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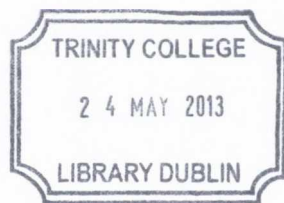
# Economy-Wide Modelling Focused on the Agricultural and Food Sectors. An Irish Case

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Thesis submitted to Trinity College, University of Dublin in  
fulfilment of the requirements for the degree of Doctor of  
Philosophy (Ph.D.)

2013



Thesis 9858

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## Summary

This thesis is a collection of four essays. The first one describes the construction of a Social Accounting Matrix (SAM) for Ireland for the year 2005. The SAM includes 55 activities, 55 commodities, two factors of production (capital and labour), one account each for households, enterprises, government and investment/saving, three tax-related accounts (direct and indirect taxes and custom duties), a trade and transport margin account and three external sectors (UK, Rest of the EU and Rest of the World). A SAM linear model of the Irish economy is constructed and used to simulate the effect of shocks on the economy as an example of the use of multiplier analysis.

The second essay describes the construction of a social accounting matrix with disaggregated agricultural and food industry sectors for Ireland for the purpose of agri-food policy simulations. The AgriFood-SAM documented here can be used as a tool to analyse the inter-sectoral linkages between the agri-food sectors and the Irish economy. The economy-wide effects of a simulation of a reduction in greenhouse gas emissions from the agricultural sector are calculated using these multiplier values.

The third essay makes use of the 2005 AgriFood-SAM for Ireland, the direct employment intensities and the estimated marginal employment coefficients to examine the job creation potential of the four main growth targets in the Food Harvest 2020 (FH2020). Two scenarios are simulated and compared in order to assess the robustness of the methods. It is found that the econometrically estimated marginal employment coefficients provides a more realistic estimation of the employment potential of the FH2020 targets on the Irish economy.

Finally, the last essay studies the impacts of further multilateral trade liberalisation for Ireland with a particular emphasis on the agricultural sector. In order to capture the economy-wide impacts of trade liberalisation, a CGE model was constructed using the social accounting matrix for Ireland for the year 2005. Household effects are captured using representative households. The simulation results suggest a small negative impact on the Irish economy. Many agricultural sectors contract in the process and the more efficient reallocation of resources into the manufacturing and services sectors does not fully compensate those losses. While urban households appear to be unaffected, rural and farm households are generally worse off.



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# Chapter 1

## Introduction to the Thesis

This thesis addresses two important issues in agriculture and food economics for Ireland namely, (i) the impact of the potential outcomes of the Doha Round negotiations and (ii) the impact of the negotiations on a new Common Agricultural Policy (CAP) for the period 2014-2020 for Ireland.

Trade policy is now an EU competence. EU trade policy was last adapted during the Uruguay Round of trade negotiations which resulted in the Uruguay Round Agreement and the establishment of the WTO in 1995. A new round of trade negotiations was launched in 2001 at Doha. Although considerable progress has been made in reaching agreement on the likely tariff reductions in the Doha Round, remaining policy differences on a small number of specific issues have so far prevented agreement. The aim of this thesis is to quantify the effects of the potential outcomes of the Doha Round negotiations, using a CGE analysis. The emphasis is on the specific outcomes of trade liberalisation for Ireland as the model used is a single country model. The Doha negotiations cover all sectors, liberalisation of agricultural, manufacturing and services trade as well as the implementation of the WTO rules. Ireland is viewed as a small open export oriented economy, which enjoys preferential access to other EU country markets as a member of the EU. The effects of further trade liberalisation on Ireland are particularly important for the Irish economy; lower tariffs on imports will negatively affect the agriculture sector and lower tariffs on exports will benefit the food and non-food manufacturing sectors. The service sectors will also be affected, but because of dearth in quantified information on trade barriers in services the impact of further trade liberalisation in this sector cannot be included. A single country CGE model with a specific treatment of the CAP and calibrated on a agri-food SAM with disaggregated household account is used. This model simulates the EU-CAP negotiations and the trade liberalisation effects and their impact at household level.

Irish agriculture is highly dependent on EU and national transfers arising from the operation of the EU's Common Agricultural Policy (CAP). The CAP has undergone a series of reforms which have reduced the importance of market price support but

increased the importance of direct transfers paid by taxpayers. Since 2005, the CAP transfers received by the Irish farmers are considered decoupled, hence the beneficiaries are free to decide what and how much to produce. The CAP is likely to undergo a further reform in the next few years as part of the negotiations on a new EU Financial Perspective for the period 2014-2020. Various suggestions have been made in the debate on this reform, including reducing farm transfers and allocating the funding to other EU policies or converting the current decoupled payment into a payment for public goods. At the same time, other EU policies (biofuels, climate change) are promoting a shift in land use from producing food to producing biomass and other renewable energies. Such changes could imply radical changes for the Irish agricultural and food processing sectors and, because of the importance of the agri-food sector for the overall economy, will have important consequences for the economy as a whole. The purpose of this thesis is to evaluate the impact of these proposed changes using a general equilibrium model which allows, in particular, the identification of winners and losers at household level.

Chapter 2 describes the construction of a Social Accounting Matrix (SAM) for Ireland for the year 2005. The SAM describes the full circular flow of money and goods in the Irish economy. The SAM includes 55 activities, 55 commodities, two factors of production (capital and labour), one account each for households, enterprises, government and investment/saving, three tax-related accounts (direct and indirect taxes and custom duties), a trade and transport margin account and three external sectors (UK, Rest of the EU and Rest of the World). Its construction takes place in three steps: (1) building the macro-SAM; (2) building an initial unbalanced SAM making use of a variety of additional data sources, and (3) balancing the SAM using the cross-entropy method. By treating the SAM as a linear model of the Irish economy and by specifying certain accounts as exogenous, the SAM can be used to simulate the effect of shocks to the exogenous variables or accounts. Examples of such multiplier analysis are presented at the end of this chapter.

Chapter 3 describes the construction of a social accounting matrix with disaggregated agricultural and food industry sectors for Ireland for the purpose of agri-food policy simulations. The base year for the AgriFood-SAM is 2005 and it builds on the 2005 SAM for Ireland detailed in Chapter 2. Its unique features include a high level of disaggregation of the agricultural and food industry sectors as well as the integration of individual household data for the purposes of micro-simulation analysis. The AgriFood-SAM documented here can be used as a tool to analyse the inter-sectoral linkages between the agri-food sectors and the Irish economy. Multiplier effects for

exogenous changes in final demand for different agri-food activities are presented. Finally, the economy-wide effects of a simulation of a reduction in greenhouse gas emissions from the agricultural sector are calculated using these multiplier values.

Chapter 4 examines the job creation potential of the four main growth targets in the Food Harvest 2020(FH2020), namely the growth targets for milk, beef, sheep and pigs. The FH2020 targets are of interest particularly in the context of the current recession. The agri-food sector is predominantly rural based and growth in this sector is important for the economy of rural regions. 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, and the spending of those employed in the agri-food sector on goods and services produced in the economy. Commonly this is described as the multiplier impact. The job creation arising out of FH2020 targets will depend on future employment intensities as measured by the level of employment per million euro of output. In this analysis two alternative scenarios are described: (i) for the first scenario we use the average employment intensities given by the ratio of employment to output as existed in 2008 for the 12 primary agricultural and 10 food processing sectors, and the 2005 average employment intensities for the remaining sectors in the economy; (ii) an econometric model is used to estimate marginal employment coefficients for almost all sectors in the economy. To the best of my knowledge, these marginal employment coefficients for Ireland are the first to be estimated at this level of sectoral disaggregation. The results of the second scenario are believed to more accurate in simulating the employment potential of the FH2020 targets.

Chapter 5 assesses the impact of further multilateral trade liberalisation for Ireland with a particular emphasis on the agricultural sector. In addition to evaluating the aggregate impacts on agricultural production as well as the spill-over effect of this on the non-agricultural sector and for overall Irish GDP, the effects for different types of households are evaluated. In order to capture the economy-wide impacts of trade liberalisation, a CGE model is constructed using the social accounting matrix for Ireland for the year 2005. Household effects are captured using nine representative households, two non-farm and seven farm households. The simulation results suggest a small positive impact on Irish GDP at market prices, domestic absorption, private consumption, but a small negative impact on GDP at factor cost. Many of the agricultural and food sectors contract as expected as the remaining import and export protection is found almost exclusively in those sectors. These contractions are compensated by expansions of the manufacturing and services sectors. Urban and non-farm rural households ex-

perience a positive effect, while all farm households experience a small negative as a result of DOHA scenario. These impacts are mediated through higher returns to the factors labour and capital but a fall in the return to land.

Chapter 2, Chapter 3 and Chapter 4 are co-supervised by Alan Mathews, Trevor Donnellan and Cathal O'Donoghue and Chapter 5 is co-authored with Ole Boysen and co-supervised by Alan Mathews, Trevor Donnellan and Cathal O'Donoghue. Chapter 2 and Chapter 3 are part of the Institute for International Integration Studies (IIIS) Discussion Papers Series, Trinity College Dublin, available on the IIIS website. An earlier version of Chapter 5 was presented at the European Association of Agricultural Economists' 122nd Seminar, February 17-18, 2011, Ancona, Italy.

Finally, Chapter 6 presents the main findings and conclusions of this thesis.

## Chapter 2

### A 2005 Social Accounting Matrix (SAM) for Ireland

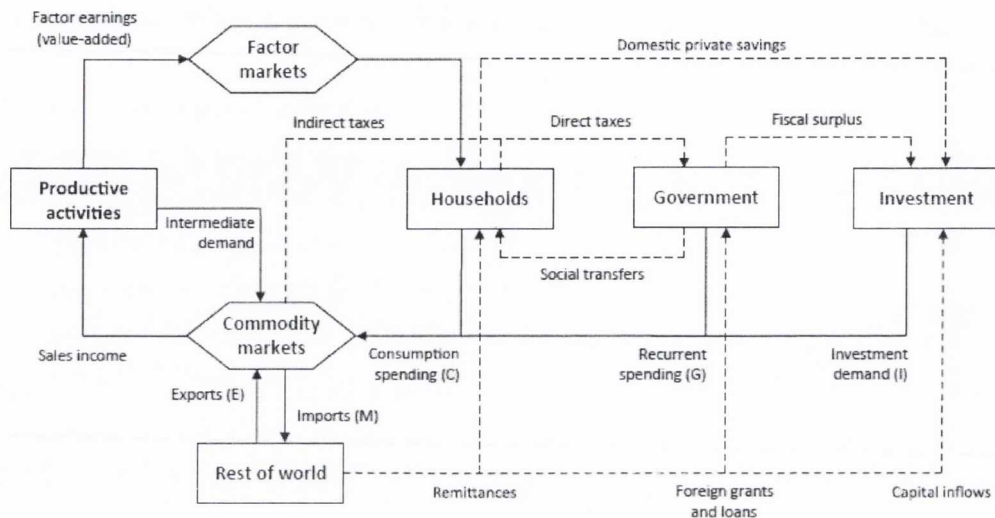
#### 2.1 Introduction

"A social accounting matrix is simply defined as a single entry accounting system whereby each macroeconomic account is represented by a column for outgoing and a row for incoming in the form of a square matrix" (Round, 1981:5). Henry (1972, 1980, 1986) was the first to construct SAMs for Ireland for economic analysis. Subsequently, O'Toole and Matthews (2002) constructed a SAM for the year 1993 based on the published Input-Output table from 1993, with particular emphasis on the agricultural and food processing sectors. A consortium of the Letterkenny Institute of Technology, the University of Missouri, the National University of Ireland Galway, and the Central Statistics Office produced a regional SAM for the Border, Midlands and Western region for 2000 with 36 production sectors and calculated a variety of multipliers from this SAM (O'Herlihy, 2004). Dixon (2006) produced a 2003 SAM for Ireland using the 1998 Input-Output table and a type of RAS procedure to scale different data from various sources to match the aggregates for the macro-economy in 2003. Wissema (2006) also built a 1998 SAM for Ireland with a disaggregated energy sector.

More recent information is now available which allows the production of a more up-to-date SAM for 2005. This information includes a comprehensive set of Input-Output (I-O) Tables for the year 2005 published by the CSO in 2009 based on a 55 sector commodity disaggregation; detailed data on marketing margins by commodity; detailed trade statistics data; and an updated Supply Table at Basic Prices, including aggregate taxes, margins and subsidies paid on each commodity, a Use Table at Purchaser Prices, direct allocation of imports and a Use Table for Imports at Basic Prices. The SAM documented in this chapter is intended to offer a benchmark data set for economy-wide analysis in Ireland through techniques such as SAM multiplier analysis and computable general equilibrium (CGE) modelling.

The history of Social Accounting Matrices starts with F. Quesnay's "tableau économique" in the 18th century and was continued by Sir Richard Stone in his article *Input-*

Figure 2.1: Circular flow diagram of the economy



Source: Breisinger et al., 2009

*Output and the Social Accounts* where he first developed the SAM framework (Stone, 1955). But it was only in 1976 that Pyatt and Thorbecke first described the SAM structure in a consistent way, and in 1977 Pyatt and Round gave the first comprehensive description using the example of Sri Lanka's SAM. Following this, SAM's have been used and applied in a wide variety of studies to address questions of distribution and redistribution, decomposition of activity multipliers and environmental and economic issues, and for both developed and developing countries and regions.

The SAM is a square matrix in which each transaction has its own row and column. Pyatt and Round (1985) give an extended discussion of the SAM structure. The convention is that the entries made in rows represent incomes or receipts; whereas the entries made in columns represent outlays or expenditures - so, for every income there exists a corresponding expenditure and their totals will be equal. Consequently, a SAM illustrates the relationships between the data on production, income generated by different institutional groups and data about expenditure of those incomes. The SAM integrates national income, input-output, flows of funds and foreign trade statistics into a comprehensive and consistent dataset.

Figure 2.1 offers an overview of the mechanisms influencing the flows in the SAM. The construction of a SAM involves distinguishing between Production, divided into factors of production, activities and commodities, on the one hand, and Institutions, divided into a current account, capital account and the rest of the world account, on

the other. Table 2.1 outlines a basic SAM, in which each account is represented twice and records the transactions between the sectors. This table is the matrix form of Figure 2.1, and can be interpreted as the representation of the circular flow production-income-expenditure-production. The SAM accounts follow the national income and product accounts relations. For example: GDP at market prices equals the value of production plus indirect taxes (Table 2.1 - 1st row/column); total absorption in the economy equals total demand (Table 2.1 - 2nd row/column); or GDP at factor cost equals value added (factor payments) (Table 2.1 - 3rd row/column), and so on. The different accounts are valued at various prices: producer prices which exclude all indirect taxes such as value added taxes and import taxes and subsidies; basic prices, defined as the price received by the producer excluding trade and transport margins and the balance of taxes and subsidies on products, or the price the producer is ultimately left with; and purchasers' prices which include trade margins, transport costs and indirect taxes. The SAM row/column totals are valued at purchaser's prices.

The basic SAM presented in Table 2.1 distinguishes the following accounts, which can be described briefly as follows:

*Production activities* produce different goods and services by buying raw materials and intermediate goods and services, paying indirect taxes to the government and creating value added that is distributed to the factors of production. The income from production activities originates from sales to other production activities, households, exports and the government.

*Factors of production* accounts include labour and capital sub-accounts. These accounts illustrate the capital and labour expenditures of the activities accounts, the supply of labour and capital to the external sector and the compensation for labour used by the external sector. The compensation of capital received by the national institutions is the net operating surplus, which is gross operating surplus plus gross mixed income, plus compensation of property income paid by the rest of the world, minus property income received by the rest of the world.

*Institutions* include the *current, capital and external accounts*. The *current account* includes households (which also contain non-profit organisations serving the households (NPOH)), enterprises (i.e. financial and non-financial corporations) and the government. Households receive factor income (wages and other labour income, rent, interest and profits) as well as transfers from government and from the rest of the nation and world (e.g. remittances). Household expenditures consist of consumption of

Table 2.1: Basic Social Accounting Matrix

OUTLAYS	PRODUCTION			INSTITUTIONS			
	1.	2.	3.	4.	5.	6.	
INCOMES	Activities	Commodities	Factors of Production	Current Account	Capital Account	Rest of the World	Total
1.	Production						Value of Production
Activities	2. Intermediate Consumption			Final Consumption	Gross Capital Formation	Exports	Aggregate Demand
2.	Commodities					Compensation of Factors from ROW	Aggregate Factor Income
3.	Gross Added Value					Current Transfers from ROW	Aggregate Income
Factors of Production	3. Value					Capital Transfers from ROW	Investment Funds
4.	Other Net Taxes on Production	Net Taxes on Products	National Product	Current Transfers	Capital Transfers	Capital Transfers from ROW	Investment Funds
Current Account	4. Taxes on Production			Domestic Savings			
5.	Capital						
Capital Account	5. Account						
6.	Rest of the World	Imports	Consumption of Factors to the ROW	Current Transfers to ROW	Capital Transfers from ROW	Transactions Value from ROW	Transactions Value to the ROW
Rest of the World	6. the World						
Total	Total Cost	Aggregate Supply	Aggregate Factor Income	Aggregate Income	Aggregate Investment	Transactions Value from ROW	

Source: Adapted from Pyatt and Round, (1985)

domestically-produced and imported goods, and income taxes with residual savings transferred to the capital account. Enterprises receive profits and transfers and spend on taxes and transfers with their residual savings channelled into their capital account. The government account is distinct from administrative public activities included in the production activities' account. These public services (such as education, public defence, etc.) buy intermediate goods, pay wages and deliver public and administrative services. The government account per se allocates its current expenditures on buying the services provided by the production activities account. Also included in government expenditures are the transfers and subsidies to households and companies and the remaining savings are transferred to the capital account. On the income side, the government receives tax revenues from a variety of sources and current transfers from abroad. The other income sources of the institutions are net indirect taxes and current transfers. The current account also shows how its income is spent between final consumption, current transfers and/or savings.

The *capital account*, or capital accumulation account, on the income side, collects savings from households, enterprises, government and the rest of the world and, in turn, transforms these aggregate savings into investment. This account is considered as a balancing account corresponding either to the financing or the saving capacity requirements of the economy.

The *external account* presents the transactions between domestic residents and foreign residents. These transactions include, on the outlay side, payments for imports, payments to factors abroad and other transfers abroad. The external account receives income by means of factor income and transfers from abroad as well as exports and capital transfers. The difference between total foreign exchange receipts and imports is by definition net capital received from abroad.

This chapter describes the construction of a 2005 SAM for Ireland emphasising the different sources of data and how they are used. The estimation of the Irish SAM involves a three-step process. (i) Building the macro-SAM: The macro-SAM has the structure shown in Table 2.1 but at a highly aggregated level. The basic information source for the macro-SAM is the national accounts, in that almost all of the flows that are part of the latter are integrated into the former. (ii) Generating the SAM:<sup>1</sup> This involves the disaggregation of the macro-SAM. Each cell of the macro-SAM corresponds to a matrix of accounts in the SAM. For example, the activity account is disaggregated

---

<sup>1</sup>This could be referred to as a micro-SAM but it is standard practice to refer to a disaggregated SAM simply as a SAM.

among 55 activities producing 55 commodities, according to the 2005 Input-Output table. This process of disaggregation results in an unbalanced but complete SAM which requires the third step of (iii) Balancing the SAM. The method used is the cross-entropy approach based on information theory developed by Shannon (1948) and brought to economics by Theil (1967). The estimation procedure minimizes the cross-entropy measure of the distance between prior coefficients and the new estimated coefficients, given a choice of constraints imposed on the basis of prior knowledge from the SAM (Kullback and Leibler, 1951).

Section 2.2 describes the construction of the macro or aggregate 2005 SAM for Ireland. Section 2.3 disaggregates the accounts to estimate a 55 sector unbalanced SAM for Ireland. Section 2.4 describes the technique used in balancing the SAM. Section 2.5 presents the multiplier values derived from the SAM and discusses the implications they have for policy. The conclusions are summarized in Section 2.6.<sup>2</sup>

## 2.2 Constructing the macro-SAM

The 2005 Irish Macro-SAM is shown in Table 2.2. The main source of data for the macro-SAM is the recently revised National Accounts System (CSO, 2009b) and the 2005 Supply and Use and Input-Output Tables for Ireland constructed by the CSO and published by Eurostat (2009).<sup>3</sup> Other sources of data are the marketing margins rate derived from the 2005 Input-Output Table (CSO, 2009e), Annual Accounts by Current Account, Institutional Sector, Year and Uses and Resources (AACA) (CSO, 2009a), Household Budget Survey 2004 - 2005 (HBS 04/05) (CSO, 2005d), Statistical Year Book of Ireland 2008 (SYB 2008) (CSO, 2009d), Service Exports and Imports 2006 (CSO, 2007), Institutional Sector Accounts Financial and Non-Financial 2007 (CSO, 2008d), Balance of International Payments (CSO, 2008a) and Revenue Commissioners (2006).

As a data framework, the design and construction of a Social Accounting Matrix is not standardized. The classification used in a SAM depends on the available data and the purposes of the study underlying its construction. There is no standard model or way of disaggregating and organising the data in a SAM. There are just two conditions that have to be fulfilled: the matrix should be square and the column total of each account should equal the row total of the same account. The cell entries are ref-

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<sup>2</sup>The pdf version of the 2005 SAM for Ireland is available from the IIIS website, URL: [http://www.tcd.ie/iiis/documents/A\\_2005\\_SAM\\_for\\_Ireland.pdf](http://www.tcd.ie/iiis/documents/A_2005_SAM_for_Ireland.pdf)

<sup>3</sup>The 2005 Supply and Use and Input-Output Tables for Ireland (CSO, 2009e) are published using a 53 sector commodity disaggregation. Eurostat (2009) published the full 55 sector commodity disaggregation which is used in this chapter.

erenced by their “row-column” position, i.e., gross value added is in the cell “*factor of production-activities*”, and are expressed in millions of euro. The following describes the macro-SAM entries and identifies their sources.

### **Row 1. Activities**

*Activities - Commodities - 331,360* - marketed production - total value of sales at purchaser prices in the activities row. This is the gross output figure reported in the 2005 Supply Table (CSO, 2009e). In principle, the value of household own consumption documented in the cell Activities-Households should be deducted from this figure. In practice this value is less than one million euro, as reported in the next paragraph and it is not subtracted out of the marketed production as it is assumed not to have a significant effect on the structure of the SAM.

*Activities - Households - 0.92* - private home consumption, home consumption of own production estimated from the (HBS 04/05) and (CSO, 2009e).<sup>4</sup>

### **Row 2. Commodities**

*Commodities - Activities - 188,169* - intermediate consumption at final use prices as documented in the Use Table (CSO, 2009e).

*Commodities-Commodities - 0* - marketing margins - are the trade and transport margins associated with domestic and imported goods. This value is computed when the SAM is generated, as the value of the trade and transport production activity less intermediate consumption and final demand for the specific sector. In the aggregate version of the SAM this cell is zero as the entries in this cell are revenues for the trade and transport commodities accounts and expenditure for all other commodities accounts. Consistency is ensured as the sum of the entries in this cell is equal to zero.

*Commodities - Households - 73,778* - private household marketed consumption plus consumption of private non-profit organisations serving households as documented in the 2005 Use Table (CSO, 2009e).

*Commodities - Government - 24,905* - government consumption as documented in the 2005 Use Table (CSO, 2009e).

*Commodities - Rest of the World - 132,368* - aggregate exports (FOB) as documented in the 2005 Input-Output Table (CSO, 2009e).

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<sup>4</sup>The estimation of own home consumption can be incorporated in the structure of the SAM for relevant analysis if need it.

Table 2.2: Numeric 2005 Irish macro SAM (million euro)

		PRODUCTION				INSTITUTIONS					
	1.	2.	3.	4.	5.	6.	7.	8.	9.	Total	
	ACT	COMM	FACT	HH	ENT	GOV	TAX	ROW	SAV	ACT	
1.	ACT	Marketed output (331,630)		Own consumption (0,92)						ACT income (331,361)	
2.	COMM	Intermediate inputs (188,169)	Trade and transport margins (0)	Private consumption (73,778)		Gov consumption (24,905)		Exports (132,368)	Investments (43,937)	Demand (463,157)	
3.	FACT	Value Added (143,083)						Factor from ROW (42,657)		Factor income (185,740)	
4.	HH			Inter-HH transfer (955)	Surplus to HH (3,941)	Transfers to HH (16,974)		Transfers from ROW (2,970)		HH Income (114,115)	
5.	ENT			Factor income to ENT (27,710)	Transfers to ENT (5,893)	Transfers to ENT (1,591)		Transfers from ROW (1,518)		ENT Income (38,095)	
6.	GOV			Factor income to GOV (1,179)			Taxes (50,179)	Transfers to GOV from ROW (454)		GOV Income (51,830)	
7.	TAX	Producer Tax, value added tax (108)	Sales Taxes, tariffs, export taxes (18,977)	Transfers to GOV, direct HH taxes (23,711)	Direct ENT taxes (7,233)	Custom Duties (150)				Taxation (50,179)	
8.	ROW		Imports (112,820)	Factor Income to ROW (67,558)	Factor Income to HH (109)	GOV transfers to ROW (527)		ROW Savings (5,071)	Capital transfers from ROW (76)	ROW Income (185,038)	
9.	SAV			HH Savings (9,669)	ENT Savings (21,590)	GOV Savings (7,683)		ROW Savings (5,071)	Capital Transfers (2,864)	Savings (46,877)	
Total	ACT (331,360)	Supply (463,157)	Factor Expenditure (185,740)	HH Expenditure (114,116)	ENT Expenditure (38,086)	GOV Expenditure (51,830)	Taxes (50,179)	ROW (185,038)	Investment (46,877)		

Source: Authors' calculation

*Commodities - Investment/Savings - 43,937* - gross capital accumulation (investment) including capital formation and inventory changes, as documented in the 2005 Input-Output Table (CSO, 2009e).

### **Row 3. Factors of Production**

*Factors of production - Activities - 143,083* - total value added as the sum of the primary factors of production, labour and capital, equivalent to GDP at factor cost, documented in the National Accounts System (CSO, 2009b).

*Factors of production - Rest of the World - 42,657* - represents the compensation of primary factors of production paid by the rest of the world from non-resident employers, as documented in (CSO, 2009a).

### **Row 4. Institutions/Current Account - Households**

*Households - Factors of production - 89,275* - wages, salaries and household enterprise profits; compensation of employees as documented in the 2005 Input-Output Table (CSO, 2009e) plus self-employed household enterprise value added as documented in (CSO, 2009a).

*Household - Household - 955* - inter household transfers. This value is taken from the (CSO, 2009a) and quantifies the transfer of income between households.

*Household - Enterprises - 3,941* - enterprises' retained earnings distributed to households represents the distributed profits, social benefits other than social benefits in kind and miscellaneous current transfers from enterprises to households, as documented in (CSO, 2009a).

*Household - Government - 16,974* - social security; information on retirement and social insurance, price subsidies for preferential goods, transfers to local authorities and other expenditures, documented in (CSO, 2009a) and Revenue Commissioners (2006).

*Household - Rest of the World - 2,970* - total net foreign transfers to households, represented by the social benefits other than social transfers in kind and miscellaneous current transfers from rest of the world to households (CSO, 2009a).

### **Row 5. Institutions/Current Account - Enterprises**

*Enterprises - Factors of production - 27,710* - gross profits including operating surplus and depreciation as documented in the 2005 Input-Output Tables (CSO, 2009e).

*Enterprises - Households - 5,893* - net non-life insurance premiums, social benefits and miscellaneous current transfers from enterprises to households as documented in (CSO, 2009a).

*Enterprises - Enterprises - 1,383* - miscellaneous current transfers within financial and non-financial corporations and non-life insurance claims from financial corporations to non-financial corporations as documented in (CSO, 2009a).

*Enterprises - Government - 1591* - enterprise subsidies plus miscellaneous current transfers from government to non-financial and financial institutions as documented in (CSO, 2009a).

*Enterprises - Rest of the World - 1,518* - total net foreign transfers to enterprises, such as non-life insurance claims received by non-financial and financial institutions from the rest of the world, reported in (CSO, 2009a).

#### **Row 6. Institutions/Current Account - Government**

*Government - Factor of production - 1,197* - gross operating surplus received by the government, reported in (CSO, 2009a).

*Government - Taxes - 50,179* - direct and indirect taxes and import tariffs, documented in (CSO, 2009b) and Revenue Commissioners (2006).

*Government - Rest of the world - 454* - net foreign transfers to government, i.e. foreign aid (grants) to government, current international cooperation, reported in the Balance of International Payments 2008 and (CSO, 2009a).

#### **Row 7. Institutions/Current Account - Taxes**

*Taxes - Activities - 108* - value added plus production activity taxes (e.g. turnover taxes from state enterprises, turnover taxes from non-state enterprises, VAT on imports plus production taxes), documented in the 2005 Input-Output Tables (CSO, 2009e).

*Taxes - Commodities - 18,977* - commodity taxes covering imports tariffs and special consumption taxes (e.g. indirect taxes on imports excluding VAT and special consumption (excise) taxes), documented in the 2005 Input-Output Tables (CSO, 2009e).

*Taxes - Households - 23,711* - current taxes on income, wealth, etc, social contributions by self-employed and non-employed persons and miscellaneous current transfers from households to the government, as documented in (CSO, 2009a).

*Taxes - Enterprises - 7,233* - current taxes on income, wealth, etc and miscellaneous current transfers from financial and non-financial institutions to government, documented in (CSO, 2009a).

*Taxes - Government - 150* - import tariffs and export refunds as documented in Revenue Commissioners (2006) and (CSO, 2009e).

#### **Row 8. External Account**

*Rest of the World - Commodities - 112,819* - aggregate imports (CIF) documented in the 2005 Input-Output Tables (CSO, 2009e).

*Rest of the World - Factors of production - 67,558* - wages and salaries paid to non-resident employees and property income received by the rest of the world as dividends payments on foreign capital invested in Ireland, documented in (CSO, 2009a) and the 2005 Input-Output Tables (CSO, 2009e).

*Rest of the World - Households - 109* - net non-life insurance, direct purchases made abroad by residents and miscellaneous current transfers from households to the rest of the world, documented in (CSO, 2009a).

*Rest of the World - Enterprises - 3,948* - enterprise transfers abroad, i.e. net non-life insurance premiums received by the rest of the world from financial and non-financial institutions, reported in (CSO, 2009a).

*Rest of the World - Government - 527* - net non-life insurance premiums, current international cooperation and miscellaneous current transfers from the government to the rest of the world reported in (CSO, 2008a) and (CSO, 2009a).

*Rest of the World - Savings - 76* - represents the acquisitions minus disposables of non-produced non-financial assets, and other capital transfers to the rest of the world, documented in (CSO, 2009a).

#### **Row 9. Capital Account**

*Investment/Savings - Households - 9,669* - household savings, documented in (CSO, 2009a).

*Investment/Savings - Enterprises - 21,590* - enterprise savings, i.e., financial and non-financial institutions savings as documented in Institutional Sector Accounts Financial and Non-Financial 2007.

*Investment/Savings - Government - 7,683* - government savings, reported in (CSO, 2009a).

*Investment/Savings - ROW - 5,071* - investment grants and other capital transfers from ROW to different institutions, (CSO, 2009a).

*Investment/Savings - Investment/Savings - 2,864* - net lending/borrowing from ROW of the Irish economy, documented in (CSO, 2009a) and Institutional Sector Accounts Financial and Non-Financial (CSO, 2008d).

Based on the data listed above, it can be observed from Table 2.2 that the accounts of what we call the macro social accounting matrix are balanced. Each and every one of the accounts shown in Table 2.2 can be further disaggregated to allow more detailed policy analysis. A well known method is to start disaggregating following a hierarchical top-down tree structure. The next section undertakes this step in constructing a 2005 SAM for Ireland.

### **2.3 The 55 sector 2005 Irish SAM**

This section describes the main steps in disaggregating the macro-SAM into a 55 sector SAM for the Irish economy.

#### **Activity/Commodity Accounts**

The first step in the construction of the SAM is to break down the activities and commodities accounts into the 55 sector disaggregation according to the 2005 Input-Output Table (Eurostat, 2009).<sup>5</sup> In the formulation of the macro-SAM, there is only one account for activities and one for commodities. Making use of the symmetric input-output table and for the sake of simplicity it is assumed that each activity produces one type of product; therefore we have 55 activities producing 55 commodities.

#### **Factors of Production Account**

One of the main differences between the SAM approach and I-O methodology is that the former takes explicitly into account the distribution of income. A SAM offers an overview of the full circular flow of income between production, factors of production and institutions in the economy. Therefore, for a better understanding of the distribution of income from primary factors to households, government and the external sector, we disaggregate the factors of production into labour and capital. This

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<sup>5</sup>The industry classification and labelling of the SAM accounts are presented in the Appendix A 1

disaggregation was done using the information provided by the Input-Output Tables (CSO, 2009e) and the National Account System (CSO, 2009b).

### **Taxes Account**

The taxes account is split into direct and indirect taxes and custom duties. Direct taxes are paid by the households and enterprises, while the indirect taxes represent: (i) payments by activities for such items as business licenses, departure charges, motor vehicle taxes, road tolls, stamp duty, and other non-tax revenue, and (ii) commodity tax entry, such as excises and value-added tax. Import tariff and export tax rates by commodity category were derived from trade information from Revenue Commissioners (2006). The government receives income from taxes (direct and indirect) and transfers from the external sector and import duties.

### **Trade and Transport Margins**

Trade and transport margins were directly taken from the 2005 Supply Table (CSO, 2009e) and represent the cost of managing and transporting commodities. This account row distributes the margins from the trade sectors over all other sectors and the column is the total margins for the trade sectors identified as the retail, wholesale and motor transport sectors.

### **External Account**

The external account is split into three according to the export and import main destinations: UK, Rest of the EU and Rest of the World, based on the external account chapter in the Statistical Yearbook of Ireland 2008 (CSO, 2009d).

Overall, the above disaggregation results in a 124x124 Irish Social Accounting Matrix for 2005, with 55 activities producing 55 commodities, 2 factors of production, 3 institutions (households, enterprises and government), 3 tax-related accounts (direct, indirect tax and custom duties), 3 external accounts (UK, REU and ROW) and one savings/investments account.<sup>6</sup> However, the SAM at this stage is now unbalanced. The procedure to balance the SAM is described in the next section.

## **2.4 Balancing the SAM using a cross-entropy approach**

Because of problems of data availability and consistency and the fact that the SAM is constructed using a variety of data sources, the initial disaggregated SAM is not balanced. The Robinson et al., (2001) cross-entropy (CE) approach was used in order

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<sup>6</sup>The structure of this SAM is similar with other SAM's constructed for Ireland. This 2005 SAM for Ireland provides a greater degree of disaggregation for the activity/commodity, external and tax accounts.

to obtain a balanced and consistent SAM starting from an unbalanced data base that contains all available information. The method is described below.

The SAM is seen as a matrix  $\mathbf{T}_{ij}$  of economic flows from an account  $i$  to an account  $j$ , representing expenditures and receipts of all the economic agents. Total expenditure and total receipts of an agent  $i$  must therefore be equal:

$$y_i = \sum_j \mathbf{T}_{ij} = \sum_j \mathbf{T}_{ji} \quad (2.1)$$

Dividing each cell entry of the matrix  $T$  by its column total we obtain a new column matrix  $A$ :

$$\mathbf{A}_{ij} = \frac{\mathbf{T}_{ij}}{y_i}, \text{ where } \sum_j \mathbf{A}_{ij} = 1, (\forall) i \quad (2.2)$$

The cross-entropy approach assumes that we have (i) information in the form of a preliminary matrix  $\bar{\mathbf{A}}_{ij}$  representing inconsistent and unbalanced data and (ii) exact information on the column totals. Therefore, the CE approach is described by the following optimization problem:

$$\min \sum_i \sum_j \mathbf{A}_{ij} * \ln \frac{\mathbf{A}_{ij}}{\bar{\mathbf{A}}_{ij}} = \min (\sum_i \sum_j \mathbf{A}_{ij} * \ln \mathbf{A}_{ij} - \sum_i \sum_j \mathbf{A}_{ij} * \ln \bar{\mathbf{A}}_{ij}) \quad (2.3)$$

subject to:

$$\sum_i \mathbf{A}_{ij} * y_j = y_i$$

$$\sum_j \mathbf{A}_{ij} = 1, \text{ where } \mathbf{A}_{ij} \in [0, 1]$$

In other words, the problem consists of finding a new  $\mathbf{A}_{ij}$  which minimizes the entropy distance between the preliminary  $\bar{\mathbf{A}}_{ij}$  and the newly estimated coefficient matrix.

Note that when  $x = 0$ ,  $x \ln x = 0$ . Therefore, in order to allow for zero entries in the SAM in the computer code, we add an epsilon small number to the arguments of the equation (2.3). Given that the equality in all but one row and column sum hold, the sum of the last row and column are also equal. Therefore one equation can be dropped,

in this case it is the rest of the world equation which is then set exogenously.

Additional equality and inequality constraints are formulated as linear constraints on the SAM elements. According to Robinson et al (2001) imposing a set of known information can significantly improve the estimates “even when information is added in an imprecise way”. Therefore we impose the following additional constraints: first, total GDP was fixed at its original value, reported in the national accounts, and equal with the GDP value reported in the SAM as well; second, the sum of overall factor payments is fixed to the aggregate value specified in the macro SAM (Table 2.2); third, trade flows (total imports and exports) are fixed to their initial level; and fourth, final demand categories (household and government consumption and investment) are fixed to their aggregate values. The aim of this approach is to use all available information in order to minimize the cross-entropy between the probabilities that are consistent with the information in the data and the prior information. Consequently the new SAM does not show any changes in these cells and columns compared with the initial SAM. The balanced macro-SAM is presented in Table 2.3.

**Table 2.3: New Macro-SAM for 2005 (million euro)**

	1. ACT	2. COMM	3. FACT	4. HH	5. ENT	6. GOV	7. TAX	8. ROW	9. SAV	TOTAL
1.ACT		331,245 (-0.03)								331,245
2.COMM	188,019 (-0.08)			73,918 (0.19)		24,934 (0.12)		132,522 (0.12)	43,937	463,330
3.FACT	143,118 (0.02)							42,698 (0.10)		185,816
4.HH			89,463 (0.21)	944 (-1.11)	3933 (-0.20)	16,934 (-0.23)		2,844 (-4.24)		114,119
5.ENT			27,811 (0.37)	5,818 (-1.28)	1,380 (-0.21)	1,587 (-0.23)			1,499 (-1.26)	38,095
6.GOV			1,287 (6.88)				50,205 (0.05)	331 (-27.18)		51,822
7.TAX	109 (1.00)	19,001 (0.13)		23,698 (-0.05)	7,274 (0.19)	150				50,205
8.ROW		113,083 (0.23)	67,255 (-0.45)	108 (-1.04)	3,929 (-0.48)	521 (-1.09)			76 (-0.06)	184,972
9.SAV				9,633 (-0.37)	21,606 (0.08)	7,695 (0.16)		5,078 (0.12)	2,869 (0.18)	46,882
TOTAL	331,245 (-0.03)	463,330 (0.04)	185,816 (0.04)	114,119	38,095	51,822 (-0.01)	50,205 (0.05)	184,972 (-0.04)	46,882 (0.01)	

Source: Authors' calculation

Note: Percentage changes from initial unbalanced SAM reported in paranthesis

The biggest difference between the initial macro-SAM and the balanced macro-SAM occurs in the reallocation of custom duties. The demand for intermediate inputs is unrestricted in the balancing process. Therefore, intermediate input demand decreases by €150 million, including total marketing margins for exports, to adjust to

total value added. Taxes are split between direct and indirect taxes and custom duties in the SAM before balancing. Consequently, once aggregating the balanced SAM the custom duties are redistributed along the Tax row. Producer taxes and value added taxes increase by 1 percent as well as sales taxes by 0.13 percent. Overall there is a 0.05 percent change in taxes compared with the prior unbalanced SAM.

The distribution of factor income increased by 0.21 percent from the initial factor income payments to households and by almost 7 percent for government factor payments. The government receives €90 million more in capital distribution and €123 million less remittances from abroad. As a result, government expenditure decreases by €8 million.

In the initial unbalanced SAM the column sums do not equal the row sums, implying that it is not possible to achieve a cross entropy measure of zero, as the prior is not feasible. Therefore, the goal is to find a new feasible SAM that is close to the prior.

## **2.5 Descriptive and multiplier analysis using the 2005 Irish social accounting matrix**

### **2.5.1 Main aggregates in the 2005 SAM**

As a general overview of the SAM, we briefly discuss the sources of income and expenditure by major account shown in Table 2.3. The activity/commodity account receives income from selling its goods and services on both domestic and external markets. Sales within this account contribute 41 percent, while the external sector accounts for 29 percent, of its income. Households provide the third largest source of income with 16 percent. The capital account contributes 9 percent, representing purchased goods from activities for the purpose of investment. The government account purchased goods worth 5 percent of the total income for the activity account. About 31 percent of the activity/commodity account was spent on remunerating factors, 41 percent on purchases between the activities themselves, while 24 percent was used to import intermediate inputs and 4 percent was spent on government taxes.

Labour and capital are the only factors included in the SAM factor account and are owned by institutions. The percentage shares in which the factor account spends its revenue are as follows, 48 percent accruing to households, 15 percent to enterprises, 36 percent to the ROW, and only 1 percent to government. The revenue of the factor account comes from two major sources, the activity/commodity account with 77 percent and the rest of the world account with 23 percent. As the principal owners of

labour and capital, households receive the biggest share, 78 percent, of their income from factors, while government, through transfers, accounts for 15 percent, followed by ROW and enterprises with 3 percent each and inter-household transfers with 1 percent. Households spend most of their income, 65 percent, on commodities produced by domestic activities, pay government about 21 percent of their income as tax and 5 percent to enterprises as net non-life insurance premium and miscellaneous transfers while savings accounts for 8 percent.

Enterprises receive 73 percent of their income from ownership of factors, 15 percent as household transfers, while government and ROW provide 4 percent each in the form of grants and subsidies, and royalties, profits and similar sources, respectively. Inter-enterprise transfers account for another 4 percent. This account spends 19 percent of its revenue as tax, while 57 percent was used for investment or capital formation, 10 percent spent on imported goods and 10 percent on households. The government account obtains its revenue from the tax account which collects indirect, direct and custom duties from the activities and institution accounts, approximately 38 percent in indirect tax, 47 percent in direct taxes from households, 14 percent in enterprises direct tax and 1 percent in custom duties. The biggest share of its revenue is spent on goods, 48 percent. The government allocates 33 percent as income transfers to households while enterprises received 3 percent of it expenditures. Only 1 percent of expenditure went to the ROW in the form of international cooperation and/or miscellaneous transfers and 15 percent was used for investment in capital.

There are two sources of income for the ROW account; the activities account with 61 percent and the factors with 37 percent, the remaining 2 percent represent transfers from the government and capital account as import payments. The income is spent mostly on buying commodities, 72 percent, and on the factor account, 23 percent in the form of wages and property income, 3 percent in returns to capital and 2 percent are distributed to households. The capital account receives the bulk of its income from private institutions, 67 percent, and from government, 16 percent. The ROW is the third most important contributor with 11 percent, which consists of foreign capital inflows. As far as capital expenditure is concerned, 94 percent is spent on activities. The remaining 6 percent represents transfers between the capital account and serves as a balancing factor.

The descriptive statistics presented above is in line with the main aggregates provided by the CSO National Accounts for 2005 and the Annual Accounts by Current Account, Institutional Sector, Year and Uses and Resources, 2005.

## 2.5.2 Multiplier analysis

A SAM is a database and not a model per se. It can be transformed into an economic model if it is assumed that all relations are of the linear type, prices are fixed and that all production activities function under the condition of excess demand, following Pyatt and Round (1979). The SAM is a singular square matrix and the first step in developing a SAM-based multiplier model is to calculate the column shares (coefficients) in order to compute the matrix multipliers. One or more accounts have to be made exogenous to allow the matrix to be invertible and consequently to calculate the multipliers.

For the multipliers reported in this section, the government account, the rest of the world account, the capital account and the account for indirect taxes are regarded as exogenous accounts as these accounts are either politically determined or outside domestic control. The remaining accounts are viewed as endogenous and include the production (activities, commodities), factors of production (value added) and institutions (households and enterprises) accounts. Consequently, the model becomes a demand-driven Keynesian model, as supply is assumed to adjust to demand. Table 2.4 shows a simplified macro SAM with four types of accounts: production activities, factors, institutions (households and enterprises) and one exogenous account. For simplicity, the exogenous accounts are aggregated into a single account which records the injections into the system and the leakages from it. The leakages include transfer income sent to the rest of the world, institutional savings, indirect taxes and imports, and the injections include transfers from the rest of the world, government transfers to institutions (households and enterprises), government consumption and export demand.

**Table 2.4:** Macro-SAM, Multiplier analysis

	Endogenous Accounts			Exogenous Accounts	Total Income
	Production Activities	Factors of Production	Institutions (Households and Enterprise)	Sum of other accounts	
Production Activities	$T_{11}$		$T_{13}$	$X_1$	$Y_1$
Factors of Production	$T_{21}$			$X_2$	$Y_2$
Institutions (Households and Enterprise)		$T_{32}$	$T_{33}$	$X_3$	$Y_3$
Sum of other accounts	$L_1$	$L_2$	$L_3$	$T$	$YX$
Total Expenditures	$Y_1$	$Y_2$	$Y_3$	$YX$	

Source: Adapted from Defourny and Thorbecke, (1984)

To introduce the multiplier analysis the following transaction matrix is defined:

$$\mathbf{T} = \begin{bmatrix} \mathbf{T}_{11} & 0 & \mathbf{T}_{13} \\ \mathbf{T}_{21} & 0 & 0 \\ 0 & \mathbf{T}_{32} & \mathbf{T}_{33} \end{bmatrix}$$

where  $\mathbf{T}_{11}$  is the matrix of intermediate inputs needed;  $\mathbf{T}_{13}$  is the matrix of consumption expenditure of institutions;  $\mathbf{T}_{21}$  is the value added (labour and capital) matrix generated by activities;  $\mathbf{T}_{32}$  is the income distribution matrix between institutions; and  $\mathbf{T}_{33}$  is the matrix of transfers between institutions.

The revenue or income of the endogenous accounts is represented by  $Y_1$ ,  $Y_2$  and  $Y_3$ , which are the production activities, factors and institutions revenue, respectively. The sum of the exogenous injections is consolidated into one vector  $X_i, i = 1, 2, 3$ , and  $L_i, i = 1, 2, 3$  represents the corresponding leakages.

In the transaction matrix, each endogenous total income,  $Y_i, i = 1, 2, 3$ , is given by the following equation:

$$Y_i = \mathbf{A}_i Y_i + X_i \quad (2.4)$$

Therefore, by definition:

$$\begin{aligned} Y_1 &= \mathbf{T}_{11} + \mathbf{T}_{13} + X_1 \\ Y_2 &= \mathbf{T}_{21} + X_2 \\ Y_3 &= \mathbf{T}_{32} + \mathbf{T}_{33} + X_3 \end{aligned} \quad (2.5)$$

or in matrix algebra :

$$Y = \mathbf{T} + X \quad (2.6)$$

By dividing each element in any of the endogenous accounts by its total income (column total),  $\mathbf{A}_{ij} = \mathbf{T}_{ij}/Y_j$ , the matrix  $\mathbf{A}_i$  of average expenditure propensities is constructed.

$$\mathbf{A}_i = \begin{bmatrix} \mathbf{A}_{11} & 0 & \mathbf{A}_{13} \\ \mathbf{A}_{21} & 0 & 0 \\ 0 & \mathbf{A}_{32} & \mathbf{A}_{33} \end{bmatrix}$$

Re-writing equation (2.4)

$$Y_i = (I - \mathbf{A}_i)^{-1}X = \mathbf{M}X \quad (2.7)$$

This equation shows the income  $Y_i$  of each endogenous account following an exogenous injection,  $X$ . The inverse matrix,  $\mathbf{M}$ , is the multiplier matrix obtained in a SAM multiplier analysis.

Equation (2.5) can be further re-written:

$$\begin{aligned} Y_1 &= \mathbf{A}_{11}Y_1 + \mathbf{A}_{13}Y_3 + X_1 \\ &= (I - \mathbf{A}_{11})^{-1}\mathbf{A}_{13}Y_3 + (I - \mathbf{A}_{11})^{-1}X_1 \\ &= (I - \mathbf{A}_{11})^{-1}(\mathbf{A}_{13}Y_3 + X_1) \\ Y_2 &= \mathbf{A}_{21}Y_1 + X_2 \\ Y_3 &= \mathbf{A}_{32}Y_2 + \mathbf{A}_{33}Y_3 + X_3 \\ &= (I - \mathbf{A}_{33})^{-1}\mathbf{A}_{32}Y_2 + (I - \mathbf{A}_{33})^{-1}X_3 \\ &= (I - \mathbf{A}_{33})^{-1}(\mathbf{A}_{32}Y_2 + X_3) \end{aligned} \quad (2.8)$$

Consequently, equation (2.8) provides the main difference between an I-O multiplier analysis and the SAM multiplier analysis. In the I-O multiplier analysis  $\mathbf{A}_{13}Y_3$  is determined exogenously. If we calculate the SAM multiplier assuming no endogenous final demand (the main assumption of the input-output model), even though  $\mathbf{A}_{13}Y_3$  is part of the exogenous final demand, it depends on the level and distribution of income and is determined simultaneously with  $Y_1$ . The input-output multipliers will be smaller than the SAM multipliers with or without endogenized household demand in both analyses.

Pyatt and Round (1979) suggest that the multiplier matrix  $\mathbf{M}$  can be decomposed into three multiplicative components: (i)  $\mathbf{M}_1$ , the transfer matrix or the direct effect multipliers which includes the Leontief output multipliers; (ii)  $\mathbf{M}_2$ , the open-loop matrix, which defines the indirect multipliers and captures the cross effects between different groups; and (iii)  $\mathbf{M}_3$ , the closed-loop matrix that captures the effect of an exogenous inflow on an endogenous account, revealing the full circular flow. Their suggested decomposition is as follows:

From equation (2.4), it follows that for any matrix  $\tilde{\mathbf{A}}_i$  of the same size as  $\mathbf{A}_i$ , such that the inverse  $(I - \tilde{\mathbf{A}}_i)^{-1}$  exists, one can write:

$$\begin{aligned}
Y_i &= \mathbf{A}_i Y_i + X \\
&= (\mathbf{A}_i - \tilde{\mathbf{A}}_i) Y_i + \tilde{\mathbf{A}}_i Y_i + X \\
&= (I - \tilde{\mathbf{A}}_i)^{-1} (\mathbf{A}_i - \tilde{\mathbf{A}}_i) Y_i + (I - \tilde{\mathbf{A}}_i)^{-1} X \\
&= \dot{\mathbf{A}}_i Y_i + (I - \tilde{\mathbf{A}}_i)^{-1} X
\end{aligned} \tag{2.9}$$

where  $\tilde{\mathbf{A}}_i$  is the diagonal bloc matrix extracted from matrix  $\mathbf{A}_i$ :

$$\tilde{\mathbf{A}}_i = \begin{bmatrix} \mathbf{A}_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \mathbf{A}_{33} \end{bmatrix}$$

and  $\dot{\mathbf{A}}_i = (I - \tilde{\mathbf{A}}_i)^{-1} (\mathbf{A}_i - \tilde{\mathbf{A}}_i)$

Multiplying by  $\dot{\mathbf{A}}_i$ :

$$\dot{\mathbf{A}}_i Y_i = \dot{\mathbf{A}}_i^2 Y_i + \dot{\mathbf{A}}_i (I - \tilde{\mathbf{A}}_i)^{-1} X \tag{2.10}$$

Now subtracting  $\dot{\mathbf{A}}_i Y_i$ :

$$\begin{aligned}
Y_i &= \dot{\mathbf{A}}_i^2 + \dot{\mathbf{A}}_i (I - \tilde{\mathbf{A}}_i)^{-1} X + (I - \tilde{\mathbf{A}}_i)^{-1} X \\
&= \dot{\mathbf{A}}_i^2 + (I - \tilde{\mathbf{A}}_i)^{-1} (I + \tilde{\mathbf{A}}_i)^{-1} X
\end{aligned} \tag{2.11}$$

Similarly, if equation (2.9) is multiplied by  $\dot{\mathbf{A}}_i^2$  and we then subtract  $\dot{\mathbf{A}}_i^2 Y_i$  we get:

$$Y_i = (I - \dot{\mathbf{A}}_i^3)^{-1} (I + \dot{\mathbf{A}}_i + \dot{\mathbf{A}}_i^2) (I - \tilde{\mathbf{A}}_i)^{-1} X \tag{2.12}$$

Equation (2.12) decomposes matrix  $\mathbf{M}$  into a product of three multiplier matrices  $\mathbf{M}_1, \mathbf{M}_2, \mathbf{M}_3$ .

$$\mathbf{M} = \mathbf{M}_3 \mathbf{M}_2 \mathbf{M}_1 \tag{2.13}$$

Using equation (2.13), Stone (1985) and further developed by Pyatt and Round (1985) showed that the multiplier matrix  $\mathbf{M}$  can be decomposed into four additive terms in order to provide an easier way of interpreting the results of a SAM multiplier analysis, of the form:<sup>7</sup>

<sup>7</sup>The additive decomposition is not unique (Round, 2003).

$$M = I + N_1 + N_2 + N_3 \quad (2.14)$$

with

$$\begin{aligned} N_1 &= M_1 - I \\ N_2 &= (M_2 - I)M_1 = M_2M_1 - M_1 \\ N_3 &= (M_3 - I)M_2M_1 = M_3M_2M_1 - M_2M_1 \end{aligned} \quad (2.15)$$

The first term,  $I$ , is the initial injection or diagonal identity matrix representing the impact of the exogenous shock on each account. The second term,  $N_1$ , captures the direct effect within the blocks or intra-group effects as in the Leontief inverse in I-O analysis. The third term,  $N_2$ , describes the net contribution of between blocks or extra-group effects affected by the shock as a consequence of a complete tour outside the original accounts without returning to it. The fourth term,  $N_3$ , describes the net contribution of within-blocks or inter-group effects that arise from the shock having completed a tour through all groups of accounts and returned to the one where it originally started.

Table 2.5 presents the SAM multiplier matrix,  $M$ , derived from the 2005 Irish SAM. Consider, for example, the multipliers shown in the first column of Table 2.5 for the Agriculture industry. For illustrative purposes, the standard assumption of an increase of €100 million in exogenous demand is adopted. Therefore, a €100 million increase in exogenous demand for agricultural products, induces an additional increase of €27 million in agricultural output as well as increases in the output of the food processing and chemical sectors of €16 million and €11 million, respectively. Overall the €100 million increase in the demand for agricultural products generates a total increase in aggregate output of €208.6 million.

In addition to output multipliers, it is also possible to calculate value added or GDP multipliers and household income multipliers. GDP multipliers show the increase in economy-wide value added at factor cost in response to a change in the exogenous accounts. For example, looking again at column 1 of Table 2.5, a €100 million increase in the final demand for agricultural output would lead to an increase in GDP at factor cost of €106.4 million. The income multiplier measures the total change in household incomes in response to the exogenous shock. For example, an increase of €100 million in agricultural output would lead to a total increase in household income of €42.1

Table 2.5: The Multiplier Matrix, M

Sectors	A_AGR1	A_FORE	A_FISH	A_CPUM	A_MING	A_FOOD	A_TABA	A_TEXT	A_FURS	A_LETH	A_WOOD	A_PAPE	A_PRME	A_PEMP	A_CHIM
A_AGR1	1.271	0.023	0.018	0.013	0.015	0.258	0.138	0.016	0.012	0.014	0.014	0.016	0.009	0.009	0.009
A_FORE	1.503	0.002	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.002	0.002	0.001	0.000	0.004	0.000
A_FISH	0.002	1.060	0.001	0.001	0.001	0.008	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A_CPUM	0.004	0.008	0.005	1.051	0.010	0.003	0.002	0.003	0.003	0.002	0.004	0.003	0.001	0.001	0.001
A_MING	0.005	0.002	0.001	0.004	1.096	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.003	0.001
A_FOOD	0.162	0.054	0.062	0.029	0.034	1.134	0.042	0.034	0.027	0.033	0.033	0.036	0.021	0.021	0.020
A_TABA	0.001	0.001	0.000	0.001	0.001	0.001	1.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
A_TEXT	0.001	0.002	0.003	0.001	0.001	0.001	1.056	0.001	0.040	0.026	0.001	0.001	0.001	0.001	0.001
A_FURS	0.001	0.002	0.001	0.001	0.001	0.001	0.001	1.017	0.002	0.001	0.001	0.001	0.001	0.001	0.000
A_LETH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.005	0.000	0.000	0.000	0.000	0.000	0.000
A_WOOD	0.002	0.009	0.002	0.003	0.003	0.002	0.005	0.004	0.003	0.002	1.134	0.004	0.001	0.034	0.001
A_PAPE	0.002	0.003	0.001	0.001	0.001	0.007	0.010	0.004	0.004	0.003	0.005	1.096	0.006	0.004	0.002
A_PRME	0.007	0.069	0.005	0.007	0.008	0.007	0.006	0.008	0.006	0.007	0.013	0.022	1.040	0.005	0.006
A_PEMP	0.018	0.046	0.026	0.015	0.033	0.012	0.008	0.013	0.008	0.009	0.017	0.011	0.005	1.042	0.005
A_CHIM	0.110	0.051	0.014	0.031	0.027	0.046	0.023	0.096	0.038	0.056	0.056	0.053	0.014	0.015	1.114
A_RUBB	0.004	0.005	0.007	0.006	0.005	0.007	0.002	0.005	0.004	0.003	0.007	0.011	0.002	0.010	0.003
A_NOME	0.005	0.008	0.002	0.006	0.074	0.004	0.002	0.003	0.002	0.002	0.004	0.002	0.002	0.014	0.002
A_BAME	0.002	0.003	0.002	0.004	0.002	0.002	0.001	0.001	0.003	0.003	0.004	0.004	0.001	0.007	0.001
A_MEMA	0.013	0.010	0.006	0.011	0.008	0.007	0.004	0.007	0.006	0.010	0.023	0.007	0.002	0.016	0.002
A_MAEQ	0.008	0.005	0.002	0.009	0.003	0.003	0.003	0.003	0.002	0.003	0.007	0.004	0.001	0.003	0.002
A_OFMA	0.002	0.030	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.005	0.003	0.002	0.002	0.002
A_ELMA	0.001	0.004	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.001
A_RATV	0.003	0.007	0.002	0.003	0.004	0.002	0.003	0.002	0.002	0.003	0.003	0.003	0.002	0.002	0.002
A_MEDI	0.002	0.004	0.004	0.002	0.002	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.002
A_MOTO	0.001	0.003	0.001	0.002	0.002	0.001	0.001	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.001
A_OTTR	0.000	0.010	0.009	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
A_RECY	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000
A_ELGA	0.031	0.063	0.040	0.052	0.055	0.027	0.016	0.032	0.020	0.017	0.049	0.029	0.010	0.022	0.014
A_WATE	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.000	0.003	0.003	0.002	0.001	0.001
A_CONS	0.020	0.098	0.020	0.035	0.031	0.010	0.008	0.008	0.007	0.008	0.029	0.009	0.005	0.010	0.005
A_TRAD	0.005	0.005	0.003	0.011	0.009	0.003	0.002	0.003	0.002	0.003	0.004	0.003	0.002	0.003	0.002
A_WHSL	0.010	0.021	0.006	0.008	0.020	0.018	0.006	0.009	0.007	0.009	0.011	0.009	0.129	0.010	0.008
A_RETS	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.009	0.001	0.001
A_FORE	0.033	0.069	0.024	0.031	0.045	0.032	0.039	0.038	0.033	0.047	0.040	0.043	0.023	0.026	0.020
A_LATR	0.013	0.066	0.016	0.055	0.205	0.031	0.016	0.031	0.022	0.048	0.055	0.039	0.012	0.025	0.007
A_WATR	0.001	0.001	0.015	0.001	0.004	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
A_AITR	0.006	0.019	0.006	0.008	0.033	0.009	0.015	0.009	0.006	0.007	0.007	0.010	0.009	0.008	0.008
A_OTTRS	0.014	0.033	0.025	0.019	0.034	0.016	0.017	0.019	0.015	0.019	0.020	0.020	0.015	0.013	0.011
A_POTL	0.025	0.048	0.019	0.023	0.037	0.024	0.031	0.029	0.025	0.035	0.030	0.028	0.023	0.018	0.017
A_FISE	0.062	0.090	0.043	0.083	0.079	0.058	0.043	0.049	0.040	0.052	0.042	0.043	0.035	0.037	0.033
A_INSE	0.031	0.071	0.072	0.036	0.040	0.023	0.039	0.032	0.033	0.056	0.033	0.037	0.019	0.024	0.016
A_OFISE	0.012	0.022	0.015	0.020	0.019	0.013	0.014	0.014	0.012	0.017	0.012	0.013	0.009	0.010	0.009
A_REES	0.048	0.131	0.030	0.052	0.056	0.041	0.047	0.055	0.045	0.054	0.068	0.058	0.033	0.034	0.029
A_RESE	0.006	0.043	0.011	0.010	0.061	0.007	0.005	0.007	0.007	0.007	0.012	0.008	0.007	0.006	0.004
A_COSE	0.012	0.032	0.010	0.033	0.028	0.017	0.028	0.019	0.013	0.037	0.019	0.021	0.027	0.017	0.036
A_RESH	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.007	0.001	0.008
A_OTBU	0.047	0.067	0.028	0.062	0.042	0.107	0.038	0.040	0.044	0.048	0.044	0.044	0.116	0.039	0.158
A_PUAD	0.011	0.007	0.008	0.007	0.007	0.005	0.005	0.004	0.002	0.005	0.004	0.004	0.003	0.004	0.003
A_EDUS	0.012	0.020	0.007	0.013	0.014	0.010	0.011	0.014	0.011	0.013	0.014	0.015	0.008	0.008	0.007
A_HEAS	0.034	0.021	0.012	0.013	0.014	0.016	0.016	0.016	0.013	0.014	0.015	0.016	0.009	0.010	0.010
A_SEWA	0.004	0.009	0.013	0.006	0.006	0.006	0.009	0.013	0.015	0.015	0.015	0.015	0.005	0.003	0.003
A_MNEC	0.006	0.025	0.002	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.006	0.005	0.003	0.003	0.002
A_RECS	0.009	0.081	0.005	0.008	0.010	0.008	0.008	0.010	0.009	0.010	0.024	0.010	0.005	0.006	0.005
A_OTSE	0.005	0.009	0.015	0.010	0.010	0.006	0.004	0.007	0.005	0.009	0.007	0.009	0.003	0.005	0.003
A_PRHO	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.000	0.000	0.000
Output Multipliers	2.086	2.920	1.682	1.808	2.202	2.010	1.686	1.743	1.582	1.711	2.052	1.780	1.641	1.660	1.597
Income Multipliers	1.064	1.022	0.779	0.775	0.788	0.747	0.953	0.738	0.618	0.767	0.794	0.748	0.605	0.462	0.605
Input Multipliers	0.644	0.850	0.442	0.584	0.609	0.504	0.597	0.606	0.501	0.583	0.617	0.630	0.397	0.371	0.381

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Table 2.5: The Multiplier Matrix, M - Continued

Sectors	A.RUBB	A.NOME	A.BAME	A.MEMA	A.MAFQ	A.FOMA	A.ELMA	A.RATV	A.MEDI	A.MOTO	A.OTTR	A.RECY	A.FLGA	A.WATE	A.CON5
A.AGRI	0.014	0.013	0.010	0.013	0.013	0.008	0.011	0.009	0.012	0.012	0.018	0.010	0.011	0.017	0.017
A.FORE	0.002	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.005
A.FISH	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
A.CPUM	0.005	0.008	0.008	0.009	0.005	0.001	0.002	0.002	0.003	0.004	0.004	0.014	0.050	0.006	0.004
A.MING	0.003	0.047	0.008	0.002	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.020
A.FOOD	0.034	0.031	0.022	0.030	0.029	0.018	0.026	0.020	0.031	0.027	0.040	0.023	0.024	0.040	0.035
A.LABA	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A.TEXT	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A.FURS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A.ETH	0.012	0.004	0.004	0.002	0.004	0.002	0.001	0.002	0.002	0.002	0.002	0.001	0.003	0.003	0.022
A.WOOD	0.003	0.005	0.002	0.002	0.007	0.003	0.001	0.002	0.003	0.002	0.002	0.002	0.001	0.003	0.022
A.PAPE	0.007	0.007	0.006	0.007	0.007	0.007	0.008	0.009	0.007	0.007	0.008	0.005	0.010	0.025	0.015
A.PREP	0.017	0.020	0.032	0.012	0.030	0.005	0.009	0.012	0.012	0.009	0.012	0.013	0.056	0.018	0.015
A.CHIM	0.078	0.006	0.040	0.023	0.019	0.015	0.017	0.041	0.056	0.022	0.018	0.021	0.013	0.040	0.029
A.RUBB	1.078	0.006	0.004	0.008	0.012	0.002	0.005	0.004	0.016	0.022	0.005	0.003	0.003	0.008	0.017
A.NOME	1.104	0.007	0.006	0.007	0.005	0.001	0.003	0.002	0.002	0.002	0.003	0.002	0.003	0.007	0.056
A.BAME	0.013	0.010	1.053	0.013	0.093	0.002	0.003	0.003	0.005	0.003	0.003	0.002	0.003	0.007	0.036
A.MEMA	0.029	0.013	0.023	0.023	1.051	0.005	0.005	0.007	0.010	0.023	0.006	0.017	0.011	0.009	0.032
A.MABQ	0.011	0.007	0.012	0.012	1.042	0.005	0.005	0.007	0.012	0.006	0.011	0.004	0.016	0.017	0.010
A.OFMA	0.003	0.002	0.002	0.003	0.003	1.307	0.036	0.060	0.008	0.020	0.004	0.002	0.007	0.007	0.006
A.ELMA	0.003	0.002	0.001	0.002	0.002	0.018	1.080	0.024	0.002	0.023	0.018	0.002	0.004	0.003	0.013
A.RATV	0.004	0.003	0.002	0.003	0.005	0.045	0.047	1.147	0.012	0.111	0.006	0.002	0.003	0.003	0.006
A.MEDI	0.002	0.002	0.001	0.001	0.003	0.012	0.004	0.015	1.160	0.004	0.009	0.001	0.002	0.008	0.004
A.MOTO	0.002	0.002	0.000	0.002	0.002	0.001	0.001	0.001	1.009	0.002	0.001	0.001	0.001	0.002	0.002
A.OTTR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
A.RECY	0.001	0.001	0.040	0.001	0.001	0.000	0.000	0.000	0.000	0.002	0.001	1.068	0.000	0.000	0.001
A.FLGA	0.042	0.058	0.055	0.042	0.026	0.010	0.020	0.025	0.018	0.021	0.029	0.031	1.274	0.097	0.023
A.WATE	0.001	0.001	0.007	0.002	0.002	0.003	0.000	0.001	0.002	0.014	0.001	0.001	0.000	0.000	0.001
A.CON5	0.009	0.011	0.010	0.010	0.010	0.008	0.015	0.009	0.006	0.008	0.018	0.007	0.015	1.015	0.001
A.TRAD	0.003	0.004	0.003	0.003	0.003	0.004	0.015	0.009	0.006	0.008	0.018	0.002	0.015	0.086	0.004
A.WHSL	0.009	0.015	0.008	0.008	0.009	0.071	0.025	0.015	0.014	0.011	0.010	0.009	0.011	0.013	0.014
A.RETS	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A.HORE	0.040	0.037	0.025	0.035	0.035	0.030	0.030	0.022	0.031	0.034	0.044	0.024	0.024	0.044	0.037
A.LATR	0.041	0.068	0.022	0.027	0.024	0.017	0.020	0.010	0.014	0.019	0.016	0.086	0.011	0.048	0.022
A.WATR	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
A.ATR	0.011	0.019	0.011	0.010	0.009	0.008	0.014	0.013	0.008	0.014	0.011	0.006	0.005	0.008	0.008
A.OTTR5	0.020	0.022	0.014	0.018	0.018	0.014	0.018	0.018	0.015	0.016	0.022	0.018	0.013	0.027	0.019
A.POTL	0.036	0.037	0.020	0.020	0.028	0.027	0.027	0.022	0.024	0.028	0.029	0.018	0.018	0.045	0.025
A.FISE	0.033	0.069	0.052	0.033	0.060	0.058	0.030	0.035	0.024	0.029	0.051	0.050	0.064	0.064	0.048
A.FISE	0.037	0.032	0.027	0.029	0.029	0.031	0.014	0.025	0.025	0.032	0.038	0.048	0.016	0.044	0.023
A.OFISE	0.012	0.017	0.013	0.015	0.015	0.008	0.010	0.007	0.009	0.013	0.015	0.015	0.014	0.016	0.012
A.REES	0.053	0.051	0.037	0.051	0.049	0.028	0.044	0.032	0.041	0.043	0.067	0.043	0.040	0.081	0.081
A.RESE	0.009	0.021	0.007	0.012	0.007	0.005	0.006	0.005	0.005	0.006	0.015	0.008	0.007	0.021	0.024
A.COSE	0.023	0.019	0.013	0.015	0.017	0.030	0.054	0.019	0.021	0.018	0.014	0.033	0.016	0.047	0.017
A.RESH	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.004	0.002	0.001	0.001	0.001	0.002	0.001
A.OTBU	0.052	0.045	0.032	0.032	0.048	0.122	0.090	0.040	0.067	0.036	0.041	0.001	0.032	0.103	0.043
A.POAD	0.005	0.004	0.007	0.006	0.006	0.004	0.004	0.002	0.002	0.006	0.009	0.014	0.010	0.009	0.005
A.EDUS	0.013	0.013	0.009	0.013	0.012	0.007	0.011	0.009	0.011	0.011	0.017	0.010	0.010	0.018	0.015
A.HEAS	0.015	0.014	0.011	0.015	0.014	0.013	0.013	0.013	0.013	0.012	0.020	0.011	0.012	0.019	0.013
A.SEWA	0.008	0.006	0.023	0.008	0.005	0.002	0.003	0.002	0.003	0.006	0.006	0.006	0.010	0.055	0.017
A.MNEC	0.004	0.004	0.003	0.004	0.004	0.002	0.004	0.003	0.003	0.004	0.006	0.003	0.003	0.007	0.003
A.RECS	0.009	0.009	0.007	0.008	0.008	0.006	0.008	0.006	0.008	0.007	0.013	0.006	0.006	0.011	0.010
A.OFISE	0.007	0.007	0.005	0.007	0.005	0.002	0.004	0.003	0.004	0.004	0.006	0.006	0.006	0.006	0.005
A.PRHO	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Output Multipliers	1.827	1.909	1.752	1.765	1.716	1.754	1.764	1.696	1.742	1.755	1.730	1.857	1.825	2.104	2.130
GDP Multipliers	0.729	0.803	0.596	0.739	0.731	0.454	0.632	0.633	0.761	0.601	0.859	0.608	0.688	0.789	0.829
Income Multipliers	0.580	0.597	0.439	0.583	0.561	0.321	0.492	0.420	0.522	0.478	0.739	0.459	0.493	0.677	0.664

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Table 2.5: The Multiplier Matrix, M - Continued

Sectors	A-TRAD	A-WHSL	A-RETS	A-HORE	A-LATR	A-WATR	A-WATR	A-ATIR	A-OTTRS	A-PTOL	A-FISE	A-OFISE	A-REES	A-RESE	A-COSE
A-AGRI	0.018	0.014	0.024	0.093	0.017	0.022	0.013	0.026	0.016	0.014	0.011	0.009	0.009	0.009	0.011
A-FORE	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
A-FISH	0.001	0.001	0.002	0.006	0.001	0.003	0.001	0.002	0.001	0.001	0.000	0.001	0.001	0.001	0.000
A-CRUM	0.003	0.002	0.003	0.003	0.005	0.004	0.006	0.003	0.002	0.002	0.001	0.001	0.001	0.002	0.002
A-MING	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
A-FOOD	0.042	0.032	0.057	0.279	0.041	0.047	0.034	0.072	0.037	0.032	0.024	0.023	0.020	0.021	0.027
A-JABA	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A-TEXT	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A-FURS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A-LETH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A-WOOD	0.002	0.001	0.002	0.003	0.003	0.002	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
A-PAPE	0.002	0.001	0.002	0.003	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
A-PRME	0.011	0.009	0.011	0.011	0.011	0.009	0.008	0.013	0.011	0.011	0.009	0.012	0.007	0.006	0.010
A-PEMP	0.015	0.011	0.014	0.013	0.036	0.027	0.047	0.019	0.011	0.008	0.007	0.006	0.006	0.008	0.008
A-CHIM	0.017	0.013	0.021	0.042	0.016	0.016	0.012	0.018	0.016	0.012	0.010	0.009	0.010	0.009	0.011
A-RUBB	0.006	0.003	0.004	0.004	0.007	0.004	0.003	0.004	0.004	0.008	0.002	0.002	0.003	0.002	0.003
A-NOME	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.002	0.001	0.009	0.001	0.002
A-BAME	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.000	0.000	0.001	0.001	0.001
A-MEMJ	0.005	0.002	0.004	0.004	0.006	0.005	0.005	0.004	0.004	0.002	0.001	0.000	0.001	0.001	0.001
A-MAEQ	0.004	0.002	0.003	0.002	0.003	0.002	0.002	0.002	0.004	0.001	0.001	0.001	0.001	0.005	0.002
A-OFMA	0.003	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.011	0.002	0.002	0.002	0.002	0.002	0.008
A-ELMA	0.002	0.001	0.002	0.001	0.003	0.002	0.002	0.002	0.010	0.001	0.001	0.001	0.001	0.001	0.003
A-RATV	0.005	0.003	0.004	0.004	0.004	0.004	0.003	0.004	0.059	0.003	0.005	0.004	0.002	0.003	0.009
A-MEDI	0.002	0.001	0.002	0.001	0.002	0.002	0.002	0.002	0.006	0.001	0.001	0.001	0.001	0.001	0.003
A-MOTO	0.006	0.002	0.002	0.002	0.003	0.002	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.001
A-OTTR	0.000	0.000	0.000	0.000	0.002	0.010	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
A-RECY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A-ELGA	0.024	0.016	0.034	0.036	0.024	0.020	0.014	0.022	0.020	0.013	0.010	0.012	0.010	0.014	0.017
A-WATE	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A-CONS	0.009	0.007	0.014	0.012	0.010	0.011	0.008	0.019	0.020	0.009	0.009	0.005	0.049	0.006	0.006
A-TRAD	1.010	0.003	0.004	0.004	0.010	0.006	0.006	0.005	0.003	0.002	0.003	0.002	0.002	0.014	0.004
A-WHSL	0.007	1.008	0.008	0.015	0.008	0.010	0.014	0.012	0.024	0.006	0.006	0.006	0.005	0.005	0.042
A-RETS	0.001	0.001	1.001	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.003
A-HORE	0.042	0.035	0.065	1.042	0.049	0.069	0.060	0.194	0.043	0.033	0.025	0.024	0.021	0.023	0.032
A-LATR	0.027	0.024	0.024	0.023	1.040	0.036	0.013	0.040	0.021	0.011	0.009	0.009	0.008	0.020	0.014
A-WATR	0.003	0.002	0.001	0.003	0.002	1.142	0.007	0.008	0.005	0.001	0.001	0.001	0.001	0.001	0.001
A-ATIR	0.011	0.009	0.009	0.012	0.016	0.031	1.078	0.148	0.017	0.009	0.007	0.006	0.005	0.008	0.008
A-OTTRS	0.036	0.044	0.033	0.034	0.086	0.185	0.098	1.130	0.031	0.021	0.017	0.019	0.014	0.022	0.018
A-PTOL	0.042	0.029	0.043	0.044	0.032	0.041	0.032	0.041	1.302	0.039	0.076	0.068	0.022	0.027	0.061
A-FISE	0.055	0.035	0.059	0.055	0.051	0.056	0.062	0.075	0.053	1.241	0.079	1.107	0.124	0.104	0.063
A-INSE	0.042	0.027	0.038	0.033	0.028	0.034	0.043	0.033	0.022	0.042	0.029	0.148	0.029	0.027	0.036
A-OFISE	0.014	0.010	0.016	0.014	0.012	0.019	0.018	0.015	0.013	0.092	0.198	1.245	0.015	0.015	0.020
A-REES	0.084	0.063	0.121	0.070	0.070	0.075	0.052	0.066	0.065	0.058	0.047	0.036	1.040	0.039	0.047
A-RESE	0.012	0.007	0.010	0.010	0.032	0.015	0.052	0.022	0.009	0.013	0.005	0.006	1.112	0.010	0.013
A-COSE	0.023	0.016	0.022	0.022	0.036	0.050	0.047	0.055	0.030	0.029	0.022	0.029	0.014	0.018	1.176
A-RESH	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.006
A-OTBU	0.043	0.035	0.049	0.070	0.046	0.067	0.067	0.068	0.046	0.070	0.046	0.052	0.036	0.046	0.160
A-PUAD	0.003	0.003	0.004	0.004	0.023	0.006	0.004	0.004	0.004	0.003	0.002	0.002	0.011	0.002	0.003
A-EDUS	0.017	0.013	0.019	0.015	0.017	0.016	0.011	0.016	0.015	0.014	0.010	0.009	0.011	0.009	0.013
A-HEAS	0.019	0.014	0.021	0.019	0.018	0.018	0.012	0.015	0.016	0.015	0.012	0.010	0.009	0.010	0.012
A-SEWA	0.009	0.006	0.011	0.012	0.009	0.008	0.006	0.007	0.006	0.003	0.003	0.004	0.004	0.006	0.006
A-MNEC	0.005	0.004	0.006	0.005	0.005	0.005	0.003	0.005	0.005	0.004	0.003	0.003	0.003	0.003	0.004
A-RECS	0.011	0.009	0.012	0.015	0.012	0.011	0.010	0.016	0.013	0.009	0.007	0.007	0.006	0.007	0.012
A-OTSE	0.005	0.004	0.006	0.011	0.005	0.007	0.007	0.007	0.006	0.005	0.003	0.003	0.003	0.006	0.004
A-PRHO	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Output Multipliers	1.712	1.535	1.804	2.069	1.814	2.117	1.886	2.216	2.005	1.849	2.160	1.899	1.540	1.627	1.894
GDP Multipliers	0.976	1.027	1.051	0.776	0.915	0.839	0.657	0.748	0.850	0.964	0.746	0.864	0.909	0.976	0.659
Income Multipliers	0.770	0.678	0.846	0.597	0.722	0.674	0.468	0.570	0.650	0.671	0.513	0.505	0.543	0.524	0.476

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Table 2.5: The Multiplier Matrix, M - Continued

Sectors	A.RESH	A.OTBU	A.PUAD	A.EDUS	A.HEAS	A.SFWA	A.MNEC	A.RECS	A.OTSE	A.PRHO	LAB	CAP	HHO	ENT
A.ACRI	0.024	0.014	0.022	0.033	0.026	0.015	0.028	0.019	0.022	0.032	0.032	0.007	0.033	0.003
A.FORE	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.000
A.FSH	0.002	0.001	0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.000	0.001	0.003	0.000
A.CPUM	0.003	0.002	0.005	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.001	0.004	0.000
A.MNG	0.001	0.001	0.002	0.001	0.001	0.006	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.000
A.FOOD	0.049	0.035	0.048	0.061	0.056	0.072	0.045	0.049	0.049	0.071	0.071	0.016	0.072	0.008
A.TABA	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.000	0.002	0.000
A.TEXT	0.002	0.001	0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.002	0.002	0.000	0.002	0.000
A.FURS	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
A.LETH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A.WOOD	0.002	0.002	0.003	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.000	0.002	0.000
A.PAPE	0.003	0.002	0.003	0.005	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001	0.002	0.000
A.PRME	0.013	0.019	0.015	0.026	0.012	0.022	0.017	0.015	0.016	0.014	0.014	0.003	0.014	0.001
A.PEMP	0.013	0.010	0.018	0.018	0.017	0.015	0.013	0.011	0.015	0.017	0.017	0.004	0.017	0.002
A.CHM	0.025	0.014	0.026	0.028	0.104	0.062	0.029	0.024	0.027	0.027	0.027	0.006	0.028	0.003
A.RUBB	0.004	0.003	0.005	0.004	0.010	0.010	0.005	0.003	0.004	0.004	0.004	0.001	0.004	0.000
A.NOME	0.003	0.002	0.008	0.004	0.003	0.015	0.005	0.004	0.003	0.003	0.004	0.001	0.004	0.000
A.BAME	0.001	0.001	0.002	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.000
A.MEMA	0.003	0.003	0.007	0.007	0.004	0.007	0.003	0.003	0.003	0.004	0.004	0.001	0.004	0.000
A.MERQ	0.003	0.002	0.003	0.003	0.002	0.004	0.003	0.002	0.002	0.003	0.003	0.001	0.003	0.000
A.OMFA	0.005	0.003	0.006	0.007	0.003	0.007	0.004	0.005	0.004	0.004	0.003	0.001	0.003	0.000
A.ELMA	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.000	0.002	0.000
A.KATV	0.006	0.004	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.005	0.005	0.001	0.005	0.001
A.MEDI	0.003	0.002	0.003	0.003	0.022	0.003	0.003	0.002	0.002	0.002	0.002	0.000	0.002	0.000
A.MOTO	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.000	0.002	0.000
A.OTTR	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A.RECY	0.003	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A.ELGA	0.026	0.021	0.036	0.045	0.024	0.038	0.024	0.028	0.030	0.025	0.025	0.000	0.025	0.003
A.WATE	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
A.ACONS	0.011	0.012	0.069	0.027	0.010	0.029	0.014	0.012	0.012	0.012	0.012	0.003	0.012	0.001
A.TRAD	0.005	0.004	0.005	0.004	0.003	0.008	0.005	0.004	0.006	0.004	0.004	0.001	0.004	0.000
A.WHSL	0.009	0.012	0.010	0.011	0.009	0.014	0.011	0.008	0.009	0.008	0.008	0.002	0.008	0.001
A.RETS	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.000	0.002	0.000
A.HORE	0.049	0.043	0.053	0.064	0.054	0.039	0.056	0.043	0.050	0.068	0.068	0.016	0.069	0.007
A.LAIR	0.020	0.016	0.035	0.022	0.019	0.051	0.018	0.014	0.020	0.019	0.019	0.004	0.020	0.002
A.WATR	0.001	0.001	0.002	0.001	0.001	0.012	0.002	0.002	0.001	0.002	0.002	0.000	0.002	0.000
A.AITR	0.012	0.015	0.010	0.017	0.010	0.011	0.013	0.010	0.011	0.010	0.010	0.002	0.011	0.001
A.OTTRS	0.031	0.030	0.024	0.031	0.025	0.034	0.025	0.025	0.032	0.034	0.034	0.008	0.034	0.004
A.POTL	0.044	0.051	0.051	0.046	0.030	0.053	0.038	0.039	0.049	0.038	0.038	0.009	0.051	0.005
A.FISE	0.061	0.061	0.057	0.053	0.041	0.082	0.059	0.065	0.066	0.050	0.050	0.011	0.051	0.005
A.INSE	0.032	0.028	0.028	0.041	0.031	0.047	0.029	0.030	0.034	0.036	0.036	0.008	0.036	0.004
A.OFSE	0.025	0.021	0.013	0.017	0.013	0.017	0.017	0.014	0.017	0.016	0.016	0.004	0.016	0.002
A.REES	0.089	0.066	0.151	0.107	0.090	0.062	0.081	0.089	0.089	0.122	0.122	0.028	0.124	0.013
A.RESE	0.010	0.010	0.009	0.009	0.006	0.038	0.012	0.015	0.022	0.008	0.008	0.002	0.008	0.001
A.COSE	0.041	0.044	0.039	0.019	0.022	0.077	0.050	0.022	0.032	0.011	0.011	0.003	0.011	0.001
A.RESH	1.011	1.002	0.002	0.002	0.002	0.005	0.002	0.001	0.001	0.001	0.001	0.000	0.001	0.000
A.OTBU	0.071	1.136	0.064	0.047	0.044	0.096	0.092	0.055	0.060	0.029	0.030	0.007	0.030	0.003
A.PUAD	0.006	0.015	1.009	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.001	0.004	0.000
A.EDUS	0.029	0.014	0.023	1.061	0.033	0.016	0.021	0.017	0.022	0.032	0.032	0.007	0.033	0.004
A.HEAS	0.026	0.015	0.021	0.029	1.238	0.020	0.023	0.018	0.028	0.034	0.034	0.008	0.035	0.004
A.SFWA	0.009	0.006	0.010	0.008	0.007	1.367	0.009	0.009	0.014	0.006	0.006	0.001	0.006	0.001
A.MNEC	0.006	0.006	0.006	0.008	0.007	1.084	0.009	0.009	0.008	0.006	0.006	0.002	0.010	0.001
A.RECS	0.014	0.012	0.018	0.036	0.017	0.016	0.096	1.098	0.017	0.019	0.019	0.004	0.019	0.002
A.OTSE	0.009	0.007	0.006	0.015	0.007	0.032	0.017	0.009	1.048	0.008	0.008	0.002	0.008	0.001
A.PRHO	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1.001	1.001	1.001	0.001	1.001	0.001
Output Multipliers	1.823	1.776	1.944	1.957	2.038	2.414	2.091	1.817	1.891	1.823	0.823	0.188	0.834	0.089
Income Multipliers	0.977	0.792	1.008	1.178	1.108	0.720	0.930	0.999	1.066	1.385	1.157	0.036	0.159	0.017
	0.872	0.593	0.838	1.096	0.975	0.562	0.806	0.751	0.921	1.328	1.439	1.329	1.458	0.156

Sector listing and labelling can be found in appendix A.1

million.

In general, sectors which are more embedded in the local economy and have fewer leakages (through imports, indirect taxes and savings) will have a higher multiplier. Looking at the multipliers in Table 2.5, the sectors with the highest output multipliers are forestry, sewage and refuse disposal services and supporting and auxiliary transport services with output multipliers of 2.920, 2.414 and 2.216, respectively. Therefore, a €100 million increase in demand for output from forestry will generate an additional €192 million in the output of all sectors in the Irish economy. Agriculture and Food have a relatively high output multiplier of over 2, while the chemical sector has an output multiplier of 1.597. The sectors with the highest value added multipliers are education, health and other services sectors, with multipliers ranging from 1.178 to 1.066 followed by the agricultural sector with a multiplier of 1.064.

To illustrate the use of the multiplier decomposition we focus on tracing the effects of an external shock arising from an increase in earnings on each of the following activities: agriculture, manufacture of food and beverages and chemicals and man-made fibres, with the previous assumption that government, capital, indirect taxes, and rest of the world accounts are classified as exogenous. These three sectors are selected to capture traded economic sectors with different degrees of embeddedness in the Irish economy (the fact that education and health have the highest GDP multiplier is of little policy relevance given that these are largely non-traded sectors where output can only be stimulated by additional government expenditure). The Stone decomposition is presented for these three sectors in Table 2.6. Overall, it can be noticed that the intra-group ( $N_1$ ) dominates, while the circular or closed-loop ( $N_3$ ) effects only prevail over very few accounts. From Table 2.6 we can see that out of the €108.6 million induced indirect increase in gross output due to an increase in demand for agricultural products of €100 million, 26.37 percent are attributed to net SAM linkages (see Adelman and Robinson, 1986). The net SAM linkages or the sum of  $N_2$  and  $N_3$  divided by the elements of the total multiplier matrix, removing the initial injection, M-I, represent the additional effects on top of the I-O multiplier effects due to including the wider range of inter-relationships in the economy. The same pattern can be observed for the other two industries presented in Table 2.6, with net SAM linkages of 24.6 percent and 29.5 percent, respectively. Consequently, most of the multiplier effects for all those two industries come from the input-output linkages.

Considering the linkage structure shown in the SAM, an exogenous injection of an extra €100 million of revenue arising from additional exports of the specific product

produced by each activity generates additional output of €108.6 million and €100.9 million when the injection occurs in the agricultural and food processing industries, respectively, and of €59.7 million in the chemical industry. Factors, labour and capital, gain €106.4 million when the injection occurs in the agricultural activity, and €74.7 million and €60.5 million for manufacture of food and beverages and chemical sector, respectively. The major factor beneficiary in all cases is capital with over 60 percent of the total factor gain. Additional household income of €42.1 million and €36.6 million is gained when the injection is into the agricultural and manufacture of food sectors, respectively, and only €25.9 million when we consider the injection in the chemicals products and man-made fibres sector, after taking into account the within-account transfer, spill-over and feedback effects.

### 2.5.3 Employment Multipliers

Table 2.7 presents the employment multipliers for the 55 sectors defined in the social accounting matrix. We define a vector of total employment by industry  $E$  of order 55, such that  $e$  is the 55 order vector of labour coefficients, with  $e_j = E_j/X_j$ . The change in employment for a particular industry is equal to the change in employment multiplied by the SAM multiplier matrix,  $M$ ,  $E = Me_j$ . The employment multipliers measure the employment generated directly, indirectly and induced in the economy when there is an increase in exogenous demand for output. Like the output, GDP and income multipliers, the employment multipliers are demand driven. Employment figures are taken from the Census of Industrial Production, (2005b), Annual Services Inquiry, (2005a) and the Annual Review and Outlook for Agriculture and Food, (2007).

The first column shows the number of jobs in the sector supported per €1 million of output, obtained by dividing total sector employment by total sector output and multiplying by €1 million, vector  $e$ . The second column provides total employment created per €1 million of additional final demand in that sector. There is substantial variation between sectors from as high as 25 employees per million of euro to as low as 3.5 employees per million of euro. The agriculture sector generates one of the largest effects in employment, with a multiplier of 25. In the chemical sector the effect is the smallest of all with a multiplier of only 3.5. However, these multipliers make the strong assumption that the additional employment created by a marginal increase in final demand is the same as the average employment intensity in each sector. This assumption does not allow for the possibility that there may be underemployment in some sectors, for example, agriculture. In Chapter 4 marginal employment coefficients are estimated to assess the impact of the Food Harvest 2020.

Table 2.6: Selected multiplier effects from the Irish SAM (injections of €100 million of income)

Sectors	A.AGRI			A.FOOD			A.CHIM			Net SAM linkages(%)				
	M	N <sub>1</sub>	N <sub>2</sub>	NetSAM linkages(%)	M	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	M		N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	
A.AGRI	100			4.13	25.83	24.86	0.00	0.97	3.76	0.86	0.17	0.00	0.69	80.50
A.FORE	0.05	0.02	0.00	67.38	0.05	0.02	0.00	0.03	58.87	0.03	0.01	0.00	0.02	72.76
A.FISH	0.19	0.10	0.00	48.42	0.27	0.17	0.00	0.08	9.33	0.06	0.01	0.00	0.06	90.59
A.CPUM	0.37	0.25	0.00	33.41	0.27	0.17	0.00	0.11	39.29	0.13	0.06	0.00	0.08	56.99
A.MING	0.50	0.46	0.00	6.61	0.16	0.13	0.00	0.03	17.61	0.09	0.07	0.00	0.02	22.63
A.FOOD	16.21	13.72	0.00	15.33	13.43	11.27	0.00	2.16	16.08	2.03	0.50	0.00	1.53	75.53
A.TABA	0.08	0.00	0.00	99.53	0.07	0.00	0.00	0.07	99.74	0.05	0.00	0.00	0.05	99.55
A.TEXT	0.10	0.03	0.00	70.92	0.07	0.01	0.00	0.06	96.64	0.06	0.01	0.00	0.04	75.14
A.FURS	0.08	0.00	0.00	95.10	0.07	0.00	0.00	0.06	96.64	0.05	0.00	0.00	0.05	95.37
A.LETH	0.01	0.00	0.00	77.92	0.01	0.00	0.00	0.01	82.21	0.01	0.00	0.00	0.01	78.90
A.WOOD	0.19	0.11	0.00	42.06	0.22	0.14	0.00	0.07	32.98	0.08	0.03	0.00	0.05	61.06
A.PAPE	0.24	0.16	0.00	35.46	0.68	0.60	0.00	0.07	10.99	0.20	0.15	0.00	0.05	26.15
A.PRME	0.68	0.20	0.00	69.66	0.66	0.25	0.00	0.41	61.72	0.61	0.32	0.00	0.29	47.13
A.PEMP	1.79	1.21	0.00	32.42	1.17	0.67	0.00	0.50	42.87	0.50	0.14	0.00	0.36	71.21
A.CHIM	10.97	10.01	0.00	8.69	4.60	3.77	0.00	0.83	18.00	11.37	10.78	0.00	0.59	5.16
A.RUBB	0.39	0.24	0.00	38.91	0.67	0.53	0.00	0.13	19.81	0.26	0.16	0.00	0.09	36.17
A.NOME	0.50	0.37	0.00	25.05	0.37	0.26	0.00	0.11	29.44	0.16	0.08	0.00	0.08	48.85
A.BAME	0.22	0.19	0.00	16.13	0.21	0.18	0.00	0.03	14.71	0.06	0.04	0.00	0.02	34.67
A.MEMA	1.26	1.12	0.00	11.29	0.70	0.57	0.00	0.12	17.73	0.21	0.12	0.00	0.09	42.07
A.MAEQ	0.80	0.71	0.00	11.32	0.35	0.27	0.00	0.08	22.63	0.21	0.15	0.00	0.06	27.07
A.ELMA	0.13	0.06	0.00	52.23	0.11	0.05	0.00	0.06	53.47	0.08	0.03	0.00	0.04	55.03
A.RATV	0.25	0.08	0.00	67.86	0.24	0.09	0.00	0.15	63.23	0.18	0.08	0.00	0.11	57.11
A.MEDI	0.18	0.11	0.00	40.32	0.12	0.06	0.00	0.06	53.26	0.16	0.11	0.00	0.05	28.95
A.MOTO	0.14	0.02	0.00	87.08	0.12	0.01	0.00	0.10	87.91	0.08	0.01	0.00	0.07	91.67
A.OTTR	0.02	0.01	0.00	53.04	0.03	0.02	0.00	0.01	35.19	0.02	0.01	0.00	0.01	46.41
A.RECY	0.03	0.03	0.00	18.65	0.08	0.08	0.00	0.01	6.37	0.01	0.01	0.00	0.00	29.75
A.ELGA	3.05	2.19	0.00	28.13	2.70	1.96	0.00	0.75	27.60	1.37	0.84	0.00	0.53	38.64
A.WATE	0.15	0.13	0.00	13.00	0.12	0.10	0.00	0.02	13.77	0.13	0.12	0.00	0.01	9.07
A.CON5	1.99	1.56	0.00	21.29	0.95	0.59	0.00	0.37	38.59	0.45	0.19	0.00	0.26	57.38
A.TRAD	0.51	0.37	0.00	26.49	0.30	0.18	0.00	0.12	39.33	0.15	0.07	0.00	0.08	54.37
A.WHSL	1.03	0.76	0.00	26.71	1.80	1.56	0.00	0.24	13.33	0.82	0.65	0.00	0.17	20.79
A.RETS	0.08	0.02	0.00	72.46	0.13	0.08	0.00	0.05	38.77	0.06	0.03	0.00	0.04	55.12
A.HORE	3.26	0.88	0.00	73.08	3.19	1.12	0.00	2.07	64.96	2.01	0.54	0.00	1.47	73.10
A.LATR	1.35	0.67	0.00	50.19	3.12	2.53	0.00	0.59	18.85	0.68	0.26	0.00	0.42	61.18
A.WATR	0.08	0.03	0.00	67.39	0.07	0.00	0.00	0.05	40.30	0.05	0.02	0.00	0.03	60.41
A.AITR	0.57	0.21	0.00	63.60	0.92	0.60	0.00	0.32	34.45	0.77	0.54	0.00	0.22	29.35
A.OTTRS	1.42	0.23	0.00	83.57	1.55	0.53	0.00	1.03	66.10	1.09	0.36	0.00	0.73	66.83
A.POTL	2.47	1.13	0.00	54.05	2.44	1.28	0.00	1.16	47.55	1.69	0.87	0.00	0.82	48.64
A.FISE	6.19	4.45	0.00	28.22	5.79	4.27	0.00	1.52	26.22	3.27	2.19	0.00	1.08	32.94

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Table 2.6: Selected multiplier effects from the Irish SAM (injections of €100 million of income) – Continued

Sectors	A.AGRI			A.FOOD			A.CHIM			Net SAM linkages(%)					
	M	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	Net SAM linkages(%)	I	M	N <sub>1</sub>	N <sub>2</sub>		N <sub>3</sub>				
A.INSE	3.13	1.89	0.00	1.24	39.57	2.32	1.25	0.00	1.08	46.36	1.61	0.85	0.00	0.76	47.37
A.OFISE	1.22	0.65	0.00	0.57	46.52	1.32	0.83	0.00	0.49	37.16	0.89	0.54	0.00	0.35	39.08
A.REES	4.83	0.57	0.00	4.26	88.15	4.12	0.42	0.00	3.70	89.85	2.95	0.33	0.00	2.62	88.88
A.RESE	0.55	0.28	0.00	0.27	49.80	0.68	0.44	0.00	0.24	35.29	0.39	0.22	0.00	0.17	43.03
A.COSE	1.17	0.78	0.00	0.39	33.00	1.73	1.40	0.00	0.34	19.33	3.59	3.35	0.00	0.24	6.62
A.RESH	0.15	0.11	0.00	0.03	23.69	0.13	0.10	0.00	0.03	23.82	0.82	0.79	0.00	0.02	2.64
A.OTBU	4.69	3.66	0.00	1.03	21.88	10.70	9.81	0.00	0.89	8.33	15.79	15.16	0.00	0.63	4.00
A.PUAD	1.09	0.97	0.00	0.12	11.12	0.54	0.43	0.00	0.11	19.56	0.33	0.26	0.00	0.07	22.52
A.EDUS	1.17	0.04	0.00	1.12	96.19	1.02	0.04	0.00	0.98	96.02	0.74	0.05	0.00	0.69	93.04
A.HEAS	3.44	2.26	0.00	1.19	34.50	1.59	0.56	0.00	1.03	64.92	0.97	0.24	0.00	0.73	75.38
A.SEWA	0.39	0.19	0.00	0.20	51.53	0.61	0.43	0.00	0.18	28.83	0.28	0.16	0.00	0.12	44.24
A.MNEC	0.57	0.24	0.00	0.33	58.11	0.37	0.08	0.00	0.29	77.69	0.24	0.04	0.00	0.20	84.21
A.RECS	0.87	0.22	0.00	0.66	75.17	0.77	0.20	0.00	0.57	74.34	0.53	0.13	0.00	0.40	75.48
A.OTSE	0.51	0.24	0.00	0.27	52.32	0.58	0.35	0.00	0.23	39.95	0.26	0.10	0.00	0.17	63.41
A.PRHO	0.05	0.00	0.00	0.05	99.93	0.04	0.00	0.00	0.04	99.79	0.03	0.00	0.00	0.03	99.56
LAB	22.96	0.00	17.56	5.41		25.19	0.00	20.49	4.70		15.61	0.00	12.28	3.33	
CAP	83.41	0.00	75.42	8.00		49.51	0.00	42.56	6.95		44.91	0.00	39.99	4.92	
HHO	42.06	0.00	34.82	7.24		36.54	0.00	30.25	6.29		25.90	0.00	21.44	4.46	
ENT	22.37	0.00	20.06	2.31		13.89	0.00	11.88	2.01		12.22	0.00	10.79	1.42	
Output Multipliers	108.65	80.00	0.00	28.64	26.37	100.95	76.07	0.00	24.88	24.65	59.69	42.05	0.00	17.63	29.54
GDP Multipliers	106.38	0.00	92.97	13.40		74.70	0.00	63.06	11.64		60.52	0.00	52.27	8.25	
Income Multipliers	64.44	0.00	54.88	9.56		50.43	0.00	42.13	8.30		38.11	0.00	32.23	5.88	

Sector listing and labelling can be found in appendix A 1

There is considerable interest among policy makers in asking about the employment effects of switching a certain percentage of household expenditure from imported to domestic goods. The employment effects will depend on the composition of household expenditure and the total employment intensity of each expenditure element. In Table 2.7, the third column shows the average sectoral share in household spending, and the fourth column provides the average employment multiplier if €1 million is spent on domestically produced goods and services. Consequently, if the household final demand for domestically produced goods increased by one million euro, 10.3 positions for employees would be created in the economy as a whole. From Table 2.3, we know that total household expenditure on both domestic and imported goods in 2005 was €73,778 million. Thus, switching 5 percentage points of this expenditure to domestic goods would create 38,000 jobs, assuming employment has follow an output change in each sector.

## 2.6 Conclusions

This chapter describes the construction of an Irish social accounting matrix for the year 2005. To complete this task a wide range of data are used from national accounts to national survey data. The discrepancies and gaps encountered during the 'building' process were fixed through the use of the cross-entropy method, designed to balance the flows of income and expenditure at sectoral level. Despite these adjustments, the information provided by the resulting SAM well reflect the structure of the Irish economy in the base year.

This chapter also presents multipliers derived from the 2005 SAM for Ireland. These illustrate the different degrees to which individual economic sectors are embedded within the economy and the strength of the indirect and induced effects of an exogenous increase in the demand for sector output. The results confirm that an expansion in the food and drink industry has greater multiplier effects for the rest of the economy than an expansion of the modern manufacturing sectors, although the differences are not as significant as sometimes supposed. For example, an exogenous increase of €100 million in exports from the food and drink industries would lead to a total increase in output of €200.9 million and additional value added of €74.7 million. A similar increase in the exports of the chemical industry would lead to a total increase in output of €159.6 million and additional value added of €60.5 million. If we focus on household income only, the figures are €36.4 million and €25.9 million, respectively. We have also calculated total employment multipliers which are 10.3 per €1 million of output for the food and drinks industry and 3.5 for the chemical industry. However, much

**Table 2.7: Employment Multipliers**

Sectors	Direct employment coefficient per €1 million domestic output (No.)	Total employment created per €1 million domestic output (No.)	Average sectoral shares in household spending (%)	Average employment multiplier per basket of €1 million spent on domestically produced goods and services (units)
A_AGRI	17.1	25.2	1.4	0.363
A_FORE	6.0	15.8	0.1	0.009
A_FISH	4.7	8.2	0.3	0.023
A_CPUM	3.5	7.6	0.4	0.028
A_MING	4.6	10.8	0.0	0.000
A_FOOD	2.6	10.5	9.7	1.017
A_TABA	1.7	6.7	2.6	0.175
A_TEXT	7.4	11.0	0.8	0.090
A_FURS	10.0	13.1	3.8	0.503
A_LETH	9.3	13.0	0.7	0.096
A_WOOD	5.6	11.0	0.2	0.018
A_PAPE	5.6	9.6	0.6	0.061
A_PRME	1.2	4.6	1.5	0.069
A_PEMP	3.2	6.4	7.7	0.489
A_CHIM	0.8	3.5	2.3	0.081
A_RUBB	6.0	10.2	0.9	0.087
A_NOME	4.6	9.1	0.4	0.033
A_BAME	3.2	6.5	0.0	0.000
A_MEMA	6.1	9.8	0.4	0.035
A_MAEQ	5.4	9.1	0.6	0.057
A_OFMA	1.0	4.4	0.4	0.016
A_ELMA	4.7	8.4	0.4	0.030
A_RATV	1.8	4.5	0.6	0.028
A_MEDI	4.4	8.0	0.1	0.011
A_MOTO	5.7	9.2	5.1	0.464
A_OTTR	10.2	14.2	0.1	0.010
A_RECY	5.0	9.1	0.0	0.000
A_ELGA	2.2	5.4	1.9	0.102
A_WATE	8.7	13.8	0.0	0.003
A_CONS	5.9	11.8	0.4	0.044
A_TRAD	15.2	18.9	0.4	0.070
A_WHSL	6.0	8.8	0.0	0.000
A_RETS	21.4	25.5	0.2	0.043
A_HORE	13.3	19.0	10.9	2.082
A_LATR	7.6	11.9	1.6	0.195
A_WATR	10.6	17.2	0.1	0.018
A_AITR	1.4	5.7	0.7	0.039
A_OTTRS	4.4	11.3	3.4	0.381
A_POTL	4.2	8.9	3.6	0.321
A_FISE	2.1	5.7	2.8	0.159
A_INSE	2.5	6.7	3.6	0.240
A_OFISE	2.8	6.2	0.9	0.056
A_REES	1.3	3.8	15.3	0.586
A_RESE	1.7	4.5	0.7	0.031
A_COSE	2.3	6.5	0.0	0.000
A_RESH	2.2	6.6	0.0	0.000
A_OTBU	6.6	10.6	0.5	0.054
A_PUAD	9.1	13.8	0.1	0.014
A_EDUS	16.1	21.7	3.8	0.823
A_HEAS	11.8	18.6	3.5	0.649
A_SEWA	0.0	5.4	0.4	0.020
A_MNEC	0.0	5.6	1.0	0.059
A_RECS	8.1	12.4	2.2	0.273
A_OTSE	20.8	25.9	0.9	0.242
A_PRHO	0.0	4.6	0.2	0.009
<b>Total</b>				<b>10.308</b>

Sector listing and labelling can be found in appendix A 1

of the employment change attributed to the food industry would show up in the agricultural sector, and particularly for this sector there is reason to doubt that using the average employment intensity to infer employment changes in response to marginal increases in output is valid. This is investigated further in Chapter 4.

Using the Stone (1985) additive decomposition of the SAM multiplier matrix shows the relative importance of traditional I-O type multipliers compared to the added contribution made by taking into account the re-spending effect of additional income by and between the institutions. These effects are always less important than the traditional I-O multiplier, but are nonetheless significant. They increase the size of the traditional input-output multipliers by around one-quarter.

In a separate experiment, we investigate the jobs impact of a switch in household expenditure from imported to domestically-produced goods and services. We estimate that switching an average of 5 percentage points of household expenditure would create 38,000 jobs. We stress again that the SAM model from which these multipliers are derived is based on rather stringent assumptions. The most important are that the economy is demand-constrained and that supply can respond elastically to additional increases in demand, and that the marginal employment effects are similar in size to average employment intensities. At least the first of these assumptions is now more realistic than would have been the case at the height of the Celtic Tiger.

The current SAM can be used as the basis for further analysis. One direction to pursue is further disaggregation of particular sectors of policy interest. In the next chapter, a disaggregation of the agricultural and food sectors for the purposes of agricultural policy analysis is presented. Another direction is to use this SAM as the basis for a CGE model of the Irish economy. This direction is pursued in Chapter 5.



## Chapter 3

# A 2005 Agriculture-Food SAM(AgriFood-SAM) for Ireland

### 3.1 Introduction

This chapter describes the construction of a social accounting matrix with disaggregated agricultural and food industry sectors for Ireland for the purpose of agri-food policy simulations. The 2005 AgriFood-SAM for Ireland documented here makes use of the 2005 Input-Output Tables (CSO, 2009e) on which the 2005 SAM for Ireland was constructed (Chapter 2). It uses the 2005 National Farm Survey (NFS) to disaggregate the agricultural sector. Given the link between the NFS and the 2004-2005 Household Budget Survey (HBS 04/05) (CSO, 2005d) it integrates all individual households available in both surveys. These new features facilitate the link of the AgriFood-SAM with the NFS and HBS 04/05 at the micro level for the purpose of micro-simulation analysis.

Henry (1972, 1980, 1986) was the first to construct SAMs for Ireland for economic analysis. Subsequently, O'Toole and Matthews (2002) constructed a SAM for the year 1993 based on the published Input-Output table from 1993, with particular emphasis on the agricultural and food processing sectors. Dixon (2006) produced a 2003 SAM for Ireland with a disaggregated agrifood sector using the 1998 Input-Output table and a type of RAS procedure to scale different data from various sources to match the aggregates for the macro-economy in 2003. Wissema (2006) also built a 1998 SAM for Ireland with a disaggregated energy sector. O'Herlihy (2004) developed a regional SAM for the Border, Midland and Western Region of Ireland. Müller et al. (2009) carried out a study at the European Commission's Joint Research Centre (JRC) to build a common social accounting matrix database for the EU-27. The JRC team constructed 27 Social Accounting Matrices for each EU member state including Ireland with a disaggregated agricultural sector for the year 2000. The disaggregation of the agricultural sectors in the 27 SAMs is based on the Common Agricultural Policy Regional Impact Analysis (CAPRI, 2008) system data. The AgriFood-SAM documented in this chapter advances

on that exercise by: (i) using more recent data; (ii) explicit disaggregation of the value added account and external accounts; (iii) provide a more careful treatment of the taxes and subsidies account for agriculture; and (iv) explicit disaggregation of the household account. This chapter starts with the unbalanced SAM in constructing the AgriFood-SAM. Balancing takes place when the disaggregation of various accounts is complete.

According to the Environmental Protection Agency (EPA, 2010), agriculture is the largest source of emissions, representing 30 percent of total national emissions in 2010, a 4 percent increase since 2007, followed by the energy sector with 22 percent. EPA projections show that Ireland can comply with its Kyoto obligations regarding the reduction in GHG emissions, but the emissions from agriculture are projected to increase by 7 percent by 2020, on 2010 levels, given the projected impact of Food Harvest 2020. A 20 percent reduction in the GHG emissions from the agricultural sector could be achieved through a reduction in animal numbers. The partial equilibrium FAPRI-Ireland model assumes that the 20 percent reduction in emission is achieved through a reduction in the number of beef cattle. The base year for the partial equilibrium model is 2005. In this chapter, a SAM-FAPRI Ireland GHG emission model is used to simulate the effects of a 20 percent reduction in GHG emissions from the agriculture sector. The results from Donnellan and Hanrahan, (2011) GHG emission model of a 20 percent reduction in the GHG emission from the primary agriculture cattle sector are used in a SAM-multiplier model to estimate its economy-wide impact.

This chapter is structured as follows. The construction of the AgriFood-SAM is outline in Section 3.2. Section 3.3 illustrates the use of the 2005 Irish AgriFood-SAM for multiplier analysis. The conclusions are summarized in Section 3.4.

### **3.2 A 2005 Agriculture-Food SAM (AgriFood-SAM) for Ireland**

In the 2005 SAM for Ireland, the agriculture, hunting and related services (NACE code 01) and manufacture of food and beverages (NACE code 15) sectors are treated as single industries, following the 2005 Input-Output Table (Eurostat, 2009). The household sector is represented by a single account and there are two factors of production. We now proceed to disaggregate the agri-food sectors in the SAM as well as the household sector to construct what we call the AgriFood-SAM. This AgriFood-SAM differs in four major respects from the 2005 SAM for Ireland just described. First, using information from the Economic Accounts for Agriculture (EAA) (CSO, 2005c), the National Farm Survey (NFS) (Teagasc, 2004 and Teagasc, 2005b) and the input-output table, 12 separate agricultural industries are constructed producing 13 commodities. Second, the

food-processing sector is disaggregated into 10 industries producing 10 commodities, thus providing greater detail about the downstream activities of the food system and its relationship with the agricultural sectors. Third, for the newly formed agricultural sectors labour is split between paid and family labour as well as introducing the return to land as another factor of production for these sectors. Fourth, the household sector is replaced by 6,866 households constructed using the NFS 2004 and the HBS 2004-2005.

The disaggregation of both agricultural, hunting and related services (AG) and manufacture of food and beverages (FD) industries presupposes the construction of a new Input-Output table giving details of the inputs required and uses for each of the disaggregated activities.

### **3.2.1 Agriculture, hunting and related services breakdown**

#### *3.2.1.1 Disaggregation of intermediate inputs*

In this section the disaggregation of the agriculture, hunting and related services sector NACE 01 is described. The main source of agricultural data was the Output, Input and Income in Agriculture 2009 (OIIA 2009) (CSO, 2009c), with additional information from the Compendium of Irish Agricultural Statistics 2008 (CIAS 2008) (DAFF, 2008), Economic Accounts for Agriculture 2005 (EAA 2005) (CSO, 2005c), National Farm Survey 2005 (Teagasc, 2005b), Annual Review and Outlook for Agriculture and Food 2007 (AROAF 2007) (DAFF, 2007) and various Teagasc publications including Management Data for Farm Planning (MDFP 2005) (Teagasc, 2005a) and Situation and Outlook in Agriculture 2008/2009 (SOA 2008/2009) (Teagasc, 2009).

The first step in disaggregating the agriculture, hunting and related services sector was to use the Output, Input and Income in Agriculture 2009 (OIIA 2009) which identifies 18 types of commodities: cattle, pigs, sheep, horses, poultry, milk, other products, barley, wheat, oats, potatoes, sugar beet, mushrooms, other fresh vegetables, fresh fruit, turf, other crops and forage plants. These were aggregated into the 12 industries used in the AgriFood-SAM as shown in Table 3.1. Each industry produces one commodity, generating a one to one relation between the SAM sectors, apart from the Cattle and Milk industries which produce cattle and milk/cull cows respectively, but also calves. Calves are the main link between the Cattle and Milk industries in the agricultural sector. Hence, the 12 agricultural industries generate 13 agricultural commodities.

**Table 3.1: Concordance between SAM and OIIA 2009 accounts**

<b>SAM Activities Accounts</b>	<b>OIIA 2009 Accounts</b>	<b>SAM Commodities Accounts</b>
Milk	Milk	Milk & Calves
Cattle	Cattle	Cattle & Calves
Sheep-Wool	Sheep, share of the other products using EuroStat specification	Sheep & Wool
Pigs	Pigs	Pigs
Poultry - Eggs	Poultry, share of the other products using EuroStat specification	Poultry & Eggs
Horses	Horses	Horses
Cereals	Barley, Wheat, Oats	Cereals
Fruit - Vegetable	Mushrooms, Other Fresh Vegetable, Fresh Fruit	Fruit - Vegetable
Sugar	Sugar Beet	Sugar
Potatoes	Potatoes	Potatoes
Forage Plants	Forage Plants	Forage Plants
Other Crops	Other Crops, Turf	Other Crops

The output matrix represents the industry - commodity relationship. Total output of the Agriculture, hunting and related services sector for the year 2005 is €5,303 million at producer prices (OIIA 2009). The output for each of the 12 industries is calculated using OIIA (2009) and EAA (2005) which reports the total output value at basic prices and producer prices and the shares of other products (i.e. wool output in the case of sheep industry) using Eurostat specifications. The value of output is reported at basic prices, as the AgriFood-SAM reports the subsidies and taxes on production in separate accounts.

The Milk and Cattle industries are closely related as both industries produce calves. In order to estimate the total output for those industries we use the total number of cattle and calves in 2005 reported by the CSO (2009c). There were 2,637,400 cows in the December 2005 census, out of which 1,150,000 were dairy cows, 1,101,100 suckler cows, and 1,693,300 domestically bred calves. The output of calves was attributed to both the Milk and Cattle industries. Given the relatively equal number of cows in both industries, we assume that each industry produces half of the total number of calves. Out of the total number of calves 885,700 head are male and 807,700 head are female, therefore of the calves produced in the Milk industry half are assumed to be female. Sufficient dairy calves for replacement are assumed to be retained within the Milk industry. Surplus heifer and bull calves from the Milk industry are transferred to the Calves activity, while cull cows are sold to the Beef processing industry. According to Management Data for Farm Planning (MDFP) 2005 and National Farm Survey 2005, a dairy cow has a milking period of approximately five years; therefore 20 percent of the milking cows must be replaced with new calves each year. The calves born in the Cattle industry are transferred to the Calves activity and then purchased as an input at the same price. The prices for cattle and calves per head are used to calculate the value of output for the cattle and calves industry. According to the Irish Farmers

Journal 2005, the average price of a cull cow was €553, heifers €526, suckler cows €490, dairy cows €787 and calves €201. The output for each agricultural sectors is reported in the Output, Input and Income in Agriculture 2009 (OIIA 2009) prepared by the CSO. Hence, the output matrix is a diagonal matrix with the exception of those two industries that register a separate output of calves. The explicit treatment of calves means that the gross value of agricultural output in the AgriFood-SAM exceeds the value of gross output in OIIA (2009) by this amount, with a corresponding additional expenditure on calves as part of intermediate input expenditure.

The main source of data for the intermediate consumption matrix is the OIIA 2009 and the EAA 2005. In the OIIA 2009 there are 11 intermediate consumption factors: Feeding stuffs, Fertilizers, Seeds, Energy and Lubricants, Maintenance and Repairs, Services, Crop protection products, Veterinary pharmaceutical products, Other Goods (detergents, small tools, etc.), Forage Plants and Contract work. Table 3.2 describes the association of the intermediate consumption factors with the sectors of the SAM. Total intermediate consumption in the agriculture sector according to EAA 2005 is €3,675 million at basic prices and €4,060 million at purchasers' prices in the 2005 Use Table for Ireland. The difference of €385 million represents the difference between the basic price reported by EAA 2005 and the purchaser price recorded in the 2005 Use Table. The total intermediate consumption within the NACE 01 agriculture industry amounts to €1,282 million at purchasers' prices in 2005, according to the 2005 Use Table for Ireland (CSO, 2009e). The total value of intermediate consumption between the 12 newly created agricultural sectors amounts to €1,131 million at basic prices, according to the EAA 2005. The 2005 Use Tables for Ireland used in constructing the AgriFood-SAM reports €1,061 million as inputs from food processing sectors (e.g. from animal feed sector), compared with the EAA 2005 that estimates €875 million feed input into agriculture sectors, resulting in a difference of €186 million in tax between the basic price reported by EAA 2005 and the purchaser price recorded in the 2005 Use Table. Hence, €1,717 million ( $€4060 - €1282 - €1061$ ) at purchaser's prices or €1,670 million ( $€3675 - €1131 - €875$ ) at basic prices, represents intermediate consumption from the other sectors in the AgriFood-SAM.

The NFS 2005 is used to calculate, for each activity, the shares of intermediate goods used. The NFS is a nationally representative survey and thus its results can be aggregated to national numbers. It distinguishes between six farm systems: dairy, dairy and other, cattle, cattle and other, mainly sheep and tillage. The systems refer to the dominant activity in each farm. The farms falling into pigs/poultry system are not represented in the NFS, due to the inability to obtain a representative sample.

**Table 3.2: Intermediate Consumption in Agriculture**

<b>Intermediate Consumption</b>	<b>NACE codes</b>	<b>Value (€million)</b>
Seeds & Planting stock	01	85.9
Energy & Lubricants	40	283.5
<i>Electricity</i>	40	60.5
<i>Gas</i>	40	0.0
<i>Other fuels</i>	40	223.0
Fertilisers - outside	24	363.3
Plant Protection	24	55.9
Veterinary Expenses	24	114.6
Feeding stuff		1,649.4
<i>Feed outside</i>	15	874.6
<i>Feed inside</i>	01	774.8
Maintenance Materials	45	278.6
Maintenance Buildings	45	70.6
Agricultural Services	01	270.1
Financial Services	65	91.0
Other goods & services	74	411.0
<b>Total Intermediate Consumption</b>		<b>3,674.5</b>

Source: Economic Agricultural Accounts 2005  
& Output, Input and Income in Agriculture 2009

Inputs used only in livestock production are first differentiated from those used in cereals production and those used in both. The NFS reports for each farm system the value of pasture, winter forage, animal feed, fertilizer, seed, and other intermediate inputs used. As a farm can produce multiple products, we use the livestock units (number of live animals, i.e. beef cows, dairy cows, sheep, horses, weighted by the basic grazing livestock unit, which is a dairy cow) reported by each farm in order to calculate the shares of intermediate inputs used in producing livestock products. Specific inputs to livestock industries are identified first, e.g. feeding stuff, concentrates, veterinary services and medicine. If a particular input is produced on the farm (i.e. most commonly seeds and feed) and is not reported as sold, we consider the input as being consumed inside the farm and allocated, together with the purchased input, between the sectors according to the calculated livestock unit share.

Overall, the allocation of specific inputs to livestock sectors is done by using the calculated livestock units shares, while the allocation of other inputs used by both types of sectors (tillage and livestock), such as fertiliser, energy, etc, was done according to the sectoral output share and based on information provided by Teagasc 2011. Inputs in the pig and poultry sectors were allocated using the limited information from the NFS 2005 and other external sources such as the Pig Survey conducted by CSO 2005e. The allocation of the intermediate inputs in the other sectors (i.e. cereals, fruit and vegetable, sugar, potatoes, other crops and fodder crops) was done according to its sectoral output share. The Compendium of Irish Agricultural Statistics, (CIAS 2008) provides information about the intermediate demand for agricultural sector products in value and quantity terms (i.e. feeding stuff, fertilizers) and was used as a secondary type of

data source to construct the intermediate demand matrix between the 12 agricultural sectors but also in allocating the flows between the agricultural and food sectors. In order to determine the intermediate demand matrix of the agricultural accounts we normalize the input coefficients taking into account the aggregated value of the intermediate consumption given by the OIIA 2009. For example, compound feedingstuffs are allocated between the livestock sectors using the CIAS 2008 quantitative data for the production of feeding stuff and the number of animals as reported in the December 2005 census as well as the value of feeding stuff reported by the OIIA 2009. Based on information provided by Teagasc 2011, a dairy cow consumes on average 700 kg of feed per year, hence the feeding stuff input into the milk sectors is €208 million.

Table 3.3 shows the transformation for gross output from purchaser prices to basic prices and the intermediate inputs expenditures as reported by the OIIA 2009 excluding agricultural services that are part of output. The second half of the table shows the aggregate intermediate inputs for each of the agricultural sectors as calculated using NFS 2005 as described in the previous paragraph. The difference in gross output for milk and cattle industries is due to the addition of calves to each of the sectors as mentioned earlier. Hence, the milk industry output increases by €124 million representing surplus dairy calves, and the cattle industry output by €170 million representing beef calves. Also, milk industry output increases by €127 million representing cull cows sold to the beef processing industry and bull calves sold to the cattle industry. Intermediate inputs for each of the two industries show the addition of calves. The difference between the intermediate input expenditure reported by the 2005 Use Table and the value reported in Table 3.3 is due to the use of calculated NFS 2005 shares and it amounts to €94 million.

### 3.2.1.2 *Disaggregation of value added*

The value added for agriculture was taken from OIIA 2009 and is used as a control total. The allocation of intermediate inputs to each activity as described in 3.2.1.1, taken together with the value of output in each activity, means that the value added in each activity is also set exogenously at this point (see Table 3.3). The next step is to disaggregate the total value added in each activity into the factor of production accounts.

The factor of production account in the AgriFood-SAM consists of four components: labour, family labour, land and capital. The 2005 Input-Output Table reports the value of wages and salaries and the value of operating surplus for the agriculture sector. The allocation of operating surplus between the factors of production is a difficult

**Table 3.3:** Sectoral allocation of Input, Output and Value Added for Agriculture Sector

Sectors	Gross Output Value (pp) (OIIA 2009)	Taxes less Subsidies on products (IO 2005)	Gross Output Value (bp) (IO 2005)	Intermediate Input Expenditure (IO 2005)	Taxes less Subsidies on production (adjusted)	Value Added (author) calculation)	Gross Output Value (bp) (adjusted)
Milk	1,408	59	1,349	547	-4	1,057	1,600
Cattle	1,489	-1,248	2,737	1,917	-873	1,736	2,780
Sheep	208	-24	232	72	-91	252	232
Pigs	308	6	302	292	2	8	302
Poultry	188	4	184	180	1	3	184
Horses	247	18	229	216	1	12	229
Cereals	194	20	174	154	-147	167	174
Fruit & Veg.	246	3	243	226	1	16	243
Sugar	70	9	61	24	0	37	61
Potatoes	83	3	80	62	1	18	80
Other Crops	93	31	62	44	1	18	62
Fodder Crops	769	4	764	527	-149	386	764
Total	5,303	-1,115	6,418	4,260	-1,257	3,709	6,712

Source: Author calculation using OIIA 2009, 2005 Input-Output tables and NFS 2005.

Gross Output = Gross Value Added + Intermediate Input Expenditure + Taxes less Subsidies on Production

Note: €4,060 = (€3,674.5(OIIA 2009) - €270.1(OIIA 2009)) + €656 at purchaser's price

€4,060 + €294 (surplus dairy calves + beef calves) = €4354 - €94 = €4,260

at purchaser's price (inputs in the AgriFood-SAM)

process because of the high frequency of family labour and owner occupied land used in farming. Family labour is an important factor of production in the agriculture sector and is not part of wages and salaries.

The share of each component used in each agricultural activity is calculated taking into account the NFS 2005 and OIIA 2009. First, the share of labour for each activity in the farm was calculated using the standard man day (SMD) variable (available from the MDFP 2005), which provides detailed information about the number of days needed for each type of activity on the farm. The NFS 2005 provides information on the total labour units employed in each farm. For example, given the fact that we know the number of beef cows per farm and the SMD used in rearing one beef cow we are able to calculate the total number of days used in rearing the total number of beef cows reported in the NFS and similarly for the other farm outputs.

Then knowing the number of paid and unpaid (family) labour units (one labour unit equals 1,800 hours) employed in each farm, the total number of labour units used for each activity on the farm was calculated by multiplying the SMD (represents eight hours of work) with the number of livestock units or output (cultivated hectares) on the farm. Consequently, labour shares for each agricultural sector were calculated. These shares are used to allocate the value of labour between the 12 agriculture sectors in the AgriFood-SAM. The 2005 Input-Output Tables give the value of employed labour in

the agriculture sector, which amounts to €448 million, excluding family labour. The NFS 2005 reports the units of family (unpaid) labour used on the farm and the value of family labour which allows us to calculate the share of family labour in total labour for each activity. These shares are used in allocating the paid and unpaid labour to each agricultural activity. The value of family labour is obtained using the average agricultural wage taken from the NFS and then subtracted from the operating surplus. The remaining operating surplus is divided between land and capital.

The CIAS 2008 provides details on the total area farmed for different crops, fruits and vegetables, potatoes, sugar, hay, silage, grazing and pasture. The total area farmed in 2005 was 4,302 million ha. The rental land price per ha in 2005 was calculated using NFS 2005 and is equal to €238.13 giving a value for land services of €1,024 million. Hence, out of total agriculture gross value added of €3,709 million, wages and salaries plus family labour amounts to €1,877 million, land rental value is €1,024 million and the returns to capital is the residual and equal to €807 million.

The quantity of land used in the six tillage sectors is taken directly from CIAS 2008. Hence, €438 million represents the value of land used in the tillage sectors (i.e. potatoes, cereals, fruit and vegetable, etc). This would leave €586 million for the pasture and grazing area used by the different livestock. The allocation of land used between the livestock sectors is calculated using the information provided in the NFS 2005 regarding the share of land used per livestock unit. Hence, 20 percent is allocated to the milk industry, 65 percent to cattle, 14 percent to sheep and 0.6 percent to horses. The use of land in farming poultry and pigs is close to zero and is treated as insignificant. Agricultural land is assumed to be used entirely in the agricultural sectors.

The capital used in the agricultural sector is allocated across the 12 new agricultural sectors as a balancing account, given the fact that it is calculated as a residual after subtracting the land and labour from value added in each sector. Table 3.4 shows the disaggregation of value added between the 12 agricultural sectors.

As a check on the results from disaggregating the value added we compared our numbers with those from the Henry estimates of the breakdown of agricultural value added in 1990 reported in Matthews (2000). Henry estimates that approximately 50 percent is attributed to the labour input, 30 percent to capital and the remaining 20 percent to land. The higher share accruing to land and the lower share accruing to capital reported in Table 3.4 is consistent with the dramatic increase in land values in Ireland over this period.

**Table 3.4: Factor of Production Allocation**

Sectors	Labour	Family Labour	Capital	Land	Total
Milk	236	361	323	123	1,044
Cattle	98	886	334	381	1,700
Sheep	9	61	48	78	197
Pig	0	0	19	0	20
Poultry	0	2	13	0	15
Horses	3	20	2	4	28
Cereals	55	54	39	67	215
Fruit & Veg	3	3	1	2	10
Sugar	19	19	11	8	57
Potatoes	8	8	5	3	23
Other Crops	3	3	0	15	21
Fodder Crops	12	12	12	343	379
Total	448	1429	807	1024	3709
		50.6%	21.8%	27.6%	

Source: Authors' calculation

### 3.2.1.3 Disaggregation of taxes and subsidies and other CAP instruments

The taxes and subsidies accounts are of great importance for the agricultural sectors. The National Accounts System (CSO,2009b) differentiates between subsidies and taxes on products and other subsidies and taxes on production. Subsidies and taxes on products are included in the calculation of output. Other taxes and subsidies are not included in the calculation of output. Examples of subsidies on production are the Single Payment Scheme (SPS), Area-based Compensatory Allowance Scheme, and Rural Environmental Protection Scheme (REPS).

The 2005 Input-Output Table (CSO,2009e) contains a vector of net-taxes on commodities and activities which is used as an instrument in the transformation of producer prices into basic prices and the reverse. Annual Accounts by Current Account, Institutional Sector, Year and Uses and Resources (CSO,2009a) and Economic Accounts for Agriculture 2005 (EAA 2005) provide further information on those four types of taxes and subsidies and how they are split across institutions, commodities and activities accounts.

Taxes on production and imports (D2 in national accounts system) include taxes on products (D21) and other taxes on production (D29). Other taxes on production include building taxes, stamp duties, vehicle taxes and other taxes of this type. The Economic Accounts for Agriculture 2005 (EAA 2005) and the Compendium of Irish Agricultural Statistics 2008 (CIAS 2008) were used in the allocation of these taxes between the agricultural sectors. The major components of taxes on products are value added tax (D211), tax and duties on imports (D212) and taxes on products except VAT and import duties (D214). The next paragraph gives a brief description of the alloca-

tion of the latter three taxes across the SAM accounts.

VAT and import duties are assigned across the commodities according to the 2005 VAT rates and additional information provided in the Statistical Report 2005 published by Revenue Commissioners (2006). The Statistical Report 2005 offers a breakdown on a percentage basis of VAT revenue based on the NACE alphabetical code, A to Q. This in turn is further disaggregated into the 2 digit NACE code used in the SAM using information on the different VAT rates of the specific commodities produced. The domestic VAT is calculated as the gross collection less refunds, but the VAT on imports is not included. The VAT and excise duties apply to imports and locally produced goods at the same rates. The VAT is allocated between the agricultural sectors using the NFS information on the type of enterprises that are registered for VAT and their total amount of sold goods.

Taxes and duties on imports are available from the Revenue Commissioners (2006) as an aggregated value and are allocated across the SAM accounts according to the main type of imported goods and the specific tariff rate applied to the main country of origin.<sup>8</sup> The tax on products except VAT and import duties is calculated as the difference between the total indirect tax minus VAT and Taxes and duties on imports for each SAM account.

The national accounts system (CSO,2009b) differentiates between subsidies on production and on products as described above. The EAA 2005 provides information on the allocation of the subsidies on products between the 12 agricultural sectors. The subsidies on production have two sources, national and EU. The EU subsidies are provided through the CAP to which the national government contributes as well. Other subsidies and grants provided exclusively by the national government are the disease eradication scheme, the installation aid for young farmers and the forestry premium. The latter is allocated to the forestry and related services account.

Under the 2003 CAP reform, in 2005 Ireland opted for full decoupling, meaning that the single farm payment replaced direct livestock and arable payments. This payment is based on the number of premium claims made in the historical three year reference period from 2000-2002. Today, the subsidies and grants offered through the CAP are the Single Payment Scheme (SPS), Area-based Compensatory Allowance Scheme (DACAS), and Rural Environmental Protection Scheme (REPS).

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<sup>8</sup>European Commission 2009, Taxation and Customs Union, Chapter 3

The allocation of those three main subsidies on production, as found in the national accounts, is done in three stages. First, given that Ireland opted for the historical model, the SPS subsidies are allocated between the agricultural sectors on the basis of historical information on the coupled payments received by each sector in 2000-2002. In the second stage the REPS and DACAS payments are allocated to sectors using the NFS 2005. The value of each subsidy payment to each farm is allocated to individual sectors according to the gross output of the specific farm, and these payments are then aggregated to the national level using the NFS weights and normalized so that the totals agree with the actual payments made under each scheme in 2005.

The AgriFood-SAM is explicitly modified to take account of the operation of the milk quota regime in 2005. Under this regime, individual dairy farmers are constrained to limit the volume of their milk output and butterfat to the amount of quota that they hold. Quota can be transferred between farmers either by sale or lease. The quota was binding in 2005, implying that dairy farmers would have been prepared to supply additional milk at the milk price prevailing in that year. The existence of the binding quota gives rise to a quota rent. This quota rent value is introduced explicitly in the AgriFood-SAM. The quota rent is estimated to be 5.4 cents/litre, with a value for the sale/purchase of quota of 16.4 cents/litre, using NFS 2005.<sup>9</sup> The average price of raw milk is 27.2 cents/litre in 2005. Thus the value of quota rent amounts to almost 20 percent of the price of milk. Hence, €180 million represents the share of quota rent in the total output of milk production. This amount is subtracted from the value of the return to milk capital and explicitly introduced in the social accounting matrix as a new account. On the income side of the matrix, quota rent is distributed to farm households, in particular the dairy farm households, according to the information provided by NFS 2005.

#### 3.2.1.4 *Disaggregation of the final demand accounts*

The household consumption of agricultural goods amounts in 2005 to €1,066 million at purchasers' prices. We used the HBS 2005 to calculate shares of household consumption for the main agricultural goods. In order to allocate this expenditure across the sectors the CSO 2009e data are used as a control. Exports and imports data for each agricultural and food processing sector were taken from CIAS 2008, which provides the total value of exports and imports for the main agricultural and food goods and the sources of destination (UK and rest of the EU). The ROW values were calcu-

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<sup>9</sup>According to DAFF, Annual Report 2005, the 2005 scheme was the first part of a two-year Restructuring Programme and the price for the sale/purchase of quota was fixed at 17.5 cents/litre (80c/gal) for 2005 which is close to the reported value in the NFS for that year.

lated as the difference between the total exports/imports and those two newly created accounts.

### 3.2.2 Manufacture of food and beverages breakdown

The manufacture of food and beverages sector is disaggregated using a two step method. First, using the Eurostat NACE Rev. 1.1. 3-digit disaggregation, the Food and Drink (FD) industry is disaggregated into seven industries: meat, fish, fruit-vegetable, dairy, animal feed-grains, other food products, and beverages. Tobacco is distinguished separately at the 2-digit level NACE Rev. 1.1. The meat industry is then further disaggregated into four sub-industries: Beef Meat, Pig Meat, Poultry Meat and Sheep Meat using the domestic supply data taken directly from CIAS 2008. The calculated shares for the four new food sectors are as follows: 56.5 percent represents beef meat production, 23.8 percent of the total meat output is pig meat, 12.7 percent poultry meat, and 7 percent sheep meat. Table 3.5 summarises the CIAS 2008 and Eurostat information.

**Table 3.5:** Sectoral allocation of Input, Output and Value Added for FD industry

	Gross Output Value (pp) (OIIA 2009)	Taxes less Subsidies on products (IO 2005)	Gross Output Value (bp) (IO 2005)	Intermediate Input Expenditure (IO 2005)	Taxes less Subsidies on production (IO 2005)	Value Added (author calculation)
Beef meat	2,028	-10	2,038	1,593	30	415
Pig meat	854	40	814	609	4	202
Poultry meat	456	19	437	343	1	93
Sheep meat	251	37	215	143	4	68
Fish and other fishing products	301	117	184	134	2	48
Fruit and vegetable	160	2	158	117	0	41
Dairy products	2,504	353	2,151	1,634	47	470
Animal feed	929	46	883	485	3	395
Other food products	8,284	494	7,790	2,661	9	5,120
Beverages	1,767	124	1,643	557	4	1,082
<b>Total</b>	<b>17,535</b>	<b>1,221</b>	<b>16,314</b>	<b>8,275</b>	<b>104</b>	<b>7,936</b>

Source: Authors' calculation using OIIA 2009 and 2005 Input-Output Tables.

Gross Output = Gross Value Added + Intermediate Input Expenditure + Taxes less Subsidies on Production

The intermediate consumption matrix was constructed on the basis of information provided by the Census of Industrial Production 2005 (CIP 2005) and the EEA 2005 accounts. The food and drink industry provides intermediate inputs mainly to the hotels and restaurants sector and to the agricultural sectors in the form of animal feed. As an example, in Table 3.2 it can be seen that animal feed which enters the intermediate consumption of agricultural sectors comes from two sources, inside the agricultural sectors (i.e. produced in the fodder crops sector) and outside it from the Animal Feed and Grain Milling sector of the Food and Drink industry.

Labour and capital are allocated according to the CIP 2005 which provides the number of employees, wages and salaries, total labour costs and capital assets (addition and sales) at the 4-digit NACE Rev.1.1 for each of the food industries mentioned above, excluding beef, sheep, poultry and pig meat industries. The average wage in the meat industries is calculated and used to construct the labour costs for those four meat producing sectors in the absence of specific information on average wage differences between sectors. Capital returns for each of the Food and Drink processing sectors is introduced as a balancing account.

Indirect taxes excluding VAT are reported in the CIP 2005. VAT and import duties are assigned according to the same procedure used in the case of the agricultural sectors. Exports are evaluated at basic prices including export refunds, which in 2005 amounted to €160m. The household consumption of food products is taken from the HBS 2004-2005 using the national figure (CSO, 2009e) as a control tool. Further disaggregation and discussion of household consumption is provided in the next section.

### 3.2.3 Disaggregating the Household Sector

To analyse issues of income distribution it is useful to further disaggregate the household sector. This exercise is facilitated by the link between the Household Budget Survey 2004-2005 and the National Farm Survey (2004), which were merged as 620 farm households interviewed in the latter are also part of the former.

The HBS 2004-2005 contains 6,884 households, of which 66 percent are urban households, 25 percent rural non-farm households and 9 percent rural farm households. Both surveys are representative for Ireland and after the merge a total of 6,866 households are used to replace the household account in the AgriFood-SAM.

Reconciling survey data and national accounts data is the next important step. The household survey data is organised in terms of the SAM income and expenditure accounts, using three concordance, CPC Ver. 2, ISIC Rev.4 and NACE Rev. 1.1.<sup>10</sup> Each product in the consumption category in the HBS 2004-2005 was first identified in the CPC Ver. 2 at a five digit level using the United Nations Statistical Division website, which also provides code correspondence with the CPC Ver. 1.1 and ISIC Rev.

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<sup>10</sup>CPC - Central Product Classification  
ISIC - International Standard Industrial Classifications of all economic activities  
NACE - Classifications of Economic Activities in EC.

4.<sup>11</sup> Then, using a correspondence table<sup>12</sup> between ISIC Rev. 4 and NACE Rev. 1.1 each good/service consumed by the households was translated into its corresponding NACE Rev 1.1, two digit code, used by the Central Statistics Office Ireland in constructing the 2005 Input-Output Table for Ireland (CSO, 2009e). The final step is to bring these values to national level by using the weights provided in the HBS 2004-2005.

On the income side, links were first established between the household income sources in the SAM (remuneration of factors, net transfers from/to government and rest of the world) and the sources of income identified in the HBS 2004-2005. These links were based on a set of assumptions. First, wage labour income is assumed to include all income (cash and in kind) received by the household members as return to their labour. Second, the return to land value was determined for each farm household according to the rental land price per ha of €238.13 and the size of the respective farm. Third, dividends, property income, etc. are the source for the return to capital. Fourth, the transfers from government and enterprises are those reported in the HBS as government and private transfer income, respectively. The concordances established are available on request.

Table 3.6 gives an overview of the differences between the household consumption expenditure (using the HBS weights) reported in the survey and the household expenditure figures reported by the 2005 Input-Output Tables (CSO, 2009e). We have deliberately highlighted those sectors where the largest discrepancies arise. The total consumption expenditure reported in the HBS 2004-2005 is under reported by 13 percent compared with the national figure. Total household expenditure on tobacco products tends to be under reported in expenditure surveys given the negative social attitudes to smoking. Household final consumption expenditure for sectors like transport, recreation and culture, health and education cannot be observed at the individual household level mainly because government partially or totally finances household consumption in these sectors. The under reported figures for insurance and financial intermediation services could be explained by the fact that the HBS 2004-2005 registers the household expenditure over a two week period which differs from the household consumption of the specific service. To account for the differences between the survey and the national accounts data, the survey data are scaled up or down as reported in Table 3.6.

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<sup>11</sup>According to the "Statistical work programme of the Commission for 2010", Eurostat is currently working on a single correspondence table from CPC to NACE.

<sup>12</sup>Source: United Nations Statistical Division website.

**Table 3.6:** Household consumption expenditure differences between HBS 2004-2005 and National accounts

SAM Sectors	AgriFood SAM Sectors	AgriFood SAM (€million)	SAM 2005 I-O (€million)	Difference	
				level	%
Products of agriculture, hunting and related services	A_APOL	78	1172	-86	-7.3
	A_AFRVE	696			
	A_APOT	183			
	A_AFOCR	301			
Food products and beverages	A_MBEF	366	7426	62	0.8
	A_MPIG	491			
	A_MPOL	334			
	A_MSHP	137			
	A_MFSH	129			
	A_MFRVE	568			
	A_MDARY	983			
	A_MANFE	3487			
	A_MBEV	870			
Tobacco products		911	1933	-1022	-52.9
Hotel and restaurant services		5828	8035	-2207	-27.5
Land transport; transport via pipeline services		680	1240	-560	-45.2
Financial intermediation services, except insurance and pension funding services		3313	2133	1180	55.3
Insurance and pension funding services, except compulsory social security services		4556	2599	1957	75.3
Real estate services		5849	11196	-5347	-47.8
Education services		1582	2843	-1261	-44.4
Health and social work services		1613	2505	-893	-35.6
Other SAM sectors		31185	32695	-1510	-4.6
Total		64137	73778	-9641	-13.1

For presentation purposes and sometimes also in modelling it is more convenient to work with representative households rather than all 6,866 individual households. To illustrate the method, nine types of representative households were created, as follows: urban households, rural non-farm households, rural dairy farm households, rural dairy and other farm household, rural cattle rearing farm household, rural cattle and other farm household, rural mainly sheep farm household, rural tillage farm household and rural other farm households. The seven types of rural farm households follow the NFS farm systems structure. The income and expenditure of the last type of farm household, which includes pigs, poultry and other farms not represented in the NFS, are calculated and distributed as a residual. The final step in constructing representative households for Ireland was to calculate the aggregated values for the nine household categories by multiplying individual households' values by their respective HBS 2004-2005 weights and summing over all households in each category. Those representative households replace the household sector in the SAM, providing a new AgriFood-SAM with representative households.

### **3.2.4 Balancing the AgriFood-SAM using a cross-entropy approach**

The AgriFood-SAM is seen as a matrix of economic flows from one account to another, representing expenditures and receipts of all the economic agents and total expenditure and total receipts of an agent have to be equal. In the process of balancing the AgriFood-SAM additional equality and inequality constraints are formulated as linear constraints on its elements. First, total GDP was fixed at its original value, as it was considered a reliable data value in the AgriFood-SAM. Second, the sum of overall factor payments is fixed to the aggregate value specified in the macro SAM (Table 2.2, macro values reported in CSO 2009b. Third, trade flows (total imports and exports) are fixed to their initial level. Finally, final demand categories (household and government consumption and investment) are fixed to their aggregate values. The aim of this approach is to use all available information in order to minimize the cross-entropy between the probabilities that are consistent with the information in the data and the prior information. Consequently the new AgriFood-SAM does not show any changes in these cells and columns compared with the unbalanced AgriFood-SAM.<sup>13</sup>

### **3.3 Multiplier analysis using the 2005 AgriFood-SAM**

In this section, multiplier values derived from the 2005 AgriFood-SAM are presented and a simulation of the economic impact of reducing greenhouse gas (GHG) emissions from the agricultural sector is undertaken.

Several approaches can be undertaken in designing scenarios to reduce GHG emissions in the agricultural sector. Most of the studies on GHG emission in Ireland propose changes in the farm management practices to achieve a reduction in emissions.<sup>14</sup> The FAPRI-Ireland model assumes that the 20 percent reduction in emission is achieved through a reduction in the number of beef cattle. This assumption is supported by a recent study (Donnellan and Hanrahan, 2011) which suggest a reduction in the cattle herd as an effect of reducing GHG emissions from Irish agriculture. In this chapter, the 20 percent reduction in GHG emissions is assumed to be undertaken through a reduction in the numbers of livestock in the cattle sector.

#### **3.3.1 Multiplier values from the AgriFood-SAM**

In order to assess the impacts of a change in the value of a final demand account using a social accounting matrix analysis the government account, the rest of the world ac-

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<sup>13</sup>The pdf version of the 2005 AgriFood-SAM for Ireland is available from the IIIS website; URL: [http://www.tcd.ie/iiis/documents/A\\_2005\\_AgriFood-SAM\\_for\\_Ireland.pdf](http://www.tcd.ie/iiis/documents/A_2005_AgriFood-SAM_for_Ireland.pdf)

<sup>14</sup>See O'Mara et al. (2007) for detailed review of this approach.

count, the capital account and the tax accounts are treated as exogenous accounts (Pyatt and Round, 1985). The remaining accounts are viewed as endogenous and include the production (activities, commodities), factors of production (value added) and institutions (households) accounts. For simplicity the exogenous accounts are aggregated into a single account which records the injections into the system and the leakages from it. The leakages include transfer income sent to the rest of the world, institutional savings, indirect taxes and imports. The injections include transfers from the rest of the world, government transfers to institutions (households and enterprises), government consumption and export demand. The exogenous account can be seen as an independent variable while the endogenous account is the dependent variable.

Table 3.7 presents the multiplier matrix,  $M$ , derived from an aggregated 2005 Irish AgriFood-SAM.<sup>15</sup> These multipliers take into account not only the direct impact on the output of an individual sector of a change in its final demand, but also the indirect effects due to interdependencies with other production sectors and induced effects caused by the responding of the institutional accounts. Consider, for example, the first column of Table 3.7 for the milk industry. If we assume an increase of €100 million in the exogenous demand for raw milk, we can see that this induces a further increase of €7.3 million in milk industry output as well as increases in the output of the cattle industry of €0.5 million and fodder crops industry of €4.7 million. The food processing industries register an overall increase in output of €7.9 million, with increases in animal feed industry output of €4.2 million, dairy industry output of €0.7 million and other foods of €2 million. There are larger indirect and induced effects in the manufacturing and services sectors which register output increases of €27.2 million and €43.3 million, respectively. Overall, the €100 million in demand for milk generates a total increase in aggregate output of €193 million.

Income multipliers and GDP multipliers are also calculated and reported in Table 3.7. Assuming a similar €100 million increase in final demand in the milk sector would lead to an increase in GDP at factor cost of €104.9 million. Labour and capital contribute with €55.7 million and €39.2 million respectively to the GDP increase, while land share is only €10 million. Household income increases by €87.5 million in response to this exogenous shock.

Table 3.8 summarizes the multiplier effects for each AgriFood-SAM sector. The sectors with the higher output multipliers among the agri-food sectors are the beef

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<sup>15</sup>For presentation reasons, we aggregate AgriFood-SAM manufacturing sectors and service sectors in two SAM accounts, thus giving an AgriFood-SAM with 22 sectors. Also, the calves sector is aggregated into the milk and cattle sectors.

Table 3.7: The Multiplier Matrix, M

Sectors	A_AMIK	A_ACATL	A_ASHP	A_APIG	A_APOL	A_ACER	A_AFRVE	A_APOT	A_AOTCR	A_AFOCR	A_FORE	A_FISH
A_AMIK	1.073	0.006	0.007	0.005	0.005	0.007	0.003	0.003	0.004	0.003	0.004	0.005
A_ACATL	0.005	1.117	0.008	0.005	0.005	0.009	0.004	0.004	0.005	0.004	0.006	0.009
A_ASHP	0.000	0.001	1.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
A_APIG	0.001	0.001	0.001	1.000	0.000	0.002	0.001	0.001	0.001	0.001	0.001	0.001
A_APOL	0.001	0.001	0.001	0.000	1.000	0.001	0.000	0.001	0.001	0.001	0.001	0.001
A_ACER	0.007	0.014	0.008	0.033	0.030	1.001	0.057	0.095	0.036	0.068	0.000	0.000
A_AFRVE	0.002	0.003	0.003	0.003	0.002	0.002	1.001	0.001	0.001	0.011	0.001	0.001
A_APOT	0.000	0.001	0.001	0.000	0.000	0.001	0.000	1.000	0.000	0.000	0.000	0.000
A_AOTCR	0.004	0.013	0.004	0.000	0.000	0.001	0.000	0.000	1.000	0.000	0.000	0.000
A_AFOCR	0.047	0.149	0.086	0.220	0.115	0.003	0.002	0.002	0.002	1.002	0.002	0.002
A_FORE	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	1.494	0.001
A_FISH	0.002	0.002	0.003	0.002	0.002	0.003	0.001	0.001	0.002	0.001	0.001	1.062
A_MBEF	0.004	0.006	0.007	0.004	0.004	0.008	0.004	0.003	0.004	0.004	0.005	0.010
A_MPIG	0.003	0.004	0.005	0.002	0.002	0.006	0.002	0.002	0.003	0.003	0.003	0.004
A_MPOL	0.002	0.002	0.002	0.001	0.001	0.003	0.001	0.001	0.002	0.001	0.002	0.002
A_MSHP	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.001
A_MFSH	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
A_MFRVE	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.000
A_MDARY	0.007	0.010	0.011	0.008	0.009	0.011	0.005	0.005	0.006	0.005	0.007	0.008
A_MANFE	0.042	0.057	0.067	0.133	0.162	0.004	0.002	0.002	0.002	0.002	0.003	0.003
A_MOTFO	0.019	0.027	0.031	0.010	0.009	0.039	0.013	0.015	0.020	0.016	0.020	0.032
A_MANUF	0.272	0.447	0.424	0.266	0.243	0.643	0.572	0.320	0.324	0.306	0.493	0.272
A_SERV	0.433	0.627	0.657	0.309	0.291	0.793	0.447	0.390	0.440	0.345	0.637	0.391
<b>Output</b>	<b>1.928</b>	<b>2.494</b>	<b>2.333</b>	<b>2.003</b>	<b>1.881</b>	<b>2.545</b>	<b>2.118</b>	<b>1.849</b>	<b>1.856</b>	<b>1.775</b>	<b>2.684</b>	<b>1.807</b>
LAB	0.557	0.721	0.669	0.168	0.166	1.008	0.288	0.424	0.530	0.215	0.551	0.152
LND	0.100	0.229	0.495	0.102	0.059	0.430	0.039	0.080	0.200	0.422	0.022	0.003
CAP	0.392	0.430	0.562	0.222	0.218	0.596	0.254	0.257	0.280	0.186	0.273	0.691
<b>GDP</b>	<b>1.049</b>	<b>1.380</b>	<b>1.727</b>	<b>0.492</b>	<b>0.443</b>	<b>2.035</b>	<b>0.581</b>	<b>0.761</b>	<b>1.011</b>	<b>0.823</b>	<b>0.846</b>	<b>0.846</b>
UHHO	0.451	0.572	0.556	0.151	0.149	0.800	0.240	0.337	0.416	0.180	0.429	0.206
RNFHHO	0.150	0.190	0.186	0.051	0.050	0.265	0.080	0.112	0.138	0.060	0.142	0.073
RDFHHO	0.033	0.065	0.124	0.026	0.017	0.116	0.015	0.026	0.055	0.099	0.015	0.005
RDOFHHO	0.021	0.042	0.082	0.017	0.011	0.076	0.009	0.016	0.036	0.067	0.009	0.003
RCFHHO	0.033	0.067	0.131	0.028	0.017	0.120	0.014	0.026	0.056	0.106	0.013	0.005
RCOFHHO	0.022	0.044	0.086	0.018	0.011	0.079	0.010	0.017	0.037	0.069	0.010	0.004
RSFHHO	0.020	0.040	0.079	0.017	0.010	0.072	0.009	0.016	0.034	0.064	0.008	0.003
RTFHHO	0.009	0.018	0.036	0.008	0.005	0.033	0.004	0.007	0.015	0.030	0.003	0.001
ROFHHO	0.002	0.005	0.009	0.002	0.001	0.008	0.001	0.002	0.004	0.007	0.001	0.000
ENT	0.135	0.160	0.207	0.071	0.068	0.229	0.082	0.092	0.110	0.083	0.099	0.185
<b>Income</b>	<b>0.875</b>	<b>1.204</b>	<b>1.495</b>	<b>0.389</b>	<b>0.339</b>	<b>1.798</b>	<b>0.462</b>	<b>0.651</b>	<b>0.902</b>	<b>0.764</b>	<b>0.730</b>	<b>0.484</b>

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Table 3.7: The Multiplier Matrix, M - Continued

Sectors	A_MBEF	A_MPIG	A_MPOL	A_MSHP	A_MFSH	A_MERVE	A_MDARY	A_MANFE	A_MOTFO	A_MANUF	A_SERV
A_AMIK	0.057	0.005	0.006	0.005	0.004	0.004	0.492	0.023	0.020	0.004	0.007
A_ACATL	0.797	0.006	0.007	0.009	0.005	0.005	0.005	0.020	0.022	0.005	0.009
A_ASHP	0.001	0.000	0.001	0.351	0.000	0.000	0.001	0.001	0.006	0.000	0.000
A_APIG	0.001	0.208	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001
A_APOL	0.001	0.001	0.179	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001
A_AGER	0.011	0.007	0.006	0.003	0.000	0.034	0.004	0.032	0.002	0.001	0.001
A_ARVE	0.003	0.001	0.001	0.001	0.001	0.006	0.001	0.002	0.001	0.001	0.001
A_AROT	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000
A_AOTCR	0.010	0.000	0.001	0.002	0.000	0.000	0.003	0.001	0.009	0.000	0.000
A_AFOCR	0.109	0.047	0.023	0.032	0.002	0.495	0.023	0.136	0.007	0.002	0.003
A_FORE	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001
A_FISH	0.010	0.008	0.009	0.009	0.009	0.008	0.009	0.008	0.008	0.001	0.002
A_MBEF	1.007	0.005	0.006	0.006	0.004	0.005	0.005	0.014	0.018	0.004	0.007
A_MPIG	0.005	1.003	0.004	0.004	0.002	0.003	0.003	0.004	0.015	0.002	0.004
A_MPOL	0.003	0.001	1.002	0.002	0.001	0.002	0.002	0.002	0.007	0.001	0.002
A_MSHP	0.001	0.001	0.001	1.001	0.000	0.001	0.001	0.002	0.003	0.001	0.001
A_MFSH	0.001	0.001	0.001	0.001	1.209	0.001	0.001	0.001	0.008	0.001	0.001
A_MERVE	0.001	0.001	0.001	0.001	0.001	1.001	0.001	0.001	0.001	0.001	0.001
A_MDARY	0.011	0.007	0.008	0.008	0.005	0.006	1.007	0.043	0.020	0.006	0.010
A_MANFE	0.044	0.030	0.031	0.025	0.002	0.021	0.021	1.004	0.005	0.004	0.004
A_MOTFO	0.071	0.029	0.137	0.044	0.014	0.019	0.054	0.017	1.016	0.015	0.019
A_MANUF	0.466	0.253	0.241	0.305	0.217	0.316	0.264	0.247	0.214	1.436	0.232
A_SERV	0.758	0.757	0.688	0.652	0.610	0.563	0.509	0.583	0.642	0.588	1.665
<b>Output</b>	<b>3.369</b>	<b>2.373</b>	<b>2.358</b>	<b>2.463</b>	<b>2.089</b>	<b>2.474</b>	<b>2.405</b>	<b>2.143</b>	<b>2.032</b>	<b>2.077</b>	<b>1.970</b>
LAB	0.747	0.357	0.322	0.481	0.417	0.456	0.485	0.344	0.318	0.360	0.478
LND	0.169	0.023	0.014	0.176	0.002	0.210	0.047	0.072	0.013	0.002	0.004
CAP	0.486	0.341	0.350	0.447	0.240	0.236	0.343	0.391	0.509	0.435	0.488
<b>GDP</b>	<b>1.403</b>	<b>0.722</b>	<b>0.685</b>	<b>1.103</b>	<b>0.658</b>	<b>0.901</b>	<b>0.875</b>	<b>0.807</b>	<b>0.840</b>	<b>0.798</b>	<b>0.969</b>
UHHO	0.599	0.302	0.278	0.405	0.329	0.357	0.392	0.300	0.298	0.317	0.408
RNFHHO	0.199	0.101	0.093	0.135	0.109	0.118	0.130	0.101	0.101	0.107	0.137
RDFHHO	0.052	0.012	0.010	0.049	0.008	0.056	0.020	0.023	0.010	0.008	0.011
RDOFHHO	0.033	0.007	0.005	0.032	0.004	0.036	0.012	0.015	0.006	0.004	0.006
RCFHHO	0.052	0.011	0.009	0.050	0.007	0.058	0.019	0.023	0.009	0.006	0.008
RCOFHHO	0.035	0.008	0.006	0.033	0.005	0.038	0.013	0.016	0.006	0.005	0.005
RSFHHO	0.032	0.007	0.005	0.030	0.004	0.035	0.012	0.014	0.005	0.004	0.005
RTFHHO	0.014	0.003	0.002	0.014	0.001	0.016	0.005	0.006	0.002	0.001	0.002
ROFHHO	0.004	0.001	0.001	0.004	0.001	0.004	0.002	0.002	0.001	0.001	0.001
ENT	0.172	0.107	0.107	0.149	0.083	0.096	0.115	0.122	0.147	0.130	0.150
<b>Income</b>	<b>1.193</b>	<b>0.559</b>	<b>0.516</b>	<b>0.901</b>	<b>0.552</b>	<b>0.813</b>	<b>0.720</b>	<b>0.621</b>	<b>0.585</b>	<b>0.584</b>	<b>0.733</b>

Sector listing and labelling can be found in appendix B 2

**Table 3.8: Output, GDP and Income multipliers**

AgriFood-SAM Sector	Output Multiplier	GDP Multiplier	Household Income Multiplier
Milk	1.928	1.049	0.875
Cattle	2.494	1.380	1.204
Sheep	2.333	1.727	1.495
Pig	2.003	0.492	0.389
Poultry	1.881	0.443	0.339
Cereals	2.545	2.035	1.798
Fruit & Veg	2.118	0.581	0.462
Potatoes	1.849	0.761	0.651
Other Crops	1.856	1.011	0.902
Fodder Crops	1.775	0.823	0.764
Forestry	2.684	0.846	0.730
Fish	1.807	0.846	0.484
Beef Proc.	3.369	1.403	1.193
Pig Proc.	2.373	0.722	0.559
poultry Proc.	2.358	0.685	0.516
Sheep Proc.	2.463	1.103	0.901
Fish Proc.	2.089	0.658	0.552
Fruit & Veg Proc.	2.474	0.901	0.813
Milk Proc.	2.405	0.875	0.720
Animal Feed	2.143	0.807	0.621
Other Food	2.032	0.840	0.585
Manufacture	2.077	0.798	0.584
Services	1.970	0.969	0.733

processing sector, cereals, fruit and vegetable, cattle and sheep, ranging from 3.3 to 2.3. Usually sectors which have fewer leakages will have a higher multiplier. Those sectors are more embedded into the national economy. For example the output multiplier for the cattle sector is 2.494; for each euro of output produced by the cattle sector, 1.494 euro of indirect and induced output is generated in other sectors in the economy.

### 3.3.2 Impact of reducing GHG emissions from the agricultural sector

To illustrate the use of the AgriFood-SAM the effect of a reduction of 20 percent in GHG emissions from agriculture is simulated. According to the Donnellan and Hanrahan, (2011) estimates using the FAPRI-Ireland model, this would require a reduction of 12.6 percent in the output of cattle in 2020, or a reduction of €183 million in the value of cattle output in that year.

Considering the structure of the social accounting matrix multiplier analysis and the Teagasc FAPRI-Ireland model results discussed above, we have a change in output and not a final demand exogenous shock. Consequently, the first step is to calculate the final demand change associated with a reduction in cattle output of 12.6 percent. The SAM multiplier matrix,  $M$ , is given by the following equation:

$$Y_i = (I - A_i)^{-1}X = MX \quad (3.1)$$

The classic case assumes that the exogenous final demand,  $X$ , is given and calculates the change in output,  $Y$ , for each endogenous account. In this instant the reduction in output,  $y_i$ , for the cattle primary agriculture sector is known and the question is to calculate the final demand,  $x_i$ , associated with this change. By re-writing the last equation in a system of equations:

$$\begin{aligned}
 y_1 &= m_{11}x_1 + m_{12}x_2 + \dots + m_{1n}x_n \\
 y_2 &= m_{21}x_1 + m_{22}x_2 + \dots + m_{2n}x_n \\
 &\vdots \\
 &\vdots \\
 &\vdots \\
 y_n &= m_{n1}x_1 + m_{n2}x_2 + \dots + m_{nn}x_n
 \end{aligned}
 \tag{3.2}$$

This system of equations is used to calculate a reduction in the final demand of €326 million in the beef processing sector (arising say from a reduction in beef exports), which results in the desired reduction in cattle output of €183 million.<sup>16</sup> From a multiplier analysis point a view a reduction in the output of cattle can be seen through a reduction in the final demand. More than half of the cattle output is used in the beef processing sector. The remaining is used in the other food processing sectors and only 6 percent is exported as live cattle. Two assumptions are made: First, the reduction in cattle output is mainly due to a reduction in the final demand of beef products; second, there is no change in the final demand of the other 75 sectors in the economy, meaning, the system of equations resumes to one equation with one unknown, the final demand for beef products.

The final demand for beef products is calculated using the equation:

$$x_j = y_i * m \tag{3.3}$$

where  $y_i$  is the reduction in the cattle output of €183 million and  $m = (m_{j1}, m_{j2} \dots m_{jn})^T$  is the column vector of coefficients used in the production of beef products given by

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<sup>16</sup>According to CSO, Output, Input and Income in Agriculture, 2011, cattle output increased by 27 percent since 2005.

the following equation:

$$y_j = m_{j1}y_1 + m_{j2}y_2 + \dots + m_{jn}y_n \quad (3.4)$$

where  $m_{ji}$  represents the input of good  $i$  needed to produce one unit of good  $j$ . So, the production of one units of good  $j$  requires  $m_{j1}y_1$  units of good 1,  $m_{j2}y_2$  units of good 2 and so on. Hence the production of beef products depends on the cattle output.

This is then the shock afflicted to get the economy wide effect of the required reduction in the output of cattle to meet the GHG target using a AgriFood-SAM based on the 2005 economy database and the multiplier analysis.

Stone's (1955) multiplier decomposition can be used to decompose the economy wide output changes into three effects: the direct ( $N_1$ ), indirect ( $N_2$ ) and closed-loop ( $N_3$ ) effect.

$$M = I + N_1 + N_2 + N_3 \quad (3.5)$$

with

$$\begin{aligned} N_1 &= M_1 - I \\ N_2 &= (M_2 - I)M_1 = M_2M_1 - M_1 \\ N_3 &= (M_3 - I)M_2M_1 = M_3M_2M_1 - M_2M_1 \end{aligned} \quad (3.6)$$

where  $M_1$ ,  $M_2$  and  $M_3$  represents the three multiplicative matrices described by Pyatt and Round (1979), the direct effect multiplier matrix, the indirect multiplier matrix and the closed-loop or full circular flow matrix, respectively.

The results are presented in Table 3.9. In addition we consider GDP and household income multiplier effects. A €326 million reduction in beef exports leads to an additional of €946 million reduction in the total gross output in the economy (Table 3.9). Most of this is accounted for by the direct effect, only a small amount is attributed to the other two effects. The biggest sectoral effects are on beef processing, cattle sector and services. The last column in Table 3.9 describes the net SAM-linkages effects that arise from the: (i) direct effect, linkages within one account; (ii) indirect effect, linkages between accounts; and (iii) induced effect, linkages arising within-account, the effects of a shock after passing from an account through a set of accounts and back to the

same account. Of the €183 million induced indirect reduction in cattle output arising from the decrease in demand for beef products, only 0.6 percent can be attributed to net SAM-linkage effects. The small net SAM-linkages effect in the cattle sector shows that the effects of an exogenous shock on the cattle sector can be explained by input-output linkages only. There is almost no "circular-multiplier" effect or leakages of the cattle sector into the wider economy that an input-output model will fail to capture. In contrast, the high net SAM-linkages of 64,2 percent in beef processing sector show the leakages of the beef processing sector on the wider economy that an input-output model fail to capture and so an input-output model would underestimate the importance of the beef processing and cattle sectors on the economy.

Because there is double-counting when the output changes in individual sectors are summed, looking at the changes in GDP gives a better indication of the effect on national welfare, although this is still imperfect given that GDP does not account for net foreign payments. Here there is a reduction of €457.4 million in factor income almost evenly distributed between labour and capital.

This change in factor income has different consequences for households depending on the composition of their income. The main effect in absolute terms will be felt by urban households followed by rural non-farm households simply because they are the largest household group in terms of numbers. Given the widespread cattle ownership among Irish farmers, most farm household types are also adversely affected. Overall, a reduction of €183 million in the value of cattle output would lead to a total decrease in household income of €332.8 million and of €56.2 million in enterprise income assuming households do not switch in producing another type of output. In Ireland urban households represent 70 percent of the total number of households, while farm household income represents almost 5 percent. On average each urban household incurs a loss in income of about 2 percent, while for a farm household the loss varies between 10 percent and 18 percent depending on the farm enterprise type of the household. The largest share of 18 percent is in the dairy and other enterprise household while the cattle enterprise household registers a loss of 11 percent. Overall, a 20 percent reduction in GHG emissions from agriculture sectors which is equivalent to a reduction of €183 million in the cattle output will cost each cattle enterprise farm household €927 on average. Each urban and rural non-farm households cost will be worse off by approximately €194 and €178 per annum, respectively. The highest reduction will be felt in the dairy and other enterprise farm household with €1,448 per annum, per household.

**Table 3.9: Multiplier effects derived from the 2005 Irish AgriFood-SAM**

	Beef processing industry					Net SAM linkages(%)
	I	M	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	
Milk		-21.54	-20.07	0.00	-1.47	7.14
Cattle		<b>-183.00</b>	-181.88	0.00	-1.12	0.61
Sheep		-0.31	-0.14	0.00	-0.17	54.14
Pigs		-0.42	-0.11	0.00	-0.31	71.89
Poultry		-0.38	-0.06	0.00	-0.32	82.77
Cereals		-13.27	-12.70	0.00	-0.57	4.29
Fruit & Veg.		-2.85	-1.17	0.00	-1.68	59.01
Potatoes		-0.54	-0.05	0.00	-0.49	90.38
Other Crops		-10.71	-10.40	0.00	-0.31	3.04
Fodder Crops		-36.02	-35.41	0.00	-0.61	1.81
Forestry		-0.53	-0.20	0.00	-0.33	61.67
Fish		-3.77	-3.01	0.00	-0.76	20.05
Beef Proc.	<b>-326.08</b>	-2.44	-0.80	0.00	-1.64	64.26
Pig Proc.		-2.24	-0.49	0.00	-1.75	75.50
Poultry Proc.		-1.33	-0.25	0.00	-1.08	77.59
Sheep Proc.		-0.64	-0.15	0.00	-0.49	73.37
Fish Proc.		-0.94	-0.30	0.00	-0.63	65.85
Fruit & Veg. Proc.		-1.75	-0.12	0.00	-1.63	89.14
Milk Proc.		-6.88	-2.63	0.00	-4.24	60.28
Animal Feed		-46.76	-45.01	0.00	-1.75	4.38
Other Food		-31.89	-21.45	0.00	-10.44	33.88
Manufacture		-234.08	-128.10	0.00	-105.98	45.69
Services		-343.57	-154.00	0.00	-189.57	55.15
Labour		-243.65	0.00	-195.58	-48.07	
Land		-55.17	0.00	-54.42	-0.74	
Capital		-158.63	0.00	-106.43	-52.21	
Enterprises		-56.24	0.00	-26.05	-30.19	
Households						
Urban		-195.25	0.00	-150.78	-44.47	
Rural Non-Farm		-64.87	0.00	-49.97	-14.90	
Rural Dairy Farm		-17.08	0.00	-15.85	-1.23	
Rural Dairy and Other Farm		-10.82	0.00	-10.13	-0.69	
Rural Cattle Rearing Farm		-17.08	0.00	-16.08	-1.00	
Rural Cattle and Other Farm		-11.52	0.00	-10.76	-0.76	
Rural Mainly Sheep Farm		-10.41	0.00	-9.78	-0.63	
Rural Tillage Farm		-4.55	0.00	-4.32	-0.23	
Rural Other Farm		-1.25	0.00	-1.15	-0.10	
Total Multipliers						
Output		-945.83	-618.49	0.00	-327.34	
GDP		-457.45	0.00	-356.43	-101.02	
Income		-389.07	0.00	-294.88	-94.19	

This results are based on a SAM-multiplier fixed price analysis that makes use of the results derived from the FAPRI-Ireland partial equilibrium model. For the purpose of this analysis it is assumed, in the partial equilibrium model, a 20 percent GHG reduction target through the cattle sector exclusive of emissions by agricultural fuel consumption. The results show the effect of a potential reduction in the domestic production of cattle output, but does not account for any price change and the supply does not elastically respond to any changes in demand. The negative effect of household level might be overcome by increase imports or agricultural factors redistribution to other agricultural activities (i.e. dairy) previously used in the cattle sector.

### 3.4 Conclusions

This chapter describes the construction of an AgriFood-SAM for the year 2005. The specific features of this SAM are the disaggregation of the agriculture and food industry sectors into 12 agricultural sectors and 10 food industry sectors, explicit disaggregation of the value added account and external accounts, careful treatment of the taxes and subsidies account for agriculture, introduction of milk quota rent and explicit disaggregation of the household account. A wide range of data is used for this exercise, from national accounts to national farm and household survey data. The discrepancies and gaps encountered during the "building" process were fixed through the use of the cross-entropy method, designed to balance the flows of income and expenditure at sectoral level. This social accounting matrix can be used in a number of different ways as a descriptive representation of the economy, in multiplier analysis of which an example is given in the chapter, and as a database for a CGE model.

This chapter also presents the economic impact of reducing GHG emissions from the agricultural sectors by 20 percent, using a SAM multiplier analysis. The linear SAM model is based on the Leontief model, but as it incorporates income generation and distribution as well as the production side, it captures the complete circular flow of the economy. The results suggest that a 20 percent reduction in GHG emissions by 2020, through a reduction in the output for cattle, will have a contractionary effect in the whole economy. This policy will reduce the total gross output in the economy by more than half a billion euro and have an indirect effect on the household by reducing its total income by more than €300 million.

In interpreting the results from a multiplier analysis we should be careful as the model assumes fixed proportion production functions, fixed prices and free availability of resources. In other words, if cattle output reduces by 12.6 percent in 2020 then the level of inputs used in this sector is assumed to be reduced by same percentage. Similarly, employment and income are assumed to be reduced in the same proportions. Also, multipliers are based on the state of technology within a sector at a point in time. Hence, multipliers may change in different sectors over time as technology changes.

Multiplier analysis is useful in considering the significance of growth (or contraction) in a particular economic sector. However, the approach has its limitations, and a sensible discussion of multiplier effects should always acknowledge these limitations.

# Chapter 4

## The Employment Effects of Food Harvest 2020

### 4.1 Introduction

The current economic crisis has had a greater negative impact on the Irish economy compared to other countries. Between 2007 and 2010, GNP per head fell by 14.7 per cent while there was a similar fall in 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 per cent while in 2011 it is over 14 per cent (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 government has set ambitious targets for growth in this sector in its Food Harvest 2020 report. These include: (i) an increase in the value of primary output in the agriculture, fisheries and forestry sector by 33 percent compared to the 2007-2009 average; (ii) an increase in the value-added in the agri-food, fisheries and wood products sector by 40 percent compared to 2008; (iii) and an increase in exports by 42 percent compared to the 2007-2009 average (Department of Agriculture, Fisheries and Food, 2010a). However, the extent to which achieving these targets would contribute to additional employment is an empirical question which requires further analysis.

This chapter investigates the economic effects of the Food Harvest 2020 (FH2020) (DAFF, 2010a) specific set targets for growth in the Irish agriculture sector relative to the size of the sector in the period 2007-09. The FH2020 objective is to achieve these growth targets by 2020. The agri-food sector is predominantly rural based and growth in this sector is particularly important for the rural economy, but is also important for

the economy more widely given the importance of the agri-food sector at the moment. The actual impact of FH2020 on the wider economy would depend on, among other things, the size of other economic sectors in 2020. The size of these sectors in 2020 cannot be easily determined, but the impact of FH2020 can be simulated on the basis of the existing economic structure. In practical terms, this means 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 Henry and Copeland (1975). Multiplier analysis has been widely applied to assess the economic importance of particular industries (for example, tourism: Norton, 1982; O'Hagan and Mooney, 1983; Failte Ireland 2008, marine sector: Morrissey and O'Donoghue, 2012, or energy sector, Sustainable Energy Authority of Ireland, 2012, etc.). 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 disrepute 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. They are also useful 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 has been the focus of many researchers over time. Wang (2010) uses several econometric models to estimate employment elasticity by sector for China. He then uses an input output model and these empirically estimated employment elasticities to analyse the impact of the decrease in China's exports due to the U.S. sub-prime crisis on China's employment. The results suggest that using average employment intensities together with an input-output model overestimates the employment effects of changes in final demand compared with the econometric models. Kapsos (2005) estimates country, regional and global employment intensities of economic growth using a cross country data set for 160 economies. Their findings suggest large gains in labour productivity and sustained

employment growth in Asia and the Pacific countries, while at a global level there is a decline in employment intensities of growth.

In this chapter we calculate employment marginal coefficients and introduce the results into a social accounting matrix multiplier analysis to simulate the impact of FH2020 agriculture targets on employment in the economy. This analysis focuses on the four main growth targets in FH2020, namely the growth targets for milk, beef, sheep and pigs. The 2005 AgriFood-SAM for Ireland used in this study consists of 180 sectoral accounts, of which 150 accounts represent the supply and use of domestic goods and services in the economy (Chapter 3).

Two sets of results are obtained: 38,430 jobs and 16,045 jobs will be created if the FH2020 targets are met, using average and marginal employment coefficients, respectively. The employment potential identified from the analysis with marginal employment coefficients, of over 16,000 jobs, should be seen as the plausible outcome if the FH2020 targets are met.

The rest of the chapter is organised as follows. The methodology, data and shocks implemented in the model are presented in section 4.2, the scenarios and results are discussed in section 4.3 and section 4.4 concludes.

## **4.2 Methodology, Data and Shocks**

This chapter uses a 2005 AgriFood-SAM for Ireland and a multiplier analysis to assess the impact of the Food Harvest 2020 targets on the wider economy. The AgriFood-SAM (Chapter 3) 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 calculated as a result of implementing the FH2020 targets.

The AgriFood-SAM used in this model is based on 2005 data when sugar production was still represented in the agricultural sector in Ireland. This does not significantly influence the results as sugar has little input into any of the four sectors shocked in the model.

### 4.2.1 Shocks

The FH2020 targets 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 FH 2020 are as follows: (i) 50 percent increase in the volume of milk production; (ii) 20 percent increase in cattle output value; (iii) 20 percent increase in sheep/lamb output value; and (iv) 50 percent increase in pig output value.

In order to implement those shocks in the SAM multiplier model the results of the FAPRI-Ireland 2012 partial equilibrium model are used to simulate the sectoral activity level associated with the Food Harvest 2020 targets. This simulation interprets the value and volume targets set out in Food Harvest 2020 so that volume shocks for four of the main agricultural sectors can be defined for this chapter. The FAPRI simulation assumes that for three of the main targets set in the FH2020 (cattle, sheep and pigs) the value growth targets are met as well as the milk output target.

Table 4.1 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 the 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. change in cattle output is modelled as a change in the final demand for beef products).<sup>17</sup> This reflects an assumption 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 percent increase in the milk sector (€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 million increase in pigs output requires a final demand increase of €374 million in pig processing.

### 4.2.2 Direct employment coefficients

In order to calculate the changes in employment in the agricultural and food sectors the initial employment figures for those sectors are calculated. The base year for the SAM for Ireland is 2005 and the FH2020 base period for the simulated shocks is the average level of production between 2007 and 2009. Hence, more up to date employment fig-

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<sup>17</sup>The method used to estimate the final demand shocks is detailed in Chapter 3, Section 4

**Table 4.1:** The volume shocks implemented in the model

Sector	Volume Shock 2020 relative to 2007-2009 (%)	Value shock (€millions)	Final demand shock (€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

ures present an advantage in estimating the impact of FH2020 targets on employment. Eurostat 2008 data are used to obtain the number of employees and output in the food processing sectors for 2008. For the agricultural sectors the Annual Review and Outlook for Agriculture, Fisheries and Food (DAFF, 2009/2010) and the Management Data for Farm Planning (Teagasc, 2005a) are used to allocate the 2008 employment numbers between the 12 agricultural sectors. The method used is the same one used in the construction of the 2005 AgriFood-SAM described in Chapter 3. The Output, Input and Income in Agriculture (OIIA, 2010) is used to generate the output for the 12 agricultural sectors for 2008. A detailed presentation of the method is provided in Chapter 3, Section 3 for 2005 and used for 2008 estimates as well.

The direct employment coefficients are calculated as the ratio of employment to output for each individual sector in the matrix. Table 4.2 contains the direct 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.<sup>18</sup> The output and employment numbers for the 53 sectors are taken from the 2005 Input Output Tables (CSO, 2009e) and from the Census of Industrial Production, 2005, respectively.<sup>19</sup> Table C 3 in the Appendix provides the direct employment coefficients for the 53 sectors in the economy for 2005 plus the 22 agriculture and food sectors for 2008.

### 4.2.3 Calculation of marginal employment intensities

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 changes in production and become less reliable as the scale of the change in the economic activity being modelled becomes larger. Also,

<sup>18</sup>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.

<sup>19</sup> A detailed description of the data source and method used is available in Chapter 2, Section 5.

**Table 4.2:** Employment Coefficients per €1 million domestic output, 2008

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

Source: Authors' calculation

multipliers may change over time as technology changes. Technology change can occur at a different pace in one sector compared with another. Related to this issue is a limitation of multiplier analysis which usually assumes fixed proportion production functions. In other words, if milk output grows by 50 percent then the level of input usage is assumed to grow by 50 percent. Similarly, employment and income are assumed to increase in the same proportions. The reality may be somewhat different. 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 are managed per farm worker). Underemployment, where the labour 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. This means that if expansion in the output of the sector is deemed to take place it need not necessarily lead to an immediate increase in the numbers employed. Instead it could result in an increase in output per worker of those already engaged in the sector. The marginal employment impact of the expansion of a sector will tend to be smaller than the average, so using the direct (average) employment coefficients will have a tendency to overstate the knock on impact in this context.

Employment elasticities represent a useful tool to capture the relationship between output and employment growth and, in this chapter, are calculated for most of the sectors in the social accounting matrix using three methods: (i) a fixed effects model using farm enterprises micro data; (ii) a fixed effects model using unbalanced panel; and (iii) non-econometrically by averaging arc elasticities calculated using a rolling window of eight years of data.<sup>20</sup>

Data are collected using the historical series of the Census of Industrial Production 2008b and of the Economic Agricultural Accounts 2008c, the Compendium of Irish Agricultural Statistics 2008 and the National Farm Survey Teagasc. Two data sets are constructed and used in this chapter: (i) a micro farm level data set using the NFS 1984-2010 is used to calculate employment elasticities for four of the main agriculture sectors in Ireland: milk, cattle, sheep and crops; and (ii) an unbalanced panel for 1995-2008 is used to calculate both arc employment elasticities and the employment elasticity for each sector.

An arc employment elasticity is the elasticity between two points in time. The following equation is used to calculate the arc elasticity of employment,  $\epsilon_i$ :

$$\epsilon_i = \frac{\Delta E/E}{\Delta Y/Y} \quad (4.1)$$

where  $E$  is the sectoral employment and  $Y$  is the sectoral output. The arc elasticity is interpreted as the percentage point change in sectoral employment if there is one percentage point change in sectoral output. This elasticity formula is very simple and easy to apply, but it omits the long-term relation between employment and output.

The employment elasticity focuses only on the demand side; the faster the growth in labour the faster the increase in output. It does not account for technology changes, or capital-labour intensity shift in production process. For example, using a rolling window approach goes some way to addressing this shortcoming. A longer window approach is preferable in terms of capturing these types of changes. An unbalanced panel of 14 years, between 1995 and 2008, that was constructed for this analysis, and a rolling window approach to calculate the employment elasticity for each sector using eight years of data, is used, i.e. the estimation sample subsequently changes by one year, with the first sample 1995-2002, the second 1996-2003 and so on until the last

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<sup>20</sup>Due to data availability, elasticities for some sectors cannot be calculated using any of the methods.

estimation sample 2001-2008. The set window of eight years allows for seven sectoral estimated elasticities for this period and avoids the instability introduced by only looking at year to year changes. In estimating the seven employment elasticities for each sectors a 3-year average of each variable, at the beginning and end of the period is used to further try to reduce the effect of volatility in the data series.

Table 4.3 presents the marginal coefficients as an average of the rolling window arc elasticity for the 22 agri-food sectors using a yearly unbalanced panel for 1995-2008. The magnitude of the marginal coefficients are close to zero for most of the agriculture and food sectors which indicates that an increase in sector's output is not associated with increased labour inputs for the 22 agriculture and food sectors.

In a second approach, the NFS can be used to calculate employment elasticities for some agriculture sectors. The employment variable is constructed using the reported hours worked on the farm and the output variable is the output reported for each activity on the farm. The sample output values are corrected for inflation and measured in constant 2000 prices using commodity-specific price indices.

A fixed effects log-log model with employment as the dependent variable and output as the independent variable is calculated for the four main primary agriculture sectors in Ireland: milk, cattle, sheep and crops.<sup>21</sup> The fixed effect least square dummy variable model estimated is described in equation 4.2:

$$\Delta \ln E_{ft} = \alpha_0 + \beta_i \sum_{i=1}^4 \Delta \ln Y_{it-1} + \delta D_t + \nu_f + \epsilon_{it} \quad (4.2)$$

where  $\Delta \ln E_{ft} = \ln E_{ft} - \ln E_{ft-1}$  is the farm employment,  $\Delta \ln Y_{it-1} = \ln Y_{it-1} - \ln Y_{it-2}$  is the activity specific output on the farm,  $D$  is a year dummy which has  $t - 1$  entities included in the model and  $\nu_f$  is the farm fixed effect. Subscript  $i$  denotes the activity on the farm: milk, cattle, sheep and crops, and  $t$  denotes time.

This fixed effects model controls for time invariant farm specific unobserved heterogeneity. Potential reverse causality is treated by using the lag of the output variable in the model. The first difference for employment and lag output is used in the regression, after testing for a unit root using the Augment Dickey-Fuller (ADF) test. The employment elasticities and marginal coefficients are presented in Table 4.3. The

<sup>21</sup>The estimated elasticity for crop products is not statistically significant and not reported/used in the analysis.

**Table 4.3:** Employment Elasticity and Marginal Employment Coefficients

Sectors	Arc Marginal	Employment	Marginal	Employment	Marginal
	Coefficient (per €1 million output) (1995-2008)	Elasticity  NFS(1984-2010)	Coefficient (per €1 million output)	Elasticity  (1995-2008)	Coefficient (per €1 million output)
Milk	0.000	0.047	3.911	0.238	6.018
Cattle	0.000	0.042	5.694	0.258	11.279
Sheep	0.000	0.012	10.743	0.244	10.664
Pigs	0.000			0.256	4.615
Poultry	0.000			0.258	4.653
Horses	0.000			0.269	1.204
cereals	0.000			0.277	1.242
Fruit & Veg	0.000			0.229	1.729
Sugar	0.341			0.257	1.938
Potatoes	0.000			0.229	2.917
Other Crops	1.971			0.300	3.821
Fodder Crops	0.032			0.256	3.870
Beef meat.	0.000			0.256	0.086
Pig meat	0.222			0.289	0.619
Poultry meat	0.237			0.294	0.630
Sheep meat	0.000			0.262	0.289
Fish and other fishing products	1.334			0.235	0.259
Fruit and vegetable	0.000			0.263	2.954
Dairy products	0.000			0.230	2.587
Animal feed	0.041			0.229	1.937
Other food products	0.072			0.249	2.103
Beverages	0.000			0.254	1.933

Source: Authors' calculation. Employment Elasticity and significance levels for the rest of the sectors are reported in Appendix, Table D 4 and E 5

marginal employment coefficients are derived for each of the four activities from the estimated elasticities using eq 4.1.

As a third approach, a fixed effects model described by equation 4.3 is used to calculate the employment elasticity for each sector for the period 1995-2008 using annual data measured in constant 2006 prices using commodity-specific price indices.<sup>22</sup> A selection of the results are reported in Table 4.3 in the fourth column. The magnitude of the elasticity for most of the sectors is small so it can be inferred that the increase in output is due to other factors such as capital investment or technological changes rather than increases in the labour input.

$$\Delta \ln E_{it} = \alpha_0 + \beta_i \sum_{i=1}^{57} \Delta \ln Y_{it-1} + \delta S_i + \epsilon_{it} \quad (4.3)$$

where  $\Delta \ln E_{it} = \ln E_{it} - \ln E_{it-1}$  is the sectoral employment,  $\Delta \ln Y_{it-1} = \ln Y_{it-1} - \ln Y_{it-2}$

<sup>22</sup>After testing for unit root using Augment Dickey-Fuller (ADF) test, the first difference for employment and lag output is used in the regression. We also control for heteroskedasticity. The complete regression results for this specification are presented in E 5.

is the sectoral output and  $S$  is a sector dummy, subscript  $i$  and  $t$  denotes the sector and time, respectively. The elasticity for each sector is calculated by adding  $\delta$  to  $\beta_i$ .

The results from both regressions are used to calculate marginal coefficients for each sector represented in the 2005 AgriFood-SAM for Ireland. An average employment to average output ratio is calculated for each sector in the sample and used to obtain the marginal coefficients for each sector using equation 4.1. Marginal coefficients for the 22 agriculture and food sectors are presented in Table 4.3. The estimated marginal coefficients for the three main agricultural sectors using the NFS micro data and the 1995-2008 unbalanced panel are of similar orders of magnitude.

### 4.3 Scenarios and results

#### 4.3.1 Employment effects of changes in output

Two scenarios are simulated using different assumptions to see how employment will respond to increased output: Scenario 1 shows the effects of the four shocks using average employment intensities based on 2008 employment intensities for the 22 agricultural and food processing sectors and 2005 employment intensities for the remaining sectors in the economy; Scenario 2 shows the effects of the four shocks using the marginal employment intensities calculated in Section 4.2.<sup>23</sup>

Table 4.4 shows the results based on Scenario 1. The output changes arising from FH2020 targets and the final demand change are presented in columns 2 to 9 of Table 4.4. Column 10 describes the average jobs coefficients calculated as the ratio of the numbers of workers to output in each sector which in the case of Table 4.4 are the same figures as in Table 4.1. Columns 11 to 14 give the total change in employment given the final demand shock by multiplying the direct employment coefficient with the change in output for each sector. The last column presents the sum of generated employment in each sector. For example, an expansion in milk output by 50 percent 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 7,337 workers in the other sectors of the economy.

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<sup>23</sup>This chapter builds on the report prepared for the Department of Agriculture, Fisheries and Food (2012), *The Economy Impact of Food Harvest 2020 on employment in Ireland*. In this report three scenarios are simulated assuming different employment marginal changes for the primary agricultural sectors. The results show the marginal impacts are still too high compared with the results of the empirical analysis in this chapter.

Table 4.5 reports the results of Scenario 2, using the estimated marginal employment coefficients in Table 4.3. The differences between the two scenarios are significant. A 50 percent increase in the milk output will only generate 4,814 jobs in the primary sectors and will indirectly generate 2,922 jobs through the dairy processing sector and another 1,766 in other sectors of the economy. Overall, a total of 10,147 jobs are created in the economy if the FH2020 milk output target is met.

Table F 6 provides a more detailed picture, including the results for the non-agriculture sectors, for each of the four shocks and its employment impact on the entire economy.

In summary, based on the results described in Table 4.4 and Table 4.5 38,430 jobs are created in the economy if direct employment coefficients are used and only 16,045 if the estimated marginal employment coefficients are used in the model. The two scenarios report a difference of over 22,000 jobs. This considerable overestimation of job creation using a SAM multiplier approach with the two different coefficients is to be expected. The estimated marginal coefficients capture changes in the employment-output relation over time, while the direct coefficients fail to capture any changes in the structure of employment and output over time. Marginal coefficients tend to be much lower than direct coefficients. The results suggest that 16,045 jobs will be created in the economy if the FH2020 targets are met.

#### **4.3.2 Employment effects of higher prices**

FH2020 expects a value increase in each of the four sectors, but this increase is made up in the FAPRI partial equilibrium model simulation of a change in volume and increased prices, only the primary agricultural sheep sector has a decline in the volume of output. Hence, in addition to the effect of the change in employment due to the change in 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 the final demand goes up by 10 percent 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. The spending behaviour of households can influence the size of multipliers. The greater the extent to which households consume goods and services from the local economy, the greater the induced multiplier effect will be. This multiplier impact forms the economic argument for initiatives such as buy Irish campaigns. Consequently, 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 impact of this increase in household expenditure on employment is simulated.

**Table 4.4: Scenario 1. Employment effect of the FH2020 targets using average employment intensities**

Sectors	Output changes arising from FH2020 targets							Direct employment coefficient per €1 million domestic output	Total employment change					Total Changes
	50% increase in milk output volume	Change in output (€m)	9% increase in cattle output volume	Change in output (€m)	7% decrease in sheep output volume	Change in output (€m)	30% increase in pigs output volume		Change in output (€m)	50% increase in milk output volume	9% increase in cattle output volume	7% decrease in sheep output volume	30% increase in pigs output volume	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
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 & Veg.		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		3.77	441.78	-0.20		1.31	3.16	23	1,408	-1	4	1,434
Pig meat.		6.30		3.23		-0.17		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		-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
<b>Total all sectors</b>		<b>2,506</b>		<b>1,239</b>		<b>-71</b>		<b>630</b>		<b>23,052</b>	<b>11,597</b>	<b>-772</b>	<b>4,552</b>	<b>38,430</b>

Source: Authors' calculation

**Table 4.5: Scenario 2. Employment effect of the FH2020 targets using marginal employment intensities**

Sectors	Output changes arising from FH2020 targets						Total employment change			Total Changes				
	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)	Marginal employment coefficient per €1 million domestic output (10)		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)
(1)														
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 & Veg.	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 Proc.	7.26			3.77		-0.20		1.31	0.630	5	281	0	1	286
Pig Proc.	6.30			3.23		-0.17		1.01	0.289	2	1	0	108	111
Poultry Proc.	3.67			1.90		-0.10		0.60	0.259	1	0	0	0	2
Sheep Proc.	1.76			0.91		-0.05		0.29	2.954	5	3	-114	1	-105
Fish Proc.	2.68			1.32		-0.07		0.42	2.587	7	3	0	1	11
Fruit & Veg. Proc.	4.50			2.39		-0.13		0.71	1.937	9	5	0	1	14
Milk Proc.	20.10	1369.13		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	1369.89			735.88		-45.31		446.96		1,766	904	-66	851	3,455
<b>Total all sectors</b>	<b>2,491</b>			<b>1,233</b>		<b>-71</b>		<b>626</b>		<b>10,147</b>	<b>4,687</b>	<b>-372</b>	<b>1,583</b>	<b>16,045</b>

Source: Authors' calculation

To capture the respending of higher household incomes due to the price increase, the price changes for the four primary agricultural sectors and some of the inputs provided by FAPRI (Table 4.6) 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.<sup>24</sup> 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 4.6:** Input and Output price changes, 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

Table 4.7 presents the results of the extra income respent in the economy as an effect of the increased prices in primary agricultural products. The results of the two scenarios described in previous section are presented. An increase in farm household income of €374 million could generate 2,161 jobs in the economy, Scenario 1 compared with only 313 jobs in Scenario 2. This arises because the differences in the scenarios focus on different coefficients, average and marginal coefficients for all the sectors. In addition to the 16,045 jobs, another 313 jobs will be created in the economy due to the change in prices, if the FH2020 targets are met.

#### 4.4 CONCLUSION

In this chapter a SAM multiplier analysis is used to investigate the employment impact of the main four targets in the FH2020. The model simulates results for two scenarios

<sup>24</sup> The FAPRI model only provides estimates for the price change for the four main agricultural products and three of the inputs used in agriculture. Therefore we assume no change in price for the rest of the eight agricultural sectors and remaining inputs used in the agricultural sectors.

**Table 4.7: Employment effect of the FH2020 targets assuming increase prices for agricultural sectors output**

Sector	Scenario1			Scenario2		
	Direct Employment coefficient per €1 million domestic output	Change in employment	Marginal Employment coefficient per €1 million domestic output	Direct Employment coefficient per €1 million domestic output	Change in employment	Marginal Employment coefficient per €1 million domestic output
A.AMIK	0	15.72	6.018	1	6	3
A.ACATL	0	20.82	11.279	2	5	1
A.ASHIP	0	22.69	10.664	1	1	1
A.APIG	0	3.42	4.615	1	4	1
A.APOL	1	5.57	4.653	2	2	1
A.AHOR	0	7.34	1.204	0	4	2
A.ACER	0	17.94	1.242	31	6	0
A.ARVE	4	1.09	1.729	0	8	0
A.ASUG	0	0.00	1.938	0	5	1
A.APOT	1	9.08	2.917	6	2	0
A.AOTCR	0	3.46	3.821	0	9	3
A.AFOCR	0	1.11	3.870	0	6	1
A.AFORE	0	4.96	3.372	0	14	5
A.AFISH	1	4.67	0.088	1	8	12
A.CPUM	3	3.45	0.086	1	8	3
A.MING	0	3.65	0.619	48	21	7
A.MBEF	4	3.16	0.630	5	8	4
A.MPIG	4	3.21	0.289	0	11	0
A.MPOL	2	3.09	0.259	1	1	0
A.MSHIP	1	3.24	2.954	8	4	3
A.MFSH	1	4.98	2.587	15	4	17
A.MPRVE	4	6.78	1.937	10	2	31
A.MDARY	8	1.52	2.103	17	3	7
A.MANFE	0	1.80	1.933	1	3	17
A.MOTFO	24	1.26	1.711	17	1	0
A.MBEV	3	1.70	0.887	3	2	0
A.TABA	6	1.72	0.606	3	2	0
A.TEXT	3	9.19	0.657	0	2	0
A.FURS	17	7.62	1.248	0	5	0
A.LETH	3	7.47	1.059	1	8	4
A.WOOD	1	5.54	1.083	0	9	1
A.PAPE	3	5.69	0.000	11	16	0
A.PRME	7	1.10	1.141	11	12	0
A.PEMP	41	3.25	1.140	5	0	0
A.CHIM	9	0.81	1.162	10	8	0
A.RUBB	4	6.19	2.362	4	20	0
A.NOME	1	4.56	2.404	0	0	0
A.BAME	0	3.11	2.813	0	0	0
<b>Total</b>				<b>374</b>	<b>2161</b>	<b>313</b>

Source: Authors' calculation

The names for each sectors can be found in the Appendix Table C 3

based on average and marginal employment response to the shocks. The first scenario projects a maximum numbers of jobs that can be created given the shocks. The second scenario is based on marginal employment coefficients and provides a lower estimate of the change in employment after implementing the shock in the model.

Two scenarios are used which make a variety of assumptions about how output growth relates to employment and these have been applied to a model of the Irish economy. Of the two scenarios examined, the employment potential identified in Scenario 2 should be seen as the one which is closest to the likely actual outcome that could arise if FH2020 were achieved. The second scenario makes use of an econometric model to captures the unobserved characteristics of the four main agriculture sectors over time, which direct employment coefficients fail to capture. Hence, the results of the second scenario will be more likely to capture the FH2020 job creation potential.

It is found that a 50 percent increase in milk output due to a final demand increase of €1,369 million in dairy products could generate a maximum of 12,575 jobs in the milk production at farm level, an additional 2,110 jobs in the dairy processing sector and an overall maximum increase of 23,052 jobs in the economy. Similarly, a 7 percent decrease in the sheep output due to a decrease in final demand for sheep meat products of €39 million creates a loss of a maximum 363 jobs in the sheep sector, an extra loss of 125 jobs in the sheep meat sector and an overall loss of 772 jobs in the economy.

In this chapter we also simulate the effects of farm households respending the extra income generated by the expected increase in prices over the period to 2020. Hence, an increase in the price of the four main growth commodities in FH2020, generates an increase in farm household income of €374 million. The respending out of this increased income will generate a maximum of 2,161 jobs in the entire economy.

Using the two different employment intensity scenarios it is found that a lower estimate of 16,045 jobs and a higher estimate of 38,430 jobs could be created in the economy as a result of achieving the four main targets in the FH2020. Adding the extra jobs created as an increase in farm household income, the model predicts a minimum of 16,385 jobs and a maximum of 40,591 jobs for the entire economy.

Multiplier analysis assumes that prices are static and that resources are freely available. These assumptions imply that if a sector grows the additional demand it generates for labour and inputs does not 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 a weakness in the case of 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 rent etc.

The second scenario is based on calculating marginal employment coefficients. This approach has its limitation as well and further work is necessary. Such an analysis will benefit from a larger sample and further improvement in the model by identifying additional influences on employment intensities, particularly regarding labour productivity, unemployment rates, etc. In summary, the use of marginal employment intensities and a social accounting model can give a better reflection of the economic impacts of a policy change, but more research is needed to better integrate the two approaches.



## Chapter 5

# Measuring the impact of trade policy in Ireland: A disaggregated analysis of household impacts

### 5.1 Introduction

This chapter introduces a model which allows *ex ante* assessment of proposed policy changes affecting Irish agriculture and the Irish economy both at the aggregate economy-wide and disaggregated household levels. Current models for *ex ante* evaluation of policy changes affecting Irish agriculture are either partial equilibrium or farm level models (for example, the FAPRI-Ireland model maintained by Teagasc, see FAPRI-Ireland Partnership, 2008; Breen et al., 2005). The agri-food sector remains important in the Irish economy accounting for 10 percent of GDP and 10 percent of employment (DAFF, 2010). It is thus important to take into account the strong interdependencies between activity levels in both the agricultural and non-agricultural sectors in undertaking agricultural policy analysis.

Recent government policy has set challenging targets for the contribution of agriculture to Ireland's economic recovery (Food Harvest 2020, DAFF, 2010a). Although agriculture and the food industry have growth potential, they also face enormous vulnerabilities. Agriculture is primarily grass-based, with beef and dairy products the major output. These are among the EU agricultural products with the highest levels of protection (for some individual Harmonised System tariff lines for these products ad valorem equivalents exceed 100 percent) and thus are vulnerable to tariff reductions negotiated in a Doha Round agreement. Agricultural incomes are heavily dependent on direct payments. For some activities (beef, sheep, cereals) the Single Farm Payment accounts for nearly all family farm income. Thus the sector is heavily exposed to reform of the EU budget and CAP farm payments which might lead to a reduction in EU transfers. Furthermore, Ireland faces very stringent targets for reducing GHG emissions under the EU's Effort Sharing Directive. Most agricultural emissions come from the livestock herd, and there are few technical mitigation options, apart from reducing

livestock numbers, to lower these emissions. Given these challenges, there is a need for a policy tool which can provide simulation results of different policy options in the trade, agricultural policy and climate change areas to support decision-making.

At the same time, analysis of the distributional effects of policy changes is increasingly important and necessary as agricultural policy moves away from sectoral interventions (tariffs, export subsidies, product-related subsidies) to targeted instruments (green payments, payments related to characteristics on individual farms). A desirable feature of a policy evaluation model would be the ability to evaluate the impact of changes in both farm and non-farm policies on both farm and non-farm households, to contribute to understanding the distributional impacts of policy reforms. A further advantage of such distributional analysis is that it allows a better understanding of the likely winners and losers from reforms, allowing the more efficient design of compensatory policies where this is deemed desirable.

This chapter uses a computable general equilibrium (CGE) model calibrated on the 2005 AgriFood social accounting matrix for Ireland for policy evaluation. As CGE models generally provide only details of income changes of one representative household, recent literature has devised a range of methods to augment CGE models for income distribution and poverty analysis. These methods take broadly two main directions. First, CGE model results are used in a subsequent step to feed a microsimulation model, built on the basis of a household survey dataset, which simulates the impacts on household income and consumption to derive a detailed post-shock income distribution. The second direction aims at building a holistic CGE model by disaggregating the representative household of the model, also on the basis of a household survey, into several representative household groups. Households are expected to respond differently to the policy shocks between groups but homogeneously within each group. This approach allows integrating the entire set of households from the survey into the CGE model. For a detailed overview of the different approaches and their advantages and disadvantages, see, for instance, Bourguignon, da Silva, and Bussolo (2008) or Bussolo and Cockburn (2010).

In this chapter, we are interested in the differential impacts of trade policy reform on different household types within farming. In the spirit of the second approach, we disaggregate the representative household into a set of households differentiated by farming system as well as two rural non-farming and urban household groups, respectively. This allows us to infer impacts on the mean income within each of these household groups and changes in distribution between these groups.

The model incorporates a number of innovations: (i) the use of a new social accounting matrix (SAM) database for Ireland calibrated to the base year 2005 and with a large element of disaggregation of the agricultural and food sectors; (ii) incorporation of a number of households disaggregated by urban and rural location and farm type into the SAM; (iii) incorporation of CAP policy instruments and subsidies in the specification of the CGE model.

This chapter investigates the consequences of further multilateral trade liberalisation due to a successful outcome to the WTO Doha Round in which both agricultural and non-agricultural tariffs are reduced. Liberalisation would mean lower producer prices for Irish farmers but also lower prices for consumers. At the same time, the Doha negotiations cover the liberalisation of manufacturing and services where Ireland already has a very open economy and would expect to benefit from improved market access to third country markets. Matthews and Walsh (2005), using a stylised liberalisation scenario, found that Ireland's welfare would increase as a result of further trade liberalisation, with positive gains from industrial and service trade liberalisation compensating for a negative impact from agricultural liberalisation. As well as revisiting their result, we are interested to observe the distributional effects between households as a result of further multilateral trade liberalisation.

For a small open economy like Ireland, the main effects of trade liberalisation are not the direct effects of changes in the country's own tariffs, but rather the terms of trade effects caused by liberalisation in other countries. As we are using a single country CGE model, these terms of trade effects must be provided exogenously. Results from a hypothetical Doha Round multilateral liberalisation conducted by Baltzer et al. (2008) are used for this purpose.

The rest of the chapter is organised as follows. The setup of the model and data is presented in section 5.2, the empirical analysis and results are discussed in section 5.3, and section 5.4 concludes with some reflections on the value and limitations of this modelling tool as a basis for evidence-based policy making.

## **5.2 Model and Database Structure**

### **5.2.1 The Database**

The CGE model is calibrated on the 2005 AgriFood-SAM for Ireland (Chapter 3). The construction of the Irish AgriFood-SAM involved a three-step process: (i) Building a macro-SAM: The macro-SAM resembles the structure described in Pyatt and Round

(1985) but at a highly aggregated level. The primary information source for the macro-SAM is the national accounts. (ii) Generating the SAM: the macro-SAM is disaggregated by splitting each cell into a matrix of accounts. For example, the activity account is initially disaggregated into 55 activities producing 55 commodities, according to the 2005 Input-Output Table (Eurostat, 2009). The agriculture, hunting and related services (NACE code 01) and manufacture of food and beverages (NACE code 15) sectors are further disaggregated using information from a variety of national sources.<sup>25</sup> For the newly formed agricultural sectors labour is split between paid and family labour as well as introducing the return to land as another factor of production for these sectors. The land is further split into three types depending on soil quality. This process of disaggregation results in a complete but unbalanced SAM. (iii) Balancing the SAM: The information theory-based cross-entropy approach implemented by Robinson and Al-Said (2000) and Robinson et al. (2001) is used to balance the SAM. The estimation procedure is to minimize the Kullback-Leibler (1951) cross-entropy measure of the distance between prior coefficients and the new estimated coefficients, given a choice of constraints imposed on the basis of prior knowledge from the SAM.

Some features of the disaggregation of the single agricultural sector in the 2005 Eurostat Input-Output table should be noted. A separate fodder production activity is distinguished which uses inputs to produce grass fodder (silage and hay). In turn, dairy, cattle and sheep activities use land directly (for grazing) but also consume fodder produced by the fodder activity. Land is introduced in the model on the basis of the soil quality. Ireland's soil quality is predominantly good with 70 percent of land under permanent pasture. Three types of land are identified, good quality land used by almost all agricultural sectors, medium and low quality land mainly used in livestock sectors. Low quality land is also used by the forestry sector. Using the NFS 2005 a rental land price per ha in 2005 for each type of land is estimated. These rental prices are used to calculate the value of each land type across activities. The same method used to allocate the land between the 12 agricultural sectors in Chapter 3, Section 3 is used here for the allocation of the three types of land.

The valuation of family-owned resources used in agricultural production raises particular issues. The family labour input was valued at the minimum agricultural wage, and the return to capital in each sector is then derived as a residual. In this chapter, family labour and hired labour for the 12 agricultural sectors are aggregated. Sales of agricultural contracting services were allocated across the newly formed agricultural sectors according to their share in gross output. In 2005 Ireland was still pro-

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<sup>25</sup>See Chapter 3

ducing sugar and therefore the AgriFood-SAM accounted for the production of sugar. As a result of the EU sugar reform, production of sugar ceased in 2006. As production in 2005 only amounted to 1.2 percent of total agricultural output, sugar beet production was included in the "other crops" sector and sugar refining was included in "manufacturing of other food products".

To analyse issues of income distribution in a CGE model, the household sector is further disaggregated. This exercise is facilitated by the link between the Household Budget Survey (HBS) 2004-2005 and the National Farm Survey (NFS) (2004), in that 620 farm households interviewed in the latter are also part of the former. The HBS 2004-2005 contains 6,884 households, of which 66 percent are urban households, 25 percent rural non-farm households and 9 percent rural farm households. Both surveys are representative for Ireland and the two datasets are merged giving a total of 6,866 households which are used to replace the household account in the AgriFood-SAM. The expenditure and income categories are reconciled to match with the economic sectors distinguished in the input-output table. The farm and household survey data were allocated to the AgriFood-SAM expenditure accounts using three concordance systems, CPC Ver. 2, ISIC Rev. 4 and NACE Rev. 1.1.<sup>26</sup>

In this chapter, households are aggregated into nine representative household types as follows: urban households, rural non-farm households, rural dairy farm households, rural dairy and other farm households, rural cattle rearing farm households, rural cattle and other farm households, rural mainly sheep farm households, rural tillage farm households and rural other farm households. The income and expenditure of the last type of farm household, which includes pigs, poultry and other farms not represented in the NFS, are calculated and distributed as a residual. The representative households replace the single household sector in the SAM, providing a new AgriFood-SAM with representative households. This aggregation is adopted as it is desirable to be able to differentiate between rural and urban households. The agricultural activity is mainly a rural activity and this distinction enables the separation of income from agricultural activities, that mostly accrues to rural households, from other types of income.

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<sup>26</sup>CPC - Central Product Classification; ISIC - International Standard Industrial Classifications of all economic activities; NACE - Classifications of Economic Activities in EC. A detailed discussion is provided in Chapter 3

### 5.2.2 The CGE Model

The CGE model used in this chapter builds on the IFPRI Standard CGE model (Lofgren et al. 2002). It is a static, non-monetary model which describes a single country open economy with 25 production sectors producing 25 commodities, nine representative consumers, a public sector, one enterprise account and one external account. The production sectors include 11 agricultural sectors, 10 food manufacturing sectors, forestry, fishing, manufacturing and services. In equilibrium three sets of conditions are satisfied simultaneously: zero profit conditions in all activities; market-clearing in all goods and capital markets assuming that all representative agents optimise rationally; and income balances for all institutions plus the macroeconomic closure represented by a set of constraints.

Production is based on combining intermediate inputs and sectoral value added according to a Leontief function. Intermediate inputs are combined according to a Leontief function and value added is determined by combining primary factors according to a constant elasticity of substitution (CES) function. Each activity produces a single commodity according to a fixed yield coefficient and the profit-maximization condition of producers is fulfilled by the first order condition that each factor's marginal productivity equals its return. Consumers regard the commodities produced and sold on the domestic market as imperfect substitutes to imported commodities. Additionally, imports from different origins, EU and non-EU plus rest of the world (ROW), are regarded as imperfect substitutes (Armington assumption). This is implemented so that, first, imports from the EU and the ROW are aggregated to a single imported commodity using a second-level CES function. Then, another CES function combines imported and domestic goods into a final composite good. Domestic demand is the sum of demands from households, government consumption, investment, intermediate inputs and transaction inputs, i.e. transport and trade. Demand and supply on different commodity markets are required to equilibrate through price adjustment.

The institutions are represented by government, enterprise, nine representative households and the rest of the world accounts. Households receive their income from ownership of the factors of production as well as transfers from government and the rest of the world. They consume commodities according to a linear expenditure system (LES). In this chapter, the Frisch parameter is set to -1 and all expenditure elasticities are set to 1 so these become Cobb-Douglas demand functions.<sup>27</sup> The government re-

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<sup>27</sup>The expenditure elasticities are set to 1 as no expenditure elasticities are available for Ireland. A sensitivity test was done using the GTAP expenditure elasticities for Ireland and no significant changes are observed. The Frisch parameter is the marginal utility of income with respect to income, and usually

ceives income from taxes and from transfers from the rest of the world. It consumes a fixed quantity of private and public services and transfers a CPI-indexed amount to households and enterprises. The rest of the world account receives payments from exports, spends on imports, invests and transfers amounts to other institutions. The difference between the rest of the world income and spending corresponds to foreign savings. Income is required to equal expenditures plus savings for all institutions.

Since CGE models generally contain more variables than equations, some macroeconomic constraints are introduced to reduce the number of variables. Government savings are allowed to change in line with government expenditure which is a constant share of total absorption while the tax rates in the model are fixed.<sup>28</sup> The current account is balanced by changes in the exchange rate keeping foreign savings constant. The marginal propensities to save of households and enterprises are assumed to adjust to the changes in the domestic value of foreign savings and price changes of investments to keep investment a constant share of total absorption. As we want to investigate impacts in the medium-run, some frictions in the mobility of labour and capital between the agricultural and non-agricultural sectors are assumed. To this end, available efficiency units of "general" labour are aggregated from agricultural and non-agricultural labour using a CES function with an elasticity of 2. Thus, returns to labour differ between agricultural and non-agricultural sectors. Capital is treated analogously. Employment levels are kept constant so that factor markets balance through changes in their returns. The three land types are only used in the agricultural sectors and forestry and are fully mobile between sectors. The CPI is fixed and serves as the numeraire of the model.

As the results for changes in import and export prices and quantities from simulations with a global CGE model are used as exogenous shocks, the import and export behaviour of our single country model should be consistent with that of the global model. To accomplish this, we follow the approach proposed by Horridge and Zhai (2005). The export demand function is a downward-sloping function as in the global model. The change in world export demand is then transmitted by shifting the location of the export demand function. The shift of the location parameter is calculated using the changes in export prices and quantities and the import substitution elasticities from the global model. As argued by Horridge and Zhai (2005), on the import side consistency is sufficiently established by transmitting the world price change from the

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calculated as the negative ratio between households total expenditure and income.

<sup>28</sup>Some tax rates are allowed to vary somewhat because parts of certain taxes are fixed in their tax value rather than fixed as a tax rate.

global model through changing import prices.

### 5.2.3 Treatment of the CAP

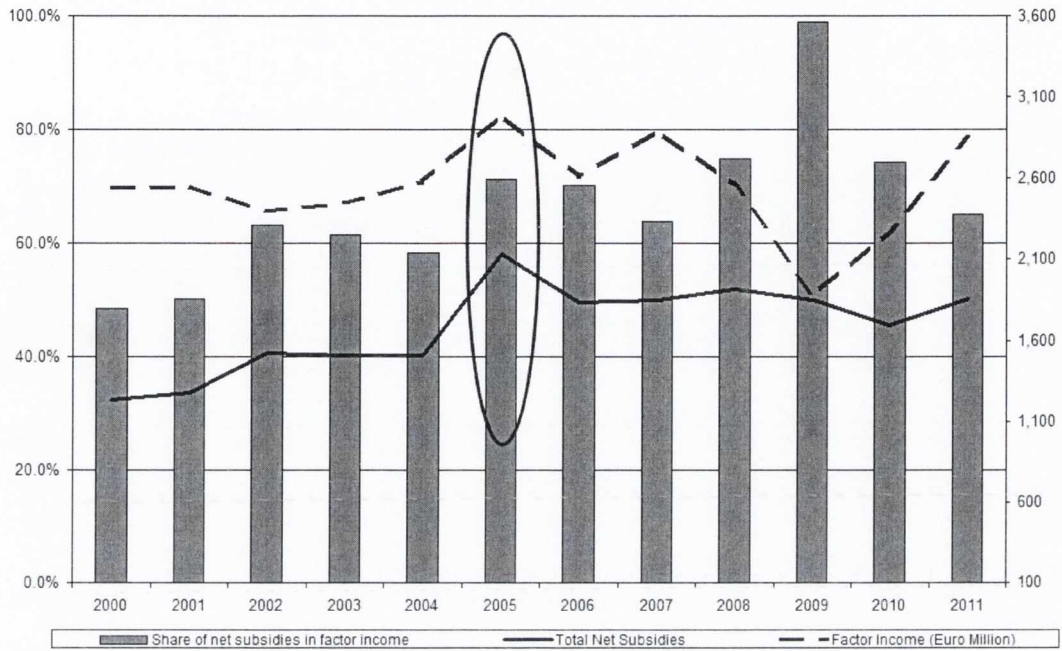
The tax and subsidy accounts are of great importance for the agricultural sectors. The National Accounts System differentiates between subsidies and taxes on products and other subsidies and taxes on production. Subsidies and taxes on products are included in the calculation of output. Other taxes and subsidies are not included in the calculation of output. These other subsidies include the Single Payment Scheme (SPS), Area-based Compensatory Allowance Scheme (DACAS), the Rural Environmental Protection Scheme (REPS) and a small residual category of "other subsidies" not related to products.

Under the 2003 CAP reform, Ireland opted for full decoupling of production-related subsidies in 2005 using the historic basis for the Single Payment Scheme. The payment received by each farm was based on the value of premium claims made under the previous coupled livestock and arable aid schemes in the three year reference period 2000-2002, adjusted for the introduction of the dairy premium intended to compensate for the reduction in intervention milk prices after 2004.

The 2005 base year for the SAM was the first year of implementation of the new Single Farm Payment (SFP). Direct payments were unusually high in 2005 because some coupled premium payments from 2004 were paid in 2005 in addition to the new SFP entitlements. We assume that, in 2005, farmers had not yet had time to adjust to the decoupling of their premium payments and that the level of agricultural activity in 2005 still reflected the coupled nature of these payments. We thus introduce the coupled payments in 2005 as well as the SFP, in the SAM as payments coupled to output.

Other payments not related to production, such as DACAS and REPS, have also been introduced as coupled payments in the version of the model used here. The three main subsidies on production are allocated to activities as follows. The SFP is allocated between the agricultural sectors on the basis of historical information on coupled payments, using survey information provided by NFS 2004. The REPS and DACAS payments are allocated across farms using the NFS 2005 data and the share of forage area that each farm uses. In the base scenario, the values of these payments are held constant in nominal terms to reflect the fact that, in practice, they are paid regardless of the level of production.

**Figure 5.1:** Net subsidies and factor income in Irish agriculture, 2000-2011, €million



Source: Author's own calculations based on CSO Database Direct.

Finally, the dairy activity output is limited by a quota which is assumed to be binding in the SAM and the corresponding quota rent is embedded as a separate part of value added.<sup>29</sup> The rent amount is paid as a transfer to households according to their respective shares in milk output. A pre-experiment intended to reflect the decoupling of the SFP, DACAS and REPS as well as the removal of milk quotas is implemented before the trade liberalisation scenario is run.

The importance of subsidies to factor income in agriculture can be observed in Figure 5.1. The share of net subsidies in total factor income is over 50 percent for each of the 12 years. In 2005 the net subsidies (including subsidies on products, the SFP, DACAS and REPS in this definition) represents over 70 percent of the total income with a share of more than 98 percent in 2009. The importance of the assumed coupled payments (including both subsidies on products and the SFP in this definition) in 2005 differs across activities and is presented in Table 5.1. For dairy, coupled subsidies are small comprising the relatively new dairy premium. But coupled subsidies contribute very substantially to factor income in the cattle activity - a total of €1,211 million out of estimated factor income of €1,700 million. For the sheep activity, the coupled payment of €146 million also accounts for most of factor income of €197 million. The coupled

<sup>29</sup>The milk quota is calculated in Chapter 3, Section 3.2.1

**Table 5.1:** The allocation of subsidies in the Irish agricultural accounts, €million

	Milk	Cattle	Sheep	Pigs	Poultry	Horses	Cereals	Fruit & Veg.	Sugar	Potatoes	Other crops	Fodder crops	Total
Subsidies on products	1	439	11	0	0	0	2	0	0	0	0	0	453
SFP	29	772	135	0	0	0	120	0	0	0	2	0	1,059
DACAS	40	150	41	0	0	0	0	0	0	0	0	0	231
REPS	49	184	50	0	0	0	0	0	0	0	0	0	283
Other Subsidies	3	3	1	0	0	0	1	0	0	0	0	0	7
Total Subsidies	122	1,548	237	0	0	0	123	0	0	0	2	0	2,033
Coupled payments	30	1,211	146	0	0	0	122	0	0	0	2	0	1,512
Factor Income	1,044	1,700	197	20	15	28	215	10	57	23	21	379	3,709
<i>Coupled payments as % Factor Income</i>	2.9%	71.3%	74.1%	0.0%	0.0%	0.0%	56.8%	0.0%	0.0%	0.0%	10.1%	0.0%	40.8%

Source: Authors' calculation using AgriFood-SAM 2005 for Ireland

Note: SFP - Single Farm Payments; DACAS - Disadvantaged Area Compensatory Allowance Scheme; REPS - Rural Environment Protection Scheme

payments account for more than 40 percent of the factor income. A significant reallocation of resources within the agricultural sector is thus expected as a result of the pre-experiment transferring coupled to decoupled payments.

## 5.3 Scenarios and Results

### 5.3.1 Scenarios

In this chapter the model implemented simulates five scenarios. A pre-experiment is first run to reflect the decoupling of direct payments and the elimination of the milk quota. The results of both these steps are shown separately in the tables which follow so that the reader can get an idea of their relative importance.

#### 5.3.1.1 *Pre-experiment*

The decoupling pre-experiment involves: (i) making the distinction between Single Farm Payments and the remainder of the 2004 coupled subsidies paid in 2005, (ii) decoupling the Single Farm Payment, the REPS and DACAS payments, (iii) abolition of the dairy quota. The 2004 payments, which represent "old" premium payments from 2004, are separated from the 2005 direct payments and introduced as coupled payments in the SAM. These payments are maintained as coupled to mimic the unique situation of the base year. Decoupling is modelled by removing the Single Farm Payment attached to each activity in 2005 and paying this as a lump sum transfer from the government to households (similar to the approach used in Gohin, 2004, and Gelan and Schwarz, 2006). The assumption behind this approach is that the SFP is, indeed, fully decoupled. Both international literature (Féménia et al., 2010) and Irish evidence (Howley et al., 2009) suggest that farmers do not treat the SFP as fully decoupled.

The participation in the REPS scheme is voluntary and attracts extensive sheep and cattle farmers compared with intensive tillage and dairy farmers (Kinsella et.al, 2009). In this chapter the REPS payments are modelled in the same way as the SFP. However it can be argued that REPS payments probably do influence the return to the farmer, a farmer in receipt of REPS has a greater incentive to stay in farming than someone not receiving this payment. Moreover, REPS payments might compensate farmers for the cost of "farming in a more extensive and environmentally friendly manner in accordance with measures as specified in an agri-environmental plan" (Kinsella et.al, 2009:1). Hence, the farmers just recover their costs and there is no additional "farm profit" to be distributed across activities or factors. It can be argued that the whole

payment should be modelled as a direct transfer to farm households to avoid any production impact, same way as it is modelled in this chapter. The drawback in this case is that the current version of the model does not allow for the production of environmental goods.

The disadvantaged area compensatory allowance scheme (DACAS), according to DAFF, (2010b), is only payable on grazing land used for cattle, sheep, equine, goats and deer, which amounts to around 70 percent of the agricultural land. This subsidy is a direct income support for the farmer conditional on the farmland being kept in good agricultural and environmental condition (GAEC). The disadvantage areas payment is modelled in the SAM as a payment to each land type and activity according to the NFS 2005. Each type of land, differentiated by soil quality, receives a specific payment. Land type 3, which includes the most disadvantaged areas with low soil quality, gets the highest payments per ha. With the pre-experiment, these area payments are decoupled from the level of the activity output and instead are given as direct subsidies to the 3 land factor types. Again, the total value of the subsidy per land type is fixed in nominal terms. These subsidies thus go to the households who own the respective type of land but they also enter the first-order condition of the production function where they lower the cost of the respective land factor.

However, the focus of this chapter is on trade policy changes rather than changes in domestic subsidies so this fully decoupled assumption is maintained for this simulation. All other subsidies are set constant at their respective initial amounts of subsidies to the particular sector. In addition, the dairy quota limit is removed allowing production to expand freely. The result of this pre-experiment is the starting point for the trade policy simulation.

#### 5.3.1.2 *DOHA scenario*

The trade policy simulation is intended to represent a Doha Round agreement based on the WTO Agriculture Committee Chairman's modalities as circulated in July 2008. This would be a multilateral agreement, and the impacts on Ireland would be felt through changes in world market prices and shifts in export demand in Ireland's main markets. For an estimate of these shocks, results from a simulation experiment undertaken by Baltzer et al. (2008) are used. Their results are based on using the tiered market access formula in the draft agricultural modalities while allowing developed countries to treat 6 per cent of their tariff lines as sensitive (8 per cent for developing

countries).<sup>30</sup> Sensitive products are reduced by one-half of the reduction that otherwise would have been required. Export subsidies are removed but there is no change in world-wide domestic support in their scenario (countries are assumed to meet tighter disciplines by reducing administrative support prices without any real effect on trade). For manufactured goods, tariffs are reduced according to the Swiss formula with coefficients 8 and 20 for developed and developing countries, respectively.<sup>31</sup> Other subtleties of the simulations are described in their study. These shocks are simulated using the GTAP Version 6.1 which uses 2001 as its base year. Performing this simulation using data for a different year, with a different level of protection, would yield different results and this should be borne in mind when interpreting the findings below. For the reductions in Ireland's own border measures due to the EU's Common External Tariff, a more schematic approach is taken. Agricultural tariffs are reduced by 70 per cent across the board and manufacturing tariffs and export subsidies are eliminated.

The approach recommended by Horridge and Zhai (2005) to link a national model to output from a global model is followed. Their approach allows the single country model to determine export supply behaviour and uses the changes in demand in the rest of the world as presented in the global model. The shift in the demand curve facing Irish exports is approximated by the expression

$$fp = \frac{(p + q)}{(\textit{elasticity of substitution among imports})}$$

where  $p$  is the percentage change in export prices and  $q$  is the percentage change in export quantities facing Ireland.

Vertical shifts in import supply are proxied by the import price shocks taken directly from the global model. The shock parameters using Baltzer et al. (2008) results are shown in Table 5.2.

Ireland is an open, trade dependent economy with the value of exports at 81 per cent of GDP exceeding the value of imports by about 18 per cent. Agri-food products account for about 8 per cent of exports while they account for about 5 per cent of imports. Although overall extra-EU import tariffs are small (the trade-weighted average import tariff for Ireland is 0.3 per cent), there are a number of agricultural and food sectors with considerable import protection in 2001. Those above 1 per cent are, in decreasing order, beef (40 per cent), dairy (34 per cent), sheep meat (22 per cent) and other

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<sup>30</sup>The tiered market access formula can be found in Appendix G 7.

<sup>31</sup>The Swiss formula can be found in Appendix H 8

**Table 5.2:** Policy shocks applied to represent Doha Round liberalisation

Sectors	EU demand shift %	ROW demand shift %	EU import price change %	ROW import price change %
Milk	-0.77	-0.20	-0.87	-0.06
Cattle	-0.58	1.12	-0.44	0.68
Sheep	-0.68	0.56	-0.42	0.67
Pigs	-0.62	-0.45	-0.53	-0.13
Poultry	-0.62	-0.45	-0.53	-0.13
Horses	-0.58	1.12	-0.44	0.68
Cereals	-7.77	6.52	-0.49	0.40
Fruit & Veg.	-2.44	4.33	-0.59	1.55
Potatoes	-0.43	0.11	-0.18	0.47
Other crops	-0.44	0.13	-0.18	0.32
Fodder crops	-0.43	0.11	-0.18	0.47
Forestry	0	0	0	0
Fish	-1.15	2.15	-0.74	-0.05
Beef meat	-2.93	3.45	-0.57	0.18
Pig meat	-0.92	4.21	-0.40	-0.77
Poultry meat	-0.92	4.21	-0.40	-0.77
Sheep meat	-0.92	4.21	-0.40	-0.77
Fish and other fishing products	-1.15	2.15	-0.74	-0.05
Fruit and vegetable	-1.15	2.15	-0.74	-0.05
Dairy products	-1.10	4.29	-0.60	0.55
Animal feed	-1.15	2.15	-0.74	-0.05
Other food products	-1.20	2.20	-0.83	-0.12
Beverages	-0.75	-0.89	-0.54	-0.18
Manufactures	-1.15	2.15	-0.74	-0.05
Services	-0.92	4.21	-0.40	-0.77

Source: Author's own calculations from Baltzer et al. (2008) results.

food products (16 percent) (The 33 percent tariff on milk is not relevant given the absence of raw milk imports from outside the EU). In addition, four sectors are protected through export subsidies where dairy (4 percent) and beef (2.2 percent) are the most significant (other crops have a high per unit subsidy because of sugar but a small share in total exports). At the same time, beef and dairy together with other food products are the largest agricultural and food sectors. More than 50 percent of the domestic output of these three sectors is exported. Moreover, Ireland imports significant shares of its domestic demand. We thus expect a large shock on the Irish agriculture and in particular to the sectors connected to beef and dairy from the proposed import and export trade liberalisations.

While trade liberalisation will likely have a negative impact on Irish agriculture and intra-EU prices are expected to fall, world prices for many agricultural and food products are forecast to increase and this will mitigate some of the effects. Manufacturing and services sectors will face greater competition on the EU market but will profit from the dismantling of trade distortions in ROW trading partners. The overall economic outcome remains ambiguous without quantitative analysis. The same applies to the impacts at the household level which will depend on the implications for income

as well as for consumer prices.

### 5.3.2 Results

Empirical results are presented for five scenarios: the decoupling scenario relative to the 2005 base where the SFP and REPS are transferred as a lump sums to households and DACAS are treated as a payment to land (DECOUP), the removal of milk quotas relative to the 2005 base (QTA); the pre-experiment which includes decoupling and elimination of the dairy quota (DECQTA); the Doha trade liberalisation scenario where Doha liberalisation is simulated against the pre-experiment DECQTA (DOHA) and show what effect DOHA adds on top of the pre-experiment; and a final scenario which combines the result of all three scenarios to show the combined effect against the 2005 base (TOTAL). The focus of our analysis is on the impact of the Doha trade liberalisation starting from a CAP-reformed economy as represented by the DOHA column of the tables.

Table 5.3 reports the results for the changes in domestic production activities for the five scenarios. Not unexpectedly, the decoupling scenario (DECOUP) shows a major shift away from those activities that were previously supported by coupled payments. These include cattle, sheep and cereals and their corresponding processing activities. The animal feed sector is surprisingly little affected which is due to the fact that in the AgriFood-SAM, even though more than half of output is used by the livestock sectors, a significant amount of fodder crops (main input of this sector) is actually imported; these imports decrease by more than a half following the decoupling shock (Table 5.4). In contrast, output in the manufacturing and services sectors expands in the decoupling scenario. The fact that output in the previously coupled sectors, particularly cattle, has not fallen over the period 2005-2013 following decoupling by the magnitudes predicted in this scenario is partly a reflection of other changes in the external environment including, for example, the introduction of the Suckler Cow Welfare Scheme, since 2005 but may also be a further indication that Irish farmers do not see the SFP as a fully decoupled payment.

The main impact of the quota elimination scenario (QTA) is, of course, a significant increase in milk output (15 percent) and dairy industry output (17 percent). Expansion of milk production takes place at the expense of most other land-using activities; with the sheep activity being the most adversely affected, but also the manufacturing sector is negatively impacted by the milk quota abolition. When the milk quota is eliminated together with decoupling in the pre-experiment (DECQTA), the results are broadly the sum of the two previous scenarios.

**Table 5.3: Changes in output levels,%**

Sector	Base €m	DECOUP	QTA	DECQTA	DOHA	TOTAL
Milk	1,622		15.1	19.7	-5.3	13.4
Cattle	2,475	-34.8	-1.3	-36.1	-6.4	-40.2
Sheep	214	-44.7	-2.5	-47.1	4.6	-44.6
Pigs	338	14.9	-1.4	12.9	3.1	16.4
Poultry	214	5.1	-0.7	4.1	1.4	5.6
Horses	239	23.1	-1.5	20.3	3.7	24.8
Cereals	163	-5.9	-1.2	-7.2	-0.2	-7.5
Fruit & Veg.	197	0.5	-0.3	0.1	0.7	0.8
Potatoes	77	2.4	-1.1	0.8	-0.2	0.6
Other crops	128	19.5	-2.2	16.1	-17.4	-4.1
Fodder crops	816	14.1	-1.5	12.6	1.9	14.8
Forestry	403	7.9	-0.9	6.4	1.2	7.7
Fish	450	3.7	0.2	3.7	-0.2	3.5
Beef meat	2,352	-34.6	-0.9	-35.7	-7.5	-40.5
Pig meat	939	4.1	-0.5	3.5	1.6	5.1
Poultry meat	504	2.7	-0.5	2.1	0.9	3.0
Sheep meat	249	-28.9	-1.6	-30.9	5.6	-27.1
Fish and other fishing products	215	0.4	0.0	0.4	-1.5	-1.2
Fruit and vegetable	184	63.8	-3.5	56.3	6.9	67.1
Dairy products	2,484	3.0	16.9	25.2	-2.1	22.6
Animal feed	1,020	4.0	-0.2	3.7	1.4	5.2
Other food products	8,992	-0.4	0.2	-0.2	-2.1	-2.3
Beverages	1,897	-1.2	-0.2	-1.5	-0.4	-1.9
Manufactures	132,150	0.7	-0.3	0.4	0.1	0.5
Services	173,129	0.5	0.0	0.4	0.2	0.6

Source: Authors' calculation.

The main focus of interest is in the outcome of the DOHA scenario which measures the comparative static effect of further multilateral trade liberalisation in both the agricultural and manufacturing sectors in the trade policy environment for Irish agriculture at the beginning of the previous decade. The results reflect the initial levels of protection across sectors. Output in the agri-food sectors generally falls (beef, dairy, crops and other food) although pig and sheep meat, which is relatively protected in the base situation, expands. The animal feed industry grows slightly despite the decrease in livestock industries because of a strong reduction of feed imports. The main gainers in this scenario are the manufacturing and services sectors where output expands by 0.1 percent and 0.2 percent, respectively. While small in percentage terms, they are large in absolute value given that they represent the bulk of economic activity.

The final column (TOTAL) shows the combined effect of the three simulations compared to the 2005 base. It is clear that the decoupling scenario is a much more severe shock than the other two and contributes most to the changes shown in the TOTAL column.

Table 5.4 shows the percentage changes in exports and imports for two scenarios: the DOHA scenario, which examines the impact of multilateral trade liberalisation against the pre-experiment baseline of decoupled direct payments and no milk quota;

and TOTAL, which compares the results of all three policy changes compared to the 2005 base. While most of the livestock product exports fall, most notably beef and sheep, pig meat exports increase. The main gains in exports occur in manufacturing and services but also in dairy products, with an increase in exports of almost 33 per cent. On the import side, there is a considerable increase in imports of milk and sheep livestock units as well as beef and sheep meat products. The imports of dairy, pig meat and other food products decrease compared with the base year.

**Table 5.4:** Changes in trade, %

Sectors	Exports			Imports		
	Base €m	DOHA	TOTAL	Base €m	DOHA	TOTAL
Milk				56	60.6	16.5
Cattle	124	10.2	-58.8	164	-2.8	3.7
Sheep	80	13.5	-70.0	38	0.0	34.0
Pigs	125	4.9	27.5	76	1.3	-2.2
Poultry	48	3.7	12.5	33	1.4	0.0
Horses	91	6.7	53.6	22	-3.0	-16.7
Cereals				118	-0.4	24.5
Fruit & Veg.	14	19.7	16.0	136	0.9	2.7
Potatoes	1	8.5	8.8	70	1.5	2.2
Other crops	17	-83.9	-78.5	177	-5.3	-23.7
Fodder crops				161	-13.1	-62.6
Forestry	21	5.0	30.3	77	-0.8	-6.3
Fish	124	0.4	10.8	26	2.0	-1.2
Beef meat	1,400	-7.9	-56.9	77	21.1	63.1
Pig meat	327	4.8	12.1	192	-0.6	-2.2
Poultry meat	248	2.5	5.5	244	0.4	0.1
Sheep meat	193	12.9	-42.3	8	2.2	25.5
Fish and other fishing products	28	-3.2	-2.8	30	1.0	1.2
Fruit and vegetable	46	13.5	136.9	492	-0.5	-6.3
Dairy products	2,005	-2.6	32.7	417	-1.4	-8.1
Animal feed	485	4.1	12.2	1,575	-0.6	-4.2
Other food products	7,153	-1.3	-1.6	554	-10.3	-10.2
Beverages	1,271	-0.6	-2.4	745	0.0	0.4
Manufactures	78,191	0.4	0.7	51,433	0.4	0.7
Services	40,130	0.5	0.8	55,143	-0.2	0.1

Source: Authors' calculation.

Table 5.5 presents the macroeconomic impacts. From the DOHA column which is the key simulation of interest, the projected Doha Round liberalisation has very little impact overall on the Irish economy. GDP at market prices would increase by 0.2 percent and domestic absorption by 0.05 percent. Private consumption by households would increase slightly by 0.1 percent. Exports increase marginally while imports increase by a small amount. The biggest macroeconomic effects are again projected to follow from the decoupling scenario with increases in all components of domestic absorption contributing to an overall increase in GDP at market prices.

Factor returns are affected by trade liberalisation, with returns to land falling considerably, ranging between 39 and 68 percent (DOHA) depending on the soil type, while returns to labour and capital increase. As a consequence of decoupling, agri-

cultural production generally has become more land extensive with less use of capital and labour relative to the fixed area of land. In the SAM, the benefit of the DACAS subsidy is spread over all factors of the activity, but in this scenario, the DACAS subsidy is solely assigned to land, so paying this subsidy to land has a positive effect on the return to land.<sup>32</sup> However, it is not surprisingly the return to land in the decoupling scenario (DECOUP) registers a significant drop. This subsidy reduces the cost of land, making the factor cheaper, but considerably more expensive than if the DACAS subsidy was still coupled to activity.

**Table 5.5: Macroeconomic impacts**

	Base €m	DECOUP	QTA	DECQTA	DOHA	TOTAL
Domestic absorption	143,265	0.46	0.02	0.47	0.05	0.53
Private consumption	74,134	0.46	0.02	0.48	0.14	0.62
Fixed investment	43,119	0.45	0.02	0.47	0.01	0.48
Stock changes	824					
Govt consumption	25,189	0.49	0.00	0.48	-0.12	0.36
Exports	132,122	0.09	0.08	0.19	0.28	0.47
Imports	-112,063	0.02	0.08	0.12	0.06	0.18
GDP market price	163,325	0.46	0.02	0.49	0.23	0.72
Net indirect taxes	20,242	4.20	0.04	4.24	3.01	7.38
GDP factor cost	143,083	-0.04	0.00	-0.03	-0.01	-0.04
	Base €m	DECOUP	QTA	DECQTA	DOHA	TOTAL
Labour returns	67,390	-0.66	0.23	-0.39	0.34	-0.05
Land returns(1)	585	-48.69	5.03	-44.37	-38.63	-65.86
Land returns(2)	339	-46.03	4.59	-42.99	-56.60	-75.26
Land returns(3)	103	-25.09	-0.08	-24.18	-67.89	-75.65
Capital return	74,486	-0.05	0.07	0.02	0.42	0.44

Source: Authors' calculation. The columns represent 2005 base values in €million and five scenario outcomes as described in the text.

The link between aggregate changes in economic activity in the economy following a trade liberalisation shock and household welfare is mediated through changes in factor returns (on the income side) and changes in the prices of consumption goods (on the expenditure side). Thus, households are affected differently by economic shocks because they own different shares of labour, capital and land and receive different levels of transfers (including agricultural subsidies). The particular sector from which a household derives its income does not influence the long-run returns to the resources that the household owns.

Table 5.6 shows that decoupling is projected to lead to a general increase in farm household income as agricultural payments, previously requiring production which was often unprofitable, are replaced by direct transfers to households. All farm house-

<sup>32</sup>A test scenario is simulated to see, only, the effects of the DACAS as a payment to land. The results show that labour and capital lose in the DECOUP scenario, but the three land types wins 13 percent, 28 percent and 61 percent, respectively compared to the test scenario.

holds experience high consumption gains in that scenario. What may appear surprising is that, under the quota (QTA) scenario, dairy farm households lose out. This is because, even though milk output expands on these farms, they lose their quota rent. When the results for the DOHA scenario of interest are examined, it appears all farm households are worse off; although, cattle and sheep farm households appear more adversely affected than others. Under the last scenario (TOTAL), which compares all scenario with the base, it appears that only the dairy farm households report a negative impact. This reflects the positive impact of multilateral liberalisation on total private consumption, as reported above in Table 5.5. The bulk of the household are urban and non-farm rural households, with only 9 percent of farm households, so the negative impact of the multilateral trade liberalisation on farm households is more than compensated by the non-farm households (marginal increase in private consumption of 0.14 percent).

**Table 5.6:** Household income changes from trade liberalisation

Household type	Base €m	DECOUP	QTA	DECQTA	DOHA	TOTAL
Urban	54,292	-0.09	0.10	0.02	0.26	0.28
Rural Non Farm	16,963	0.00	0.09	0.10	0.35	0.45
Dairy	706	7.01	-6.68	-0.55	-2.51	-3.05
Dairy + Other	377	23.75	-3.05	20.13	-2.65	16.96
Cattle	679	9.38	0.48	9.71	-3.70	5.66
Cattle + Other	481	13.52	0.39	13.77	-2.53	10.90
Sheep	418	17.28	0.41	17.58	-3.47	13.50
Tillage	142	22.25	0.66	22.69	-3.09	18.90
Other farms	73	20.43	0.55	20.88	-1.45	19.12

Source: Authors' calculation. Impacts are measured in terms of changes in household income.

## 5.4 Conclusions

In this chapter, we introduce a single country CGE model of the Irish economy with strongly disaggregated agricultural and food activities for the ex ante evaluation of policy changes affecting both agricultural and non-agricultural sectors. A feature of the model is the disaggregation of the single representative household in the standard CGE model using information from the Irish household budget survey which is a representative sample of Irish households, thus allowing the distributional consequences of policy changes as well as their aggregate impacts to be evaluated.

A pre-experiment simulation was undertaken to reflect the likely policy environment for the agri-food sector towards the end of this decade when a Doha Round agreement, if one is successfully negotiated, would be fully implemented. This pre-experiment takes account of policy changes which are already implemented or announced since the 2005 base year for the model database, notably decoupling of the

CAP subsidies and elimination of milk quotas.

The outcomes from a CGE simulation of a hypothetical Doha trade liberalisation scenario suggest a small positive impact on Irish GDP at market prices, domestic absorption, and private consumption, but a small negative impact on GDP at factor cost. The gains from shifting resources from previously strongly protected agricultural and food sectors into more efficient uses are outweighed by the adverse movement in Ireland's terms of trade. Many of the agricultural and food sectors contract as expected as the remaining import and export protection is found almost exclusively in those sectors. These contractions are compensated by expansions of the manufacturing and services sectors. At the household level, urban and non-farm rural households would experience rising incomes, while all farm households experience a small income decrease as a result of the DOHA scenario. Farm households, and particularly cattle, sheep, and tillage farm households, experience a bigger negative impact. These impacts are mediated through higher returns to the factors labour and capital but a fall in the return to land.

Further work will focus on increasing the realism of the model, relaxing the assumption of fixed factor supplies for labour, as well as improving the specification of agricultural subsidies, distinguishing better between subsidies coupled to output, subsidies coupled to land and decoupled subsidies.

# Chapter 6

## Conclusions

This thesis was motivated by the current discussions on the future of the EU's Common Agricultural Policy post 2013, the WTO Doha Round negotiations and the strategy statement for the Irish agri-food sector against the background of recent economic policies and events in the Irish economy. The four chapters provide empirical analyses on the agricultural and food sectors of the Irish economy. This thesis contributes to the existing literature on several aspects.

First, a social accounting matrix using the latest input-output tables and a wide range of data, from national accounts to national survey data has been constructed for the Irish economy for the year 2005. This database - model is a useful instrument in providing an inside look at the structure of the economy and as the basis for a variety of possible areas of research. The structure of this SAM allow for wide range of economic modelling using CGE models or SAM multiplier models due to the level of disaggregation of the production, taxation and external accounts. In Chapter 2, the multipliers derived from the 2005 SAM for Ireland illustrate the different degrees to which individual economic sectors are embedded within the economy and the strength of the indirect and induced effects of an exogenous increase in the demand for the output of different sectors. As an experiment, the jobs impact of a switch in household expenditure from imported to domestically-produced goods and services is estimated. The model estimates that switching an average of 5 percent of household expenditure would create 38,000 jobs. The SAM multiplier model from which the results are derived is based on rather stringent assumptions. The most important are that the economy is demand-constrained and that supply can respond elastically to additional increases in demand, and that the marginal employment effects are similar in size to average employment intensities.

Second, using the 2005 SAM for Ireland, the National Farm Survey 2004 and 2005, the Household Budget Survey 2004-2005 and other data sources, a 2005 agricultural and food SAM for Ireland was build. This database - model is used extensively in this thesis to answer various economic questions related to agricultural and food poli-

cies. The specific features of this SAM are the disaggregation of the agriculture and food industry sectors into 12 agricultural sectors and 10 food industry sectors, explicit disaggregation of the value added account and external accounts, careful treatment of the taxes and subsidies account for agriculture, introduction of milk quota rent and explicit disaggregation of the household account. A linear SAM model based on the Leontief model, but which incorporates income generation and distribution as well as the production side, is used to estimate the economic impact of reducing GHG emissions from the agricultural sectors by 20 percent. The results suggest that a 20 percent reduction in GHG emission by 2020, through a reduction of 12.6 percent in cattle output, will have a contractionary effect in the whole economy. This policy will reduce the total gross output in the economy by more than half a billion euro and have an indirect effect on the household by reducing its total income by more than €300 million. The limitation of a multiplier analysis should be considered as it assumes fixed proportion production functions, fixed prices and free availability of resources. In other words, if cattle output reduces by 12.6 percent in 2020 then the level of inputs used in this sector is assumed to be reduced by same percentage. Similarly, employment and income are assumed to be reduced in the same proportions. Also, multipliers are based on the state of technology within a sector at a point in time. Multipliers may change in different sectors over time as technology changes. However, multiplier analysis is useful in considering the significance of economy-wide growth (or contraction) in a particular economic sector.

Third, an agri-food SAM multiplier - econometric model is used to estimate the employment impact of the Food Harvest 2020, which is the current government strategy paper for the Irish agri-food sector. The model simulates results for two scenarios based on average and marginal employment responses to the production targets in this report. The first scenario projects the maximum numbers of jobs that might be created assuming the production targets are met. The second scenario is based on marginal employment coefficients and provides a more likely estimate of the change in employment of achieving the FH2020 production targets in the model. In Chapter 4, employment marginal coefficients are calculated and introduced into a social accounting matrix multiplier analysis to simulate the impact of FH2020 agriculture targets on employment in the economy. This analysis focuses on the four main growth targets in FH2020, namely the growth targets for milk, beef, sheep and pigs. This approach has its limitation as well and further work could improve the estimated coefficients. Such an analysis will benefit from a larger panel data and further improvement in the model by identifying additional influences on employment intensities, particularly regarding labour productivity, unemployment rates, etc. In summary, the use of marginal em-

ployment intensities and a social accounting model can give a better reflection of the potential economic impacts of a policy change, but more research is needed to better integrate the two approaches.

Fourth, a single country CGE model of the Irish economy is calibrated on the agri-food SAM to evaluate the effects of the WTO Doha Round negotiations on the Irish economy. The model allows for the disaggregation of the single representative household and the land factor in the standard CGE model using information from the Irish household budget survey and national farm survey, thus allowing the distributional consequences of policy changes as well as their aggregate impacts to be evaluated. The CAP instruments are modelled to reflect policy changes which are already implemented or announced since the 2005 base year for the model database, notably decoupling of the SFP and elimination of milk quotas. The results from a CGE simulation of a hypothetical Doha trade liberalisation scenario suggest a positive impact on the entire economy. Private consumption and GDP at market prices are predicted to increase slightly. Urban and non-farm households experience a positive effect, but all farm households are negatively affected in the DOHA scenario.

Some potential avenues for further research emerged during the course of this thesis. Increasing the realism of the CGE model by relaxing the assumption of fixed factor supplies for labour, as well as improving the specification of agricultural subsidies, distinguishing better between subsidies coupled to output, subsidies coupled to land and decoupled subsidies.

The labour factor could be further disaggregated according to the skill level, skilled versus unskilled, as well as making use of family labour already implemented in the AgriFood-SAM and which is specific to the agricultural sector. This feature would allow the model to better account for the potential substitutability between unskilled labour between the agricultural and non-agricultural sectors. This is mainly a sensitivity analysis which involves in a first stage further improvement of the database.

The use of all heterogeneous household linked with the AgriFood-SAM for Ireland at income and expenditure level can be introduced into the CGE model through an integrated approach as described in Cockburn, 2010. The replacement of the nine representative households with households from nationally representative household and farm surveys allow to observe the macro-economic shocks impacts on individual households.



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# Appendix

Table A 1: SAM Sector listing and labelling

SAM Sectors	LABEL	
	Activities	Commodities
Products of agriculture, hunting and related services	A_AGRI	C_AGRI
Products of forestry, logging and related services	A_FORE	C_FORE
Fish and other fishing products; services incidental of fishing	A_FISH	C_FISH
Coal, peat, petroleum and metal ore extraction	A_CPUM	C_CPUM
Other mining and quarrying products	A_MING	C_MING
Food products and beverages	A_FOOD	C_FOOD
Tobacco products	A_TABA	C_TABA
Textiles	A_TEXT	C_TEXT
Wearing apparel; furs	A_FURS	C_FURS
Leather and leather products	A_LETH	C_LETH
Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	A_WOOD	C_WOOD
Pulp, paper and paper products	A_PAPE	C_PAPE
Printed matter and recorded media	A_PRME	C_PRME
Petroleum and other manufacturing products	A_PEMP	C_PEMP
Chemicals, chemical products and man-made fibers	A_CHIM	C_CHIM
Rubber and plastic products	A_RUBB	C_RUBB
Other non-metallic mineral products	A_NOME	C_NOME
Basic metals	A_BAME	C_BAME
Fabricated metal products, except machinery and equipment	A_MEMA	C_MEMA
Machinery and equipment n.e.c.	A_MAEQ	C_MAEQ
Office machinery and computers	A_OFMA	C_OFMA
Electrical machinery and apparatus n.e.c.	A_ELMA	C_ELMA
Radio, television and communication equipment and apparatus	A_RATV	C_RATV
Medical, precision and optical instruments, watches and clocks	A_MEDI	C_MEDI
Motor vehicles, trailers and semi-trailers	A_MOTO	C_MOTO
Other transport equipment	A_OTTR	C_OTTR
Secondary raw materials	A_RECY	C_RECY
Electrical energy, gas, steam and hot water	A_ELGA	C_ELGA
Collected and purified water, distribution services of water	A_WATE	C_WATE
Construction work	A_CONS	C_CONS
Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel	A_TRAD	C_TRAD
Wholesale trade and commission trade services, except of motor vehicles and motorcycles	A_WHSL	C_WHSL
Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	A_RETS	C_RETS
Hotel and restaurant services	A_HORE	C_HORE
Land transport; transport via pipeline services	A_LATR	C_LATR
Water transport services	A_WATR	C_WATR
Air transport services	A_AITR	C_AITR
Supporting and auxiliary transport services; travel agency services	A_OTTR	C_OTTR
Post and telecommunication services	A_POTL	C_POTL
Financial intermediation services, except insurance and pension funding services	A_FISE	C_FISE
Insurance and pension funding services, except compulsory social security services	A_INSE	C_INSE

Continued on Next Page...

Table A 1 – Continued

SAM Sectors	LABEL	
	Activities	Commodities
Services auxiliary to financial intermediation	A_OFISE	C_OFISE
Real estate services	A_REES	C_REES
Renting services of machinery and equipment without operator and of personal and household goods	A_RESE	C_RESE
Computer and related services	A_COSE	C_COSE
Research and development services	A_RESH	C_RESH
Other business services	A_OTBU	C_OTBU
Public administration and defence services; compulsory social security services	A_PUAD	C_PUAD
Education services	A_EDUS	C_EDUS
Health and social work services	A_HEAS	C_HEAS
Sewage and refuse disposal services, sanitation and similar services	A_SEWA	C_SEWA
Membership organisation services n.e.c.	A_MNEC	C_MNEC
Recreational, cultural and sporting services	A_RECS	C_RECS
Other services	A_OTSE	C_OTSE
Private households with employed persons	A_PRHO	C_PRHO
Labour	LAB	
Capital	CAP	
Households	HHO	
Enterprises	ENT	

**Table B 2: AgriFood-SAM Sector listing and labelling**

NACE CODE	AgriFood-SAM Sectors	LABEL		
		Activities	Commodities	
1	Milk	A_AMIK	C_AMIK	
	Cattle	A_ACATL	C_ACATL	
	Dairy Calve	A_ADCAV	C_ADCAV	
	Sheep	A_ASHP	C_ASHP	
	Pig	A_APIG	C_APIG	
	Poultry	A_APOL	C_APOL	
	Horses	A_AHOR	C_AHOR	
	Cereals	A_ACER	C_ACER	
	Fruit and Vegetable	A_AFRVE	C_AFRVE	
	Sugar	A_ASUG	C_ASUG	
	Potatoes	A_APOT	C_APOT	
	Other Crops	A_AOTCR	C_AOTCR	
	Fodder Crops	A_AFOCR	C_AFOCR	
	2	Products of forestry, logging and related services	A_FORE	C_FORE
	5	Fish and other fishing products; services incidental of fishing	A_FISH	C_FISH
15	Beef meat	A_MBEF	C_MBEF	
	Pig meat	A_MPIG	C_MPIG	
	Poultry meat	A_MPOL	C_MPOL	
	Sheep meat	A_MSHP	C_MSHP	
	Fish and other fishing products	A_MFSH	C_MFSH	
	Fruit and vegetable	A_MFRVE	C_MFRVE	
	Dairy products	A_MDARY	C_MDARY	
	Animal feed	A_MANFE	C_MANFE	
	Other food products	A_MOTFO	C_MOTFO	
	Beverages	A_MBEV	C_MBEV	
	10to14, 16to45	Manufacturing	A_MANUF	C_MANUF
	50to71	Services	A_SERV	C_SERV
		Labour	LAB	
		Capital	CAP	
		Land	LND	
	Urban Households	UHHO		
	Rural Non-Farm Households	RNFHHO		
	Rural Dairy Farm Household	RDFHHO		
	Rural Dairy and Other Farm Household	RDOFHHO		
	Rural Cattle Rearing Farm Household	RCFHHO		
	Rural Cattle and Other Farm Household	RCOFHHO		
	Rural Mainly Sheep Farm Household	RSFHHO		
	Rural Tillage Farm Household	RTFHHO		
	Rural Other Farm Households	ROFHHO		
	Government	GOV		
	Enterprises	ENT		
	Direct Taxes	TINCO		
	Taxes on production	TPTON		
	Subsidies on production	SPTON		
	VAT	TVAT		
	Taxes and duties on imports	TIMP		
	Taxes on products excluding VAT and import duties	TPTS		
	Subsidies on products	SPTS		

Continued on Next Page...

Table B 2 – Continued

NACE CODE	AgriFood-SAM Sectors	LABEL	
		Activities	Commodities
	Export refunds	EXREF	
	Trade and Transport Margins	TRDTR	
	External Account-UK	UK	
	External Account-Rest of the EU	REU	
	External Account-Rest of the World	ROW	
	Savings/Investments	SAV	

**Table C 3: Employment Coefficients per €1 million domestic output, 2005 and 2008**

NACE Codes	Sectors Codes	Sectors Name	Direct 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	4.96
5	A.FISH	Fish and other fishing products; services incidental of fishing	4.67	4.67
10to13	A.CPUM	Coal, peat, petroleum and metal ore extraction	3.45	3.45
14	A.MING	Other mining and quarrying products	3.65	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	1.72
17	A.TEXT	Textiles	9.19	9.19
18	A.FURS	Wearing apparel; furs	7.62	7.62
19	A.LETH	Leather and leather products	7.47	7.47
20	A.WOOD	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	5.54	5.54
21	A.PAPE	Pulp, paper and paper products	5.69	5.69
22	A.PRME	Printed matter and recorded media	1.10	1.10
23&36	A.PEMP	Petroleum and other manufacturing products	3.25	3.25
24	A.CHIM	Chemicals, chemical products and man-made fibers	0.81	0.81
25	A.RUBB	Rubber and plastic products	6.19	6.19
26	A.NOME	Other non-metallic mineral products	4.56	4.56
27	A.BAME	Basic metals	3.11	3.11
28	A.MEMA	Fabricated metal products, except machinery and equipment	6.29	6.29
29	A.MAEQ	Machinery and equipment n.e.c.	5.31	5.31
30	A.OFMA	Office machinery and computers	0.87	0.87
31	A.ELMA	Electrical machinery and apparatus n.e.c.	4.27	4.27
32	A.RATV	Radio, television and communication equipment and apparatus	1.85	1.85
33	A.MEDI	Medical, precision and optical instruments, watches and clocks	3.85	3.85
34	A.MOTO	Motor vehicles, trailers and semi-trailers	5.56	5.56

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Table C 3 – Continued

NACE Codes	Sectors Codes	Sectors Name	Direct employment coefficient per €1 million domestic output	
			2005	2008
35	A_OTTR	Other transport equipment	7.64	7.64
37	A_RECY	Secondary raw materials	4.82	4.82
40	A_ELGA	Electrical energy, gas, steam and hot water	2.07	2.07
41	A_WATE	Collected and purified water, distribution services of water	8.66	8.66
45	A_CONS	Construction work	5.87	5.87
50	A_TRAD	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel	14.26	14.26
51	A_WHSL	Wholesale trade and commission trade services, except of motor vehicles and motorcycles	7.83	7.83
52	A_RETS	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	20.77	20.77
55	A_HORE	Hotel and restaurant services	13.63	13.63
60	A_LATR	Land transport; transport via pipeline services	7.52	7.52
61	A_WATR	Water transport services	10.51	10.51
62	A_AITR	Air transport services	1.43	1.43
63	A_OTTRS	Supporting and auxiliary transport services; travel agency services	4.28	4.28
64	A_POTL	Post and telecommunication services	4.20	4.20
65	A_FISE	Financial intermediation services, except insurance and pension funding services	1.97	1.97
66	A_INSE	Insurance and pension funding services, except compulsory social security services	2.56	2.56
67	A_OFISE	Services auxiliary to financial intermediation	2.86	2.86
70	A_REES	Real estate services	1.31	1.31
71	A_RESE	Renting services of machinery and equipment without operator and of personal and household goods	2.19	2.19
72	A_COSE	Computer and related services	2.26	2.26
73	A_RESH	Research and development services	4.52	4.52
74	A_OTBU	Other business services	7.62	7.62
75	A_PUAD	Public administration and defence services; compulsory social security services	9.07	9.07
80	A_EDUS	Education services	15.51	15.51
85	A_HEAS	Health and social work services	11.82	11.82
90	A_SEWA	Sewage and refuse disposal services, sanitation and similar services	0.01	0.01
91	A_MNEC	Membership organisation services n.e.c.	0.01	0.01
92	A_RECS	Recreational, cultural and sporting services	8.38	8.38
93	A_OTSE	Other services	20.21	20.21
95	A_PRHO	Private households with employed persons	0.00	0.00

Source: Authors' calculation

**Table D 4:** Fixed effects regression results - farm level data

	(1)	(2)	(3)	(4)
	ln_empl	ln_empl	ln_empl	ln_empl
Milk output	0.0468*** (3.35)			
Cattle output	(-1.62)	(-2.92) 0.0419*** (3.95)	(-2.40)	(-3.76)
Sheep output			0.0123* (1.67)	
Crops output				0.00697 (0.92)
_cons	7.313*** (49.51)	7.332*** (77.01)	7.615*** (130.81)	7.628*** (114.63)
<i>N</i>	12872	31166	13002	16937

*t* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table E 5: Fixed effects regression results - panel data

D.ln_employment							
A_AMIK	0.238*** (-4.5)	A_MPIG	0.0510*** (-24.59)	A_PRME	0.00686 (-1.53)	A_TRAD	0.413*** (-52.03)
A_ACATL	0.0196*** (-17.22)	A_MPOL	0.0558*** (-23.19)	A_CHIM	0.0199*** (-3.3)	A_WHSL	0.118*** (-84.39)
A_ASHP	0.00556* (-1.7)	A_MSHP	0.0239*** (-125.49)	A_RUBB	0.0136*** (-13.75)	A_RETS	0.104*** (-58.73)
A_APIG	0.0181*** (-77.82)	A_MFSH	-0.00347*** (-11.88)	A_NOME	0.0184*** (-5.21)	A_HORE	0.0202*** (-3.8)
A_APOL	0.0202*** (-89.24)	A_MFRVE	0.0245*** (-11.45)	A_BAME	0.0262*** (-7.86)	NACE 60to64	0.127*** (-21.55)
A_AHOR	0.0307*** (-6.79)	A_MDARY	-0.00809*** (-17.05)	A_MEMA	0.0309*** (-9.96)	A_REES	0.114*** (-14.27)
A_ACER	0.0392*** (-70.06)	A_MANFE	-0.00866*** (-28.83)	A_MAEQ	0.00616*** (-3.14)	A_RESE	0.0466*** (-7.26)
A_AFRVE	-0.00856*** (-6.23)	A_MOTFO	0.0110*** (-3.2)	A_OFMA	-0.00872*** (-2.92)	A_COSE	0.0564*** (-4.58)
A_ASUG	0.0191*** (-17.03)	A_MBEV	0.0159*** (-1559.74)	A_ELMA	-0.0295*** (-9.63)	A_RESH	0.147*** (-10.48)
A_APOT	-0.00888*** (-3.15)	A_TABA	-0.0133*** (-2.91)	A_RATV	0.00534** (-2.36)	A_OTBU	0.265*** (-27.17)
A_AOTCR	0.0621*** (-41.63)	A_TEXT	-0.0536*** (-16.60)	A_MEDI	0.0550*** (-8.63)	A_RECS	0.124*** (-29.77)
A_AFOCR	0.0178*** (-10.89)	A_FURS	-0.112*** (-16.70)	A_MOTO	0.00744** (-2.56)	A_OTSE	0.0565*** (-10.96)
NACE 02,05	-0.0151*** (-5.85)	A_LETH	-0.0936*** (-7.96)	A_OTTR	0.00978*** (-3.84)	_cons	-0.0360*** (-16.55)
NACE 10to14	0.0242*** (-8.76)	A_WOOD	0.0365*** (-12.16)	A_ELGA	-0.0369*** (-7.41)		
A_MBEF	0.0180*** (-81.35)	A_PAPE	0.00129 (-1.2)	A_CONS	0.0964*** (-12.63)		
N	636						

*t* statistics in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table F 6: Scenario 1. Employment effect of the FH2020 targets using average employment intensities-all sectors**

Sectors	Output changes arising from FH2020 targets						Direct employment				Total employment change				Total Changes
	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)	Direct employment coefficient per €1 million domestic output (10)	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)	(15)	
(1)															
A_AMIK		800.00		30.48		-0.21		1.45	15.72	12,575	479	-3	23	13,074	
A_ACATL		4.89		250.00		-0.14		0.99	20.82	102	5,206	-3	21	5,325	
A_ASHP		0.88		0.42		-16.00		0.14	22.69	20	10	-363	3	-330	
A_APIG		1.14		0.59		-0.03		90.00	3.42	4	2	0	308	314	
A_APOL		0.97		0.52		-0.03		0.17	5.57	5	3	0	1	9	
A_AHOR		0.31		0.13		-0.07		0.09	7.34	2	1	-1	1	3	
A_ACER		18.71		18.16		-0.49		9.98	17.94	336	326	-9	179	832	
A_AFRVE		5.16		3.71		-0.16		1.22	1.09	6	4	0	1	11	
A_ASUG		2.03		0.88		-0.04		0.27	0.00	0	0	0	0	0	
A_APOT		1.36		0.73		-0.04		0.22	9.08	12	7	0	2	21	
A_AOTCR		8.66		15.56		-0.16		0.11	3.46	30	54	-1	0	84	
A_AFOCR		29.63		44.40		-1.22		17.21	1.11	33	49	-1	19	100	
A_FORE		1.27		0.66		-0.04		0.26	4.96	6	3	0	1	11	
A_FISH		13.83		5.13		-0.40		3.61	4.67	65	24	-2	17	104	
A_CPUM		16.98		10.11		-0.49		3.56	3.45	59	35	-2	12	104	
A_MING		4.74		3.96		-0.16		0.78	3.65	17	14	-1	3	34	
A_MBEF		7.26		3.77		-0.20		1.31	3.16	23	1,408	-1	4	1,434	
A_MPIG		6.30		3.23		-0.17		1.01	3.21	20	10	-1	1,203	1,233	
A_MPOL		3.67		1.90		-0.10		0.60	3.09	11	6	0	2	19	
A_MSHIP		1.76		0.91		-0.05		0.29	3.24	6	3	-125	1	-115	
A_MFSH		2.68		1.32		-0.07		0.42	4.98	13	7	0	2	22	
A_MFRVE		4.50		2.39		-0.13		0.71	6.78	31	16	-1	5	51	
A_MDARY	1369.13	20.10		10.73		-0.58		3.96	1.52	2,110	16	-1	6	2,132	
A_MANFE		88.00		57.49		-3.15		34.80	1.80	159	104	-6	63	319	
A_MOTFO		101.76		43.34		-2.15		12.45	1.26	128	54	-3	16	195	
A_MBEV		11.10		6.47		-0.45		2.07	1.70	19	11	-1	4	33	
A_TABA		12.72		6.90		-0.37		2.11	1.72	22	12	-1	4	37	
A_TEXT		5.87		3.31		-0.17		1.04	9.19	54	30	-2	10	92	
A_FURS		20.32		11.02		-0.59		3.29	7.62	155	84	-4	25	259	
A_LETH		4.23		2.31		-0.12		0.73	7.47	32	17	-1	5	53	
A_WOOD		6.07		3.09		-0.18		1.38	5.54	34	17	-1	8	57	
A_PAPE		33.48		13.31		-0.97		8.71	5.69	190	76	-6	50	310	
A_PRME		12.61		6.68		-0.39		2.94	1.10	14	7	0	3	24	
A_PEMP		90.10		59.07		-2.50		19.25	3.25	292	192	-8	62	538	
A_CHIM		69.63		55.07		-2.24		17.72	0.81	56	44	-2	14	113	
A_RUBB		25.41		10.99		-0.74		6.21	6.19	157	68	-5	38	259	
A_NOME		9.81		4.99		-0.29		2.17	4.56	45	23	-1	10	76	

Source: Authors' calculation

**Table F 6: Scenario 1. Employment effect of the FH2020 targets using average employment intensities-all sectors**

Sectors	Output changes arising from FH2020 targets									Direct employment coefficient per domestic output volume	Total employment change					Total Changes
	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)	employment (€ million) (10)		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)	(15)	
A_BAME	9.01			4.56	-0.27			2.16	3.11	28	14	-1	7	48		
A_MEMA	21.66			13.65	-0.68			4.47	6.29	136	86	-4	28	246		
A_MAEQ	19.75			13.72	-0.64			3.77	5.31	105	73	-3	20	194		
A_OFMA	6.79			3.43	-0.21			1.64	0.87	6	3	0	1	10		
A_ELMA	5.20			2.83	-0.16			1.12	4.27	22	12	-1	5	38		
A_RATV	10.37			5.52	-0.31			2.25	1.85	19	10	-1	4	33		
A_MEDI	3.65			2.09	-0.11			0.82	3.85	14	8	0	3	25		
A_MOTO	29.30			15.75	-0.85			4.74	5.56	163	88	-5	26	272		
A_OTTR	2.26			1.06	-0.07			0.58	7.64	17	8	-1	4	29		
A_REC Y	1.15			0.46	-0.03			0.31	4.82	6	2	0	1	9		
A_ELGA	47.47			25.36	-1.44			10.55	2.07	98	53	-3	22	170		
A_WATE	1.89			1.02	-0.06			0.43	8.66	16	9	-1	4	28		
A_CONS	18.72			12.32	-0.60			3.70	5.87	110	72	-3	22	200		
A_TRAD	5.40			3.31	-0.17			1.07	14.26	77	47	-2	15	137		
A_WHSL	36.68			14.31	-1.09			10.56	7.83	287	112	-9	83	473		
A_RET S	0.94			0.50	-0.03			0.16	20.77	19	10	-1	3	33		
A_HORE	81.05			42.61	-2.38			15.61	13.63	326	136	-9	82	535		
A_LATR	43.31			18.11	-1.26			10.88	7.52	1,105	581	-32	213	1,866		
A_WATR	2.01			0.95	-0.06			0.47	10.51	21	10	-1	5	35		
A_ATR	18.96			8.74	-0.57			4.94	1.43	27	12	-1	7	46		
A_OTTR S	27.05			13.91	-0.80			5.78	4.28	116	60	-3	25	196		
A_POTL	48.37			25.49	-1.48			11.23	4.20	203	107	-6	47	351		
A_FISE	104.45			55.15	-3.21			24.86	1.97	205	108	-6	49	357		
A_INSE	60.74			34.44	-1.85			12.46	2.56	156	88	-5	32	271		
A_OFISE	23.34			11.85	-0.72			5.80	2.86	67	34	-2	17	115		
A_REFS	80.08			43.84	-2.34			14.64	1.31	105	57	-3	19	178		
A_RESE	12.22			6.03	-0.37			2.94	2.19	40	20	-1	6	46		
A_COSE	17.77			8.76	-0.59			6.36	2.26	40	20	-1	14	73		
A_RESH	11.24			6.20	-0.36			3.36	4.52	51	28	-2	15	92		
A_OTBU	203.02			88.76	-10.24			189.90	7.62	1,548	677	-78	1,448	3,594		
A_PUAD	8.33			5.67	-0.28			2.10	9.07	76	51	-3	19	143		
A_EDUS	20.12			10.90	-0.58			3.38	15.51	312	169	-9	52	525		
A_HEAS	32.56			21.22	-1.00			5.34	11.82	385	251	-12	63	687		
A_SEWA	9.15			4.21	-0.27			1.29	0.01	0	0	0	0	0		
A_MNEC	7.48			4.38	-0.22			1.29	0.01	0	0	0	0	0		
A_RECS	16.88			9.14	-0.50			3.14	8.38	141	77	-4	26	240		
A_OTSE	8.69			4.33	-0.26			1.89	20.21	176	88	-5	38	296		
A_PRHO	0.88			0.48	-0.03			0.15	0.00	0	0	0	0	0		
<b>Total all sectors</b>	<b>1,369</b>	<b>2,506</b>	<b>442</b>	<b>1,239</b>	<b>-39</b>	<b>-71</b>	<b>374</b>	<b>630</b>	<b>23,052</b>	<b>11,597</b>	<b>-772</b>	<b>4,552</b>	<b>38,430</b>			

Source: Authors' calculation

**Table G 7: Market Access - Tiered Formula**

The Market access reduction suggestions likewise follow the tiered formula approach. The reduction commitments fall in four tiers:

- a) Final bound tariffs greater than 0 and less than 20% (30% for developing countries) are reduced by 48-52% (2/3 of this cut for developing countries)
- b) Final bound tariffs greater than 20% (30% for developing countries) and less than 50% (80% for developing countries) are reduced by 55-60% (2/3 of this cut for developing countries)
- c) Final bound tariffs greater than 50% (80% for developing countries) and less than 75% (130% for developing countries) are reduced by 62-65% (2/3 of this cut for developing countries)
- d) Final bound tariffs greater than 75% (130% for developing countries) are reduced by 66-73% (2/3 of this cut for developing countries)

Source: Baltzer et al. (2008)

**Table H 8: Tariff - Swiss Formula**

The general instrument for specifying tariff reduction commitments is the so-called simple Swiss formula, defined as:

$$t_1 = \frac{(a \text{ or } b)t_0}{(a \text{ or } b) + t_0}$$

where,

$t_0$  = Base rate

$t_1$  = Final bound tariff

$a$  = Coefficient for developed Members (= 8)

$b$  = Coefficient for developing Members subject to the formula (= 20)

The base rate is given as the current bound rate or, in the case of unbound tariff lines, the Most Favoured Nation (MFN) rate plus a constant mark-up of 25 percentage points. The Swiss formula is constructed in such a way that the highest tariffs are reduced the most, thus eliminating tariff peaks. Also, the final bound tariffs will be no higher than the coefficient used in the formula, i.e. 25 percent for developing and 8 percent for developed countries.

Source: Baltzer et al. (2008)