	1.141	8	A_SEWA	1	0	0	0	0
A_PEMP	41	3.25	134	1.140	47	A_MNEC	5	0	0	0	0
A_CHIM	9	0.81	7	1.162	11	A_RECS	10	8	81	0	0
A_RUBB	4	6.19	22	2.362	9	A_OTSE	4	20	71	0	0
A_NOME	1	4.56	6	2.404	3	A_PRHO	0	0	0	0	0
A_BAME	0	3.11	0	2.813	0	Total	374		2,161		313

Source: Authors' calculation.
The names for each sector can be found in the Appendix Table A1.

generate inflation in the price of these inputs or in wages. In the current high unemployment environment in Ireland this is probably a reasonable assumption in the case of labour, but the assumption could be questioned in the case of other inputs. The expansion of Irish agriculture of itself is not likely to generate inflation in the case of imported inputs (because demand from Ireland is small in a global context), but it could generate inflation in the price of domestically produced inputs such as replacement animals and land rents. Any such responses would tend to dampen the multiplier impacts estimated above.

Further work could be done to improve the quality of the estimated marginal employment coefficients. Future analysis would benefit from larger samples and further improvements in the econometric model by identifying additional influences on employment coefficients, such as trends in labour productivity or unemployment rates, and/or by taking account of possible asymmetric responses of employment to output increases and decreases.

In summary, the use of a social accounting model together with estimates of the employment intensity of additional output has allowed us to provide estimates of the additional economy-wide employment likely to be created as a result of achieving the sectoral agricultural growth targets set out in FH2020. Achieving these targets would make a significant contribution to helping the Irish economy recover from the recession and high unemployment of recent years.

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Received 4 October 2013

Appendix

Table A1. Average employment Coefficients 2005 and 2008 (thousand employees per million euro of domestic output)

NACE codes	Sectors codes	Sectors name	Average employment coefficient per €1 million domestic output	
			2005	2008
1	A_AMIK	Milk	18.07	15.72
	A_ACATL	Cattle	23.12	20.82
	A_ASHP	Sheep	19.07	22.69
	A_APIG	Pig	3.68	3.42
	A_APOL	Poultry	5.49	5.57
	A_AHOR	Horses	6.40	7.34
	A_ACER	Cereals	26.44	17.94
	A_AFRVE	Fruit and Vegetable	1.18	1.09
	A_ASUG	Sugar	26.12	0.00
	A_APOT	Potatoes	8.06	9.08
	A_AOTCR	Other Crops	3.71	3.46
	A_AFOCR	Fodder Crops	1.33	1.11
2	A_FORE	Products of forestry, logging and related services	4.96	
5	A_FISH	Fish and other fishing products; services incidental of fishing	4.67	
10 to 13	A_CPUM	Coal, peat, petroleum and metal ore extraction	3.45	
14	A_MING	Other mining and quarrying products	3.65	
15	A_MBEF	Beef meat	3.34	3.16
	A_MPIG	Pig meat	3.59	3.21
	A_MPOL	Poultry meat	3.62	3.09
	A_MSHP	Sheep meat	3.95	3.24
	A_MFSH	Fish and other fishing products	9.31	4.98
	A_MFRVE	Fruit and vegetable	9.72	6.78
	A_MDARY	Dairy products	2.57	1.52
	A_MANFE	Animal feed	2.96	1.80
	A_MOTFO	Other food products	1.41	1.26
	A_MBEV	Beverages	0.66	1.70
16	A_TABA	Tobacco products	1.72	

Table A1. (Continued)

NACE codes	Sectors codes	Sectors name	Average employment coefficient per €1 million domestic output	
			2005	2008
17	A_TEXT	Textiles	9.19	
18	A_FURS	Wearing apparel; furs	7.62	
19	A_LETH	Leather and leather products	7.47	
20	A_ WOOD	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	5.54	
21	A_PAPE	Pulp, paper and paper products	5.69	
22	A_PRME	Printed matter and recorded media	1.10	
23&36	A_PEMP	Petroleum and other manufacturing products	3.25	
24	A_CHIM	Chemicals, chemical products and man-made fibres	0.81	
25	A_RUBB	Rubber and plastic products	6.19	
26	A_NOME	Other non-metallic mineral products	4.56	
27	A_BAME	Basic metals	3.11	
28	A_MEMA	Fabricated metal products, except machinery and equipment	6.29	
29	A_MAEQ	Machinery and equipment n.e.c.	5.31	
30	A_OFMA	Office machinery and computers	0.87	
31	A_ELMA	Electrical machinery and apparatus n.e.c.	4.27	
32	A_RATV	Radio, television and communication equipment and apparatus	1.85	
33	A_MEDI	Medical, precision and optical instruments, watches and clocks	3.85	
34	A_MOTO	Motor vehicles, trailers and semi-trailers	5.56	
35	A_OTTR	Other transport equipment	7.64	
37	A_RECY	Secondary raw materials	4.82	
40	A_ELGA	Electrical energy, gas, steam and hot water	2.07	
41	A_WATE	Collected and purified water, distribution services of water	8.66	
45	A_CONS	Construction work	5.87	
50	A_TRAD	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel	14.26	
51	A_WHSL	Wholesale trade and commission trade services, except of motor vehicles and motorcycles	7.83	
52	A_RETS	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	20.77	

Table A1. (Continued)

NACE codes	Sectors codes	Sectors name	Average employment coefficient per €1 million domestic output	
			2005	2008
55	A_HORE	Hotel and restaurant services	13.63	
60	A_LATR	Land transport; transport via pipeline services	7.52	
61	A_WATR	Water transport services	10.51	
62	A_AITR	Air transport services	1.43	
63	A_OTTRS	Supporting and auxiliary transport services; travel agency services	4.28	
64	A_POTL	Post and telecommunication services	4.20	
65	A_FISE	Financial intermediation services, except insurance and pension funding services	1.97	
66	A_INSE	Insurance and pension funding services, except compulsory social security services	2.56	
67	A_OFISE	Services auxiliary to financial intermediation	2.86	
70	A_REES	Real estate services	1.31	
71	A_RESE	Renting services of machinery and equipment without operator and of personal and household goods	2.19	
72	A_COSE	Computer and related services	2.26	
73	A_RESH	Research and development services	4.52	
74	A_OTBU	Other business services	7.62	
75	A_PUAD	Public administration and defence services; compulsory social security services	9.07	
80	A_EDUS	Education services	15.51	
85	A_HEAS	Health and social work services	11.82	
90	A_SEWA	Sewage and refuse disposal services, sanitation and similar services	0.01	
91	A_MNEC	Membership organisation services n.e.c.	0.01	
92	A_RECS	Recreational, cultural and sporting services	8.38	
93	A_OTSE	Other services	20.21	
95	A_PRHO	Private households with employed persons	0.00	

Source: Authors' calculation based on the Eurostat annual detailed enterprise statistics 1995–2008 dataset (2009), Census of Industrial Production 1994–2008 dataset (CSO, 2011a), and annual review and outlook for agriculture, fisheries and food DAFF (2010a).

Note: 2008 is the most recent year for which data are available on both employment numbers and output for all 12 primary agricultural and 10 food processing sectors.

Table A2. Fixed effects regression results

Δ *lnEmployment*							
A_AMIK	0.238***	A_MPIG	0.051***	A_PRME	0.007	A_TRAD	0.413***
A_ACATL	0.019***	A_MPOL	0.056***	A_CHIM	0.019***	A_WHSL	0.118***
A_ASHP	0.006*	A_MSHP	0.024***	A_RUBB	0.014***	A_RETS	0.104***
A_APIG	0.018***	A_MFSH	–0.003***	A_NOME	0.018***	A_HORE	0.020***
A_APOL	0.020***	A_MFRVE	0.024***	A_BAME	0.026***	NACE 60 to 64	0.127***
A_AHOR	0.031***	A_MDARY	–0.008***	A_MEMA	0.031***	A_REES	0.114***
A_ACER	0.039***	A_MANFE	–0.008***	A_MAEQ	0.006***	A_RESE	0.046***
A_AFRVE	–0.008***	A_MOTFO	0.011***	A_OFMA	–0.009***	A_COSE	0.056***
A_ASUG	0.019***	A_MBEV	0.016***	A_ELMA	–0.029***	A_RESH	0.147***
A_APOT	–0.008***	A_TABA	–0.013***	A_RATV	0.005**	A_OTBU	0.265***
A_AOTCR	0.062***	A_TEXT	–0.054***	A_MEDI	0.055***	A_RECS	0.124***
A_AFOCR	0.017***	A_FURS	–0.112***	A_MOTO	0.007**	A_OTSE	0.056***
NACE 02,05	–0.015***	A_LETH	–0.094***	A_OTTR	0.009***	constant	–0.036***
NACE 10 to 14	0.024***	A_WOOD	0.036***	A_ELGA	–0.037***		
A_MBEF	0.018***	A_PAPE	0.001	A_CONS	0.096***		
			N	636			
			R^2	0.263			

*The milk sector is omitted in the regression above to avoid perfect collinearity. Hence, the employment elasticities for each sector, reported in Table 3, are calculated a*dding δ to β. *Full table including employment elasticities and marginal employment coefficients can be provided on request.*