Impact of the 2001 Foot and Mouth Outbreak on the Irish Economy

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Abstract

This paper examines the impact of the recent outbreak of foot-and-mouth disease on the Irish economy using IMAGE, a CGE model of the Irish economy. The direct impacts on the tourism sector, the agricultural sector and on government finances are identified and their overall consequences for the economy are calculated by model simulation. The overall impacts on the agricultural sector are positive because of higher prices for meat products arising from the FMD outbreak in the UK, but significant adverse impacts are found for the tourism and retailing sectors.

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1 Introduction

Ireland experienced its first foot and mouth (FMD) outbreak since 1941 in March 2001. For three months the entire country, not least the farming community, held its breath while fearfully watching the course of the outbreak of the disease in the UK. Stringent control measures were put in place by the Irish Department of Agriculture, Food and Rural Development (DAFRD) to try to prevent transmission of the disease from the UK, to limit the extent of the outbreak which did occur and to prevent its spread. These measures imposed additional costs on Irish agriculture, but had their greatest knock-on effects on the tourist and service sectors, particularly in rural areas, as much of the countryside was placed off-limits for the three-month period.

DAFRD has recently published a study undertaken by the consulting firm Indecon which estimated the cost to the Irish economy of controlling the 2001 FMD outbreak (Indecon, 2002). The initial estimate of the impact on government expenditure is 100m, while the estimated negative impact on tourism revenues is 200m. On the other hand, the report estimates that there were offsetting gains to the agricultural sector of the order of 100m, due to the impact of the UK outbreak which resulted in higher than expected export prices for livestock exports, particularly sheepmeat. The overall cost of controlling the FMD outbreak is estimated at around 0.2% of GDP. Despite the smaller relative size of its farming sector, the greater severity of the disease outbreak in the UK means that projected estimates of the impact of the outbreak on UK GDP in 2001 are somewhat higher, ranging from £1.6 billion (0.2% of GDP) to £6.3 billion (0.7% of GDP).[1] The Countryside Agency (2001) suggests that a reasonable estimate is 0.3-0.5% of GDP. Notably, the UK studies concur that the greatest economic

[1] Countryside Agency (2001). See also the contributions of Harvey (2001), Midmore (2001), Blake et al (2001) and House of Commons Library (2001). Much of the debate in the UK has been on the relative merits of a slaughter or a vaccination policy in tackling the disease. The UK has a relatively minor export trade in livestock (in part because of its BSE problem which had led to a total ban on the export of beef until recently) and agriculture's share of GDP in the UK is now less than 1 per cent. Thus the conclusions reached for the UK are not necessarily appropriate in the Irish context.

impact was on the tourist industry, and particularly rural tourism, rather than agriculture. The distribution of the costs of controlling the disease are thus of particular interest.

The purpose of this paper is to provide a further assessment of the costs to the Irish economy of the 2001 FMD outbreak. This study differs from the Indecon one in two respects. First, quantification of the impact of FMD controls requires a view of the counterfactual situation which would have occurred in the absence of the outbreak, and there is room for debate as to what the counterfactual situation might have been. In this paper, we develop slightly different estimates of the initial impacts of the FMD outbreak on the agricultural and tourism sectors.

Second, and more important in our view, is the methodological use of a computable general equilibrium (CGE) model in this paper to quantify the direct and indirect effects. The Indecon paper included an estimate of the indirect effects using a simple multiplier assumption.[2] Assuming that the inter-industry linkages are of the same magnitude in every industry may be overly simplistic – for example, tourism inputs tend to be sourced domestically, so the marginal propensity to import for tourism is lower than for other industries. The corresponding income and employment multipliers for changes in tourism expenditure tend to be bigger. Using a CGE model allows an explicit calculation of the distribution of the economic impacts across industrial sectors to be made. In this paper, we focus particularly on the impacts on the food processing and tourism industries. Finally, a fully functioning general equilibrium model takes into account constraints in the economy such as the government budget and the balance of trade constraints. Simulating the impact of the FMD outbreak in a CGE model requires specific assumptions to be made about the behaviour of these constraints (called 'closure rules' in CGE modelling). The advantage of this approach is that it makes explicit the economic assumptions held by the analyst in reaching his or her results, although it has the drawback that the results derived can be sensitive to the closure rules adopted.

The paper is structured as follows. In section 2 we discuss the characteristics of the disease in terms of its biological and economic effects and briefly describe the course of the FMD

[2] They applied a multiplier value of 1.7 to the direct effects, which they argue is consistent with estimates reported in the economic literature for Ireland.

outbreak in Ireland in the first half of 2001. In section 3.1 we introduce the IMA*GE* model which is used to quantify the impact of the disease, in section 3.2 we discuss the closure of the model while in section 3.3 we discuss the calculation of the 'shocks' which are applied to the base model to estimate the impact of the disease. The results of the simulation are discussed in section 4, while section 5 concludes.

2 The FMD outbreak in the Irish Republic

FMD is a virulent virus found in cloven-hoofed animals such as cattle, sheep, pigs, goats and deer, and is one of the most contagious animal diseases (FAO, 2002). Animals can become infected through inhalation, ingestion and through reproduction. The primary mechanism of spread within herds is by direct contact, through inhalation of virus aerosols. Under the right conditions long distance spread (measured in kilometres) of FMD by wind-borne virus can occur. Movement of infected animals is the most important method of spread between herds. Other sources of infection include contaminated vehicles, equipment, people and products. The FMD virus can survive for long periods in meat if pH does not fall below 6.2, and can also survive in frozen lymph nodes, bone marrow and viscera. The FMD virus will also survive well in salted and cured meats, and in non-pasteurised dairy products.

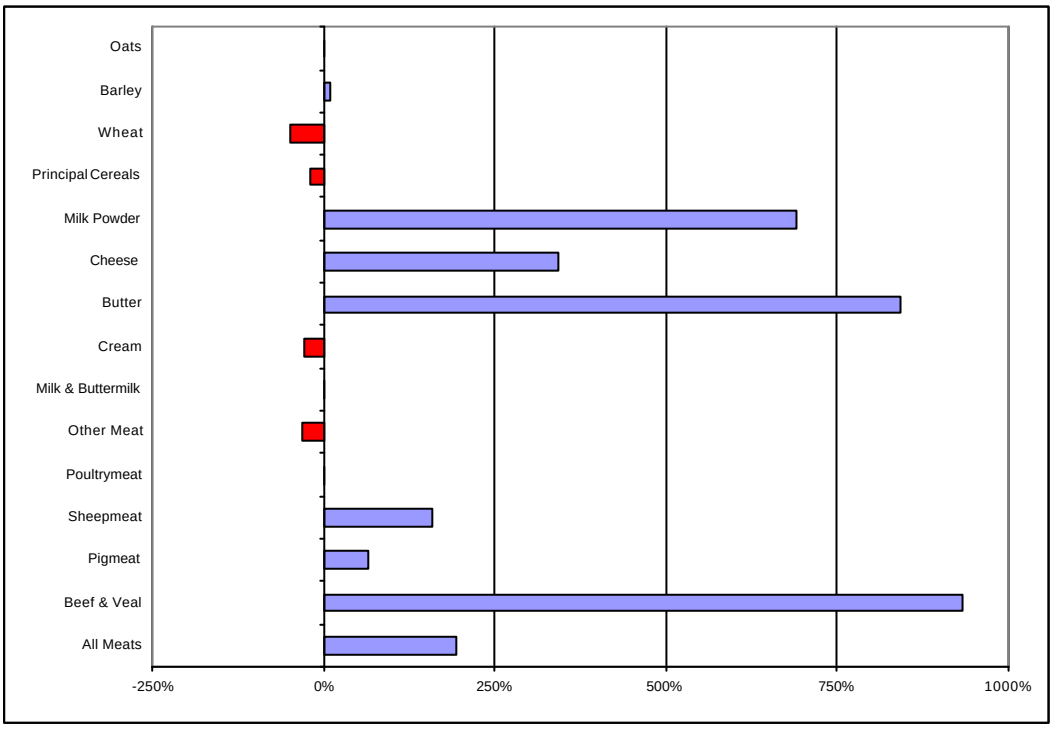
In terms of animal husbandry, animals that are infected with FMD almost never regain the weight they lost and often remain somewhat lame. Milk-producing animals do not return to pre-infection milk production levels and pregnancy rates usually drop. Young animals grow more slowly, so it costs more to raise them to marketable weights. The disease itself is fatal in less than 5 percent of infected animals. If an outbreak occurs within a herd, 80% of sheep and cattle, and 40% pigs are likely to be infected. It is more difficult to spot signs in sheep. Most animals once infected recover in a relatively short time span (around a few weeks), and for most animals the disease is not particularly debilitating. Therefore the primary cost of the disease is economic. FMD is not considered to be a human health threat.

The reason for the strong measures taken in Ireland in reaction to the British outbreak was due to fears that the potential loss in export markets, particularly for beef and sheep meat but also dairy products, would be very large. The Republic of Ireland is what is called a "white listed" country and has access for its food products to world-wide markets. This "white listed" status

is lost if an FMD outbreak occurs, which would lead to the exclusion of Irish livestock exports from most of its major export markets. Irish agriculture is hugely dependent on exports. Graph 1 shows the amount of output by commodity available for export, as a percentage of domestic consumption. The 0% line indicates self sufficiency. For example, Ireland does not produce sufficient wheat to cover its domestic consumption, but exports of beef are nine times domestic consumption. Dairy products are the other major group of exports that would be affected by an outbreak of FMD, and more specifically, milk powder, cheese and butter. There is some disagreement as to whether these products can be adequately heat treated so as to allow their continued export even in case of an infection.

Graph 1:

Export by Commodity as a Percentage of Domestic Consumption



Source: Statistical Compendium, DAFRD

The Indecon study also estimated the likely economic impacts of an FMD outbreak if control measures were not introduced. They argue that, for agriculture, there would have been a ban on all exports of susceptible products to the EU and non-EU countries, the need for a comprehensive programme of culling and disposal of animals and the consequent loss in stock,

as well as a significant cost in loss of reputation for Ireland's food producing image. In terms of tourism, they assume that the restrictions on tourism would need to be extended as the life of the outbreak would be longer. In effect, Indecon's alternative to the policy undertaken is that the same containment policy would need to be implemented, but would be inadequate. They do not investigate other policy alternatives such as vaccination. They estimate that the cost of FMD in the agricultural sector would range from 1% to 5.4% of GDP, with further additional costs to the tourism sector and exchequer finances.

The chronology of the FMD outbreak in Ireland can be summarized as follows. On February 19, the first cases of foot-and-mouth disease in Britain in 20 years were discovered at an abattoir in Essex. The next day, a ban on imports from the United Kingdom including Northern Ireland of cattle, sheep, pigs, goats and deer and on a range of animal products from such animals was imposed, with additional security forces assigned to police the border to ensure compliance. The threat of infection on the island was raised when an 8 km restriction zone was placed around a farm in Northern Ireland after a cow died showing symptoms of the disease, and the disease was confirmed there a week later, on the 28 February. A ban was introduced on movement of all susceptible animals within the State other than those going directly for slaughter, which included a permit system to certify the movement of animals to abattoirs or meat plants. This movement restriction between farms resulted in additional costs to farmers in terms of the extra feed required for livestock that would normally be sold on to other farmers.

The impact on social and cultural events of the announcement on the 19 February of the British outbreak was almost immediate. The IRFU cancelled the Wales-Ireland rugby match, the Irish Kennel Club cancelled working farmdog classes in the St Patrick's Day dog show, while Dublin Zoo was closed. On the 28 February, a request was made that various sporting, cultural and other activities be postponed. Added to this, people were discouraged from visiting Ireland because of negative publicity and because of direct pleas from both the British and Irish governments to restrict movement between the two countries.

On March 22 the first outbreak of foot-and-mouth was confirmed in the Irish Republic in a sheep flock near Jenkinstown, Co Louth. An aggressive slaughter policy was initiated with the cull of animals extending to 13,000 sheep and 3,000 cows within the exclusion zone in County

Louth. As the end of March approached, army marksmen were called in to help the cull in Louth. The EU announced that the export ban was limited to Co. Louth due to Ireland's stringent measures against the disease.

By the end of April, Britain announced that the mass cull of healthy cattle designed to halt the spread of foot-and-mouth disease was to be wound down because the number of new outbreaks was waning. On 19 April, thirty days after the discovery of the State's only incident of foot-and-mouth disease in Co Louth, the Minister for Agriculture announced a lifting of the trade restrictions which applied to Co. Louth, with the exception of the restrictions in place within a 10km zone around Proleek and in the Cooley peninsula. Sporting and tourism groups welcomed the end of the ban on fishing, hillwalking and pony trekking from May 11. On 19 September the world animal health organisation OIE restored Ireland's status as foot and mouth free. Northern Ireland recorded four cases in all.

3 The Theoretical Model

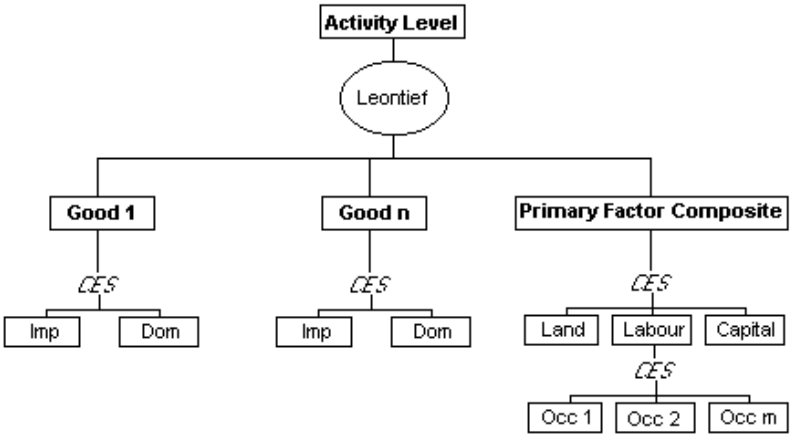
3.1 Model Structure

The IMA*GE* model is based on the widely known ORANI model (Dixon et al. 1982) of the Australian economy which has been used extensively for policy analysis in Australia for nearly two decades. The model has a theoretical structure that is typical of many CGE models. It is a static model, as it does not have any mechanism for the accumulation of capital. It is based entirely on the assumption of perfect competition, with no individual buyer or seller being able to influence price. Demand and supply equations are derived from the solution of optimisation problems (e.g. profit or utility maximization) for private sector agents. The model allows for multiple household types, export destinations, land types and labour occupations. It also incorporates an explicit treatment of government revenue and expenditure. For further details see O'Toole and Matthews (2002a) and O'Toole and Matthews (2002b).

The model distinguishes 34 industries, the first eight of which relate to farm level production, making it the most disaggregated CGE model for Ireland thus far. There are two sources of commodities, namely domestic and overseas. There are nine occupational groups and three household types, namely urban, rural farm, and rural non-farm. The industry classification is

listed in Appendix 1. The model allows every industry to produce several commodities by using domestic or imported intermediates and a primary factor composite consisting of land, labour and capital. This would suggest a potentially very large and complex system that would be extremely difficult to calibrate. To keep the model to a manageable size, we assume, firstly, that each industry only produces one good and secondly, that input-output separability holds.

Graph 2: Nest Structure of Production Side of Model



The production structure used in detailed in Graph 2. At the top level of the nest the volume employed of each of the n intermediate inputs and the primary factor composite by each firm is assumed to be in a constant proportion. Each of the intermediate goods is the product of a hypothesised 'mixing' industry characterised by a CES function which combines the imports and domestic production of good i. The primary factor composite is formed through a combination of land, labour and capital. Household consumption is based on a Stone-Geary utility function, which leads to a linear expenditure system. Household consumption is divided into two components, a minimum or subsistence amount and a luxury amount. Each of the three households choose combinations of each consumption good to minimise a CES function.

The database for the model is a social accounting matrix for the Irish economy for the year 2001 which has been developed as follows. The original source for the input-output data required is the CSO input-output tables for the Irish economy for 1993, modified to incorporate a much more extensive disaggregation of the agri-food sector (for details, see O'Connor and Matthews, 2001) and extended to a social accounting matrix (SAM) showing the flows to

institutions in the economy using the CSO National Income Accounts for 1993 and other sources (for details, see O'Toole and Matthews, 2002b). This 1993 SAM was then updated to 1998 using published CSO data on the row and column totals (household and government expenditure, imports and exports, industrial production by sector, etc.). Finally, the 1998 SAM was projected forward to 2001 using the ESRI medium term review forecasts contained in ESRI (1999).

3.2 Model Closure

Given that the model has far more variables than equations, to close it we must exogenously set the rate of change of numerous variables exogenously at zero. In terms of the labour market, the assumption is often made for large economies that in the short run either real or nominal wages are fixed, with employment adjusting to economic shocks, while in the long run employment is held fixed while wages are assumed to adjust. However, the standard distinction between short and long term closures may not be appropriate for the Irish economy with a largely open labour market. In the long run we might expect a more elastic employment response, moving to a scenario whereby Ireland's wages are set exogenously in the UK. For the short-run closure, we allow for the aggregate economy wide labour supply to respond sluggishly to changes in the real wage. For every 1% increase in the real wage, aggregate labour supply increases by 0.5%. Numbers employed in each industry either decrease or increase to ensure that wage relativities in each industry and occupation are unaffected in the short run. Capital, on the other hand, is assumed to be fixed in the short run, with capital rents being free to adjust to ensure equilibrium. Finally, the quantity of land of each quality class is exogenously fixed, though can move between farm uses. The balance of trade is set exogenously at an unchanged level, with the nominal exchange rate acting as numeraire.

We also adopt a specific closure with respect to output in the agricultural sectors where we hold output fixed in the FMD simulation. We justify this on two grounds. First, this is a short-run simulation and agricultural output, in the short-run, is well known to be inelastic. Thus, within a year, the levels of livestock and livestock products output are largely determined by the size of the breeding herds and the inventory of livestock numbers at the start of the year, and there is limited scope for farmers to change output particularly in response to an improvement in prices during the year. Second, the output of most major Irish agricultural products is now

constrained by supply controls under the EU's Common Agricultural Policy so that, even in the longer-term, output supply is inelastic. The one exception we make to the assumption of fixed agricultural output concerns those animals slaughtered as a result of the cull policy in Co. Louth. Although in an accounting sense these animals count as output, they were excluded from the food chain and thus their economic value was a loss to the economy. We make a specific adjustment to the CGE model results to account for this in the following simulation.

3.3 Model Shocks

This section discusses the way in which the specific shocks arising from the FMD outbreak in Ireland were calculated and modelled. The most important issue is defining the counterfactual situation in the absence of the outbreak. We assume that the non-FMD scenario would imply that neither Ireland nor the UK were hit by FMD. An alternative scenario might be to assume that Ireland had to implement control measures due to an isolated FMD outbreak in this country and in the absence of an FMD outbreak in the UK. Because the existence of FMD in the UK led to some offsetting benefits to the Irish economy in both the agriculture and tourism sectors (see below), this counterfactual would give higher cost estimates of the FMD outbreak than those we report below. However, we adopt the first counterfactual for consistency with the Indecon study and also because the Irish outbreak was clearly linked with that in the UK.

In terms of the cost of tackling the FMD threat in Ireland, both farm and non-farm costs are involved. The restrictions imposed on animal movement had an adverse effect on farm incomes in the early part of the year and input costs increased due to increased usage. As in the UK, the costs to the non-farm sectors, particularly tourism and distribution services in rural areas were also of a very serious magnitude. Hotels reported an average decline in tourism business of between 10 and 15 per cent on the previous year, partly due to the FMD threat at a critical time for bookings, although the economic downturn in the US was also a factor (Irish Hotels Federation, *Irish Independent* 30 July 2001). The shocks that are applied to the model fall into one of three categories, namely, the direct impact on agricultural inputs and prices, the direct impact of increased government expenditure and its financing, and finally the direct impact on changes in tourism expenditure. The model is a single-period static model, so we assume that the FMD impacts were fully absorbed within the year. In practice, this is a defensible assumption. Although some impacts may carry over to later years, in practice they

are of relatively small magnitude. The results are comparative static results. They show the impact on the Irish economy of controlling the FMD outbreak, *ceteris paribus.* Each of the shocks are now dealt with in turn.

Direct Impact on Agricultural Inputs and Prices

We would not wish to disregard the psychological impact on farmers of the FMD outbreak due to the potential of losing herds of animals built up over long periods, the distressing sight of animal pyres in the UK and the reality of various other animal welfare considerations on the farm, not to mention the huge uncertainty created. However, much of the impact on the farming community of the crisis (in a monetary sense) was actually either neutral or benign. The shocks that are imposed on the model as regards the direct impact on farming are as follows.

Animals purchased for destruction in the exclusion zone in County Louth in an effort to prevent the spread of the disease were, in a purely monetary sense, just another market for the farmer for his produce. We assume that the compensation paid reflected the market price of animals. To take account of the restrictions on movement and sale of livestock during the period in question, we assume a negative technology shock of 5% in the "*farm-animal feed*" input, indicating that to produce the same quantity of cattle as in the base period, an additional 5% of farm animal feed was required. However, the most important impact was that, due to the strict mobility restrictions and widespread slaughter in the UK, a shortage of beef, pork and lamb there translated into a jump in their respective prices, an effect which significantly benefited Irish producers.

To estimate the contribution of the FMD outbreak to these price increases for the purpose of the model simulation, one approach would be to try to estimate the FMD effect from the change in processed meat export prices. The observed change would be the outcome of offsetting changes in demand in major markets. Third country importers outside the EU immediately banned EU imports, including imports from Ireland, resulting in a negative shock to Irish meat and livestock exports. On the other hand, the supply shortfall caused by the animal cull in the

UK resulted in a lift in prices in the UK and continental European markets.[3] However, changes in export unit values can be confounded by changes in the composition of exports between products of different value. Instead, we estimate the farm-level effect using farm-level prices for the major livestock categories. We run a regression on monthly prices for the period from January 1995 to December 2001 for cattle, sheep and pig prices with seasonal monthly dummies, and a FMD dummy from February 2001. This is not intended as a full model of price determination, and merely represents a first pass estimate. The results for cattle, sheep and pigs were that the FMD scare caused an increase in price of 4.41%, 44.58% and 4.84% respectively. The reason for the very sharp rise in sheep prices is that in effect supply is concentrated in the UK, France and Ireland. The effect of greatly reducing the supply from any one of these markets has a large impact on aggregate supply. Finally, taking into account that approximately 83% of cattle and pigs, and 89% of sheep are slaughtered from March to December in a typical year, the price shock for the year as a whole for cattle, sheep and pigs is calculated at 3.84%, 39.67% and 4.21% respectively.

The modelling difficulty in shocking the prices of the raw products cattle, pigs and sheep by this amount is that there is a consequent increase in the input cost to the processed meat products industry. In the absence of a corresponding increase in the output price of this industry in the model, its profitability would collapse and output would fall. In practice, the increase in farm-level prices reflects the net effect of the higher prices obtained by the meat factories and live exporters arising from the combined impact of more buoyant demand in the UK market and elsewhere, against the closure of non-EU markets. To overcome this problem, we endogenise the demand curves for exports of processed meat products and live animals, and exogenise the ratio of processed exports to live exports. Given the earlier assumption that farm level supply of livestock is fixed in the simulation, this implies that a change in the quantity of meat processed in Ireland can only occur if there is a change in the proportion of the total livestock output is exported. This is because of the assumption that a fixed proportion of exports are sent as live exports (and thus not available for processing) whereas all meat which

[3] The Indecon (2002) report contains detailed statistics on price and volume movements in major markets.

is consumed domestically must be processed. Any switch to exports at the expense of the domestic market will thus reduce processing activity given this assumption.

Government Expenditure

There are two issues which relate to the modelling of government expenditure. The first is the identification and quantification of the various costs such as compensation for farmers and income for vets, additional Gardai etc. The second issue relates to how the government pays for the increased expenditure. In relation to the first, the following major costs can be identified, along with the industry classification of where the money was spent. Note that all costs relate to direct exchequer expenditure. Changes in government receipts due to a fall off in VAT revenues as less tourists visit Ireland and purchase goods are indirect effects which are incorporated into the final estimate. The tourism expenditure figure relates to additional expenditure to counter the negative impact of the FMD publicity. The tourism advertising figure is assumed to be split between expenditure in Ireland and expenditure overseas – only the component spent in Ireland is assumed to have a knock-on affect on other industries in an input-output sense, while the overseas component is simply a services import.

Table 1

Estimated Breakdown of Government Expenditure in Response to the FMD Outbreak

Expense	**Final Cost**	**Industry**
Department Expenses	16.0m	Public Services
Direct Compensation of Farmers	10.1m	Purchase of Livestock
DAFF Staff Costs	18.3m	Public Services
Tourism Advertising	12.7m/2 = 6.3	Market Services
Gardai Overtime	49.5m	Public Costs
Total	**100.3**	

Source: INDECON (2002)

In relation to the financing question, one option is to assume a non-distortionary lump sum tax to fund the costs of the FMD outbreak. However, non-distortionary lump sum taxes do not exist in the real world. It is therefore important to model the fact that additional revenues must be met by coercive taxation which will inevitably reduce the level of economic activity elsewhere in the economy. A variation on the theme of the lump-sum tax is that the money involved is simply borrowed and not repaid until future years. However, simply allowing the national debt to rise defers the imposition of a distortionary tax until when the debt is repaid. Therefore, any change in government revenues is assumed to be financed by scaling up or down some tax instrument. This revenue replacement feature should be viewed as holding constant the size of the baseline government surplus. An alternative assumption would be to allow government expenditures to adjust to reflect the change in revenues while holding the baseline size of the government surplus constant. While this might be appropriate in the case of a recurring charge on government revenue, it is less realistic in terms of a once off charge. The final issue is to choose which tax to adjust to ensure that the government surplus remains unchanged. For the purposes of this simulation it is assumed that the revenue spent on containing the FMD virus is raised by an increase in indirect taxes.

As a welfare measure we calculate the change in the real value of public plus private consumption arising from the FMD simulation. However, this variable needs to be adjusted to take account of the fact that the government expenditure arising from the FMD outbreak does not increase social welfare. Thus in calculating this variable we subtract the costs of government measures to control foot and mouth. The logic for this is as follows. Our counterfactual is a situation whereby the national herd is not infected with the FMD virus. We know that animals purchased by the government for destruction in County Louth were disposed of through burial or incineration, while any beef bought by consumers results in increased consumption. Therefore we subtract the value of beef destroyed from the calculated change in real public plus private expenditure. We follow a similar logic for the remainder of the governments expenditure incurred in the effort to curtail the FMD outbreak. In the absence of FMD, the 100m spent by the government would either have been spent on public goods (parks, hospitals, road transport etc) or private goods (cars, holidays, food etc.), or some public-private combination. By spending the 100m in an effort to curtail the spread of FMD, the purchased ‘goods’ of security, veterinarian fees, disinfectant etc. merely cancel out the ‘bad’ of

FMD. There is no net benefit to the public or private consumer over and above the counterfactual of no FMD in the first place.[4]

Impact on Tourism

In measuring the impact of a change in tourism expenditure we first note that tourism is not a separate industry in the input-output accounts. Rather than classifyng tourism as an industry at all, it is more helpful to think of tourists as just a distinct class of consumer who demand goods and services, alongside other consumer groupings. To measure the vector of tourists' expenditure, we update the corresponding figures calculated by Henry and Deane (1997) for both international and domestic tourists by applying expenditure shares to the appropriate total expenditure for 2001. Formally, this assumes that tourist consumption is based on a Cobb-Douglas technology, with shares of expenditure of each good or service accounting for a fixed share of total expenditure.

These estimated aggregates are then expressed as values of exports by industrial sector. This represents an important assumption of the simulation - lost international tourism revenue is assumed to be, indeed, lost to the Irish economy, and does not allow for the possibility of people deferring visits. The derived figures are shown in table 2 which shows the sectors for which tourism creates a final demand, ranked in terms of importance.

The next step is to estimate the fall in tourism numbers due to the foot and mouth outbreak, for which we need an estimate of what tourism volume would have been in the absence of the outbreak. A first assumption might be to assume that the long term increase in tourism numbers should extend into 2001. Given the worldwide slowdown in economic growth that preceded both the FMD outbreak and the 11 September terrorist attacks, it was predicted by Bord Failte, the Irish Tourist Board, that tourism numbers for 2001 would have risen above the 2000 numbers by only 5%, well below the 8% per annum actually observed since 1996. We

[4] In reality, we can think of a couple of positive spin-offs such as the fact that the increased police presence at the border probably reduced smuggling. We assume benefits such as this are negligible.

take this as the counterfactual benchmark against which to measure the tourism impact of FMD.

We must also make some assumptions to remove the impact of the 11 September terrorist attacks. It is assumed that, in the absence of the 11 September attacks, the fourth quarter of 2001 would have been unaffected by the FMD scare, and therefore visitor numbers would have increased by the assumed average annual increase. The terrorist attacks only have an impact on the end of the third quarter, and are most likely to have affected the North American market. What is surprising from Table 2 is that the transatlantic visitor numbers were so strong in the first half of the year, despite the fact that North American tourism numbers were up only 3% in the first quarter and actually down 8% in the second quarter. The difference between transatlantic visitor numbers and numbers by area of residency in Canada or the U.S. can be explained by the number of 'indirect' visitors who travel to Ireland via the UK or Europe. This suggests perhaps that there was a large discouragement effect for American tourists arriving via Britain/Europe to come to Ireland. The adjustment in the third quarter is to replace the observed 16% fall in North American visitor numbers due to September 11 by an assumption that the level of tourist numbers would have been unchanged from the corresponding quarter in the previous year.

Table 2

Estimated Total Expenditure by Tourists in 2001 by IMAGE Sector, IR£m

	International Tourists	Domestic Tourists		International Tourists	Domestic Tourists
Lodging & Catering	632	223	Milk Products	21	21
Other Services	193	51	Communications	18	11
Trade Margin	91	38	Non-Metallic Minerals	14	0
Beverage & Tobacco	83	29	Rubber & Plastics	12	0
Inland Transport	70	26	Petrol-Coal	6	9
Meat Products	47	47	Chemicals	4	2
Other Food	39	39	Fruit & Vegetables	1	1
Wood & Paper	32	11	Fishing	1	1
Textiles	21	0	**Total**	**1285**	**509**

Table 3:

Overseas Visitors to Ireland

	1996 - 2000		Observed Change Over 2001			Predicted increase in 2001 ex FMD and 11th Sept	Actual Increase in 2001, adjusted to exclude 11th Sept	Estimated decrease in 2001, incl. FMD and excluding 11th Sept
	Cumul.	P.A.	Q1	Q2	Q3			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7) - (6)
Total Overseas Visits	35%	8%	-2%	-7%	-7%	5%	-3%	-8%
Route of Travel								
Air Cross-Channel	48%	10%	-1%	-4%	-4%	7%	-1%	-8%
Sea Cross-Channel	9%	2%	-17%	-21%	-12%	-1%	-14%	-13%
Continental European	38%	8%	10%	1%	-5%	5%	1%	-5%
Transatlantic	70%	14%	5%	5%	-8%	11%	6%	-5%
Area of Residence								
Great Britain	35%	8%	-7%	-9%	-1%	5%	-3%	-8%
Other Europe	26%	6%	8%	-2%	-12%	3%	-4%	-7%
North America	49%	11%	3%	-8%	-16%	8%	0%	-8%
Other Areas	49%	11%	13%	10%	-4%	8%	5%	-3%
Reason For Journey								
Business	44%	9%	-5%	0%	-17%	6%	N.A.	N.A.
Holiday/Leis/Recreation	38%	8%	5%	-10%	-8%	5%	N.A.	N.A.
Visit/Friends/Relatives	40%	9%	-7%	4%	5%	6%	N.A.	N.A.
Other	-12%	-3%	-3%	-29%	-13%	-6%	N.A.	N.A.

Source: CSO Tourism and Travel Release, Q3 2001. The predicted column based on Bord Failte (2002). The calculated observed column is based on the average of the actual changes in the first three quarters and an assumption that the actual change in the fourth quarter would equal the value in the predicted column, with the exception of North American visitors (see text).

With these assumptions, we can derive predicted numbers for 2001 excluding FMD scare and 11 September (column 6) and observed numbers for 2001, adjusted to remove the impact of 11 September (column 7). A few observations relating to these predicted numbers are relevant. Firstly, the greatest falls seems to be in cross-channel traffic, not surprising given the fact that the outbreak had greatest public recognition in the UK. The predicted fall in sea cross-channel

journeys of 1%, due largely to substitution in favour of increasingly cheap air transport, was accelerated, with this mode of transport experiencing a 13% decline due to the FMD scare. The corresponding decrease for air transport from the UK is 8%. As expected, the fall off in numbers from North America and continental Europe due to FMD is less pronounced at 5% for each.

The final step is to translate these figures for visitor numbers into changes in tourism revenue. This is important as the greatest falls in tourist numbers are from groups with a relatively small spend per head.

Table 4: Expenditure Per Head

Expenditure Per Head (£)	**1996**	**1997**	**1998**	**1999**	**2000**
Great Britain	204.6	220.5	218.4	214.2	232.5
Other Europe	396.9	386.4	365.3	368.3	391.7
North America	436.7	449.0	445.6	458.1	522.9
Other Areas	517.2	472.6	467.6	476.4	542.3
Change	**96 - 97**	**97 - 98**	**98 - 99**	**99 - 00**	**1996 - 2000**
Great Britain	8%	-1%	-2%	9%	3%
Other Europe	-3%	-5%	1%	6%	0%
North America	3%	-1%	3%	14%	5%
Other Areas	-9%	-1%	2%	14%	1%

Source: Bord Failte (2002)

As can be seen from table 4, the rate of increase in expenditure by tourists has averaged around 2% per annum, although with differences by area of origin and considerable volatility from year to year. We assume a 2% increase from 2000 to 2001 for all passengers. Applying the average expenditure per grouping to the estimated decrease in numbers due to FMD, results in an estimated aggregate loss of international tourist receipts due to the FMD scare of £158m (200m). We then apply this aggregate to the international tourism shares as calculated by Deane and Henry (1997) to get the change in export receipts from international tourism.

It is more difficult to assess the impact on domestic tourism of the FMD restrictions. A number of possible mechanisms were at work. Firstly, Irish residents who would otherwise have gone

to the UK on holidays instead chose to holiday in Ireland or not to holiday at all. Offsetting this would have been a discouragement effect whereby Irish residents cancelled domestic holiday plans due to the virtual shutdown of the rural sector and the cancellation of a number of sporting events. Problems arise, firstly, in measuring the number of domestic residents holidaying here in the counterfactual, and secondly determining what was done with income not spent in Ireland. If this income was spent on holidays abroad, then this would represent an import of services, while if the holiday budget was reallocated then it would represent an increase in the expenditure on the typical basket of goods. For the purposes of this simulation we assume that there is a zero net effect on domestic tourism flows and domestic tourism expenditure due to the FMD crisis. This is consistent with the Indecon assumption of a very small positive (8m) increase in domestic tourism expenditure.

4 Results

The results displayed in table 5 are disaggregated into the expected impacts of the agricultural shocks (changes in price and requirement for additional farm animal feed), the fall in international tourism, the increase in government expenditure and the economic impact of the replacement tax which ensures that government savings remains unaffected by the FMD crisis. We now discuss each of these individual shocks in turn:

Shock 1: The Impact of FMD on Agriculture

In relation to prices, the model estimates the total impact on the price of agricultural produce to be an increase of 3.88%. This dominates the results, with very little change in real output elsewhere in the economy as agricultural output is fixed in the short run. The GDP deflator increases by 0.11%, while import costs rise by 0.06%, resulting in a real appreciation of the currency of 0.05%. As can be seen from the real consumption figures, household consumption increases significantly, mainly at the expense of investment. Note also that there is a small fall in employment as the sector which benefits (agriculture) has very low labour usage, while the outputs of manufacturing and services which are relatively labour intensive by comparison decline slightly due to the real appreciation.

Shock 2: The Impact of FMD on Tourism

With the balance of payments fixed, the fall in the value of service exports (i.e. tourism) must be offset by increases in export volumes or reductions in imports. This reallocation within the economy is achieved through a real devaluation of the currency which makes imports less competitive domestically, and increases the demand for exports. In the simulation as shown, the volume of imports actually rises slightly. This is because the fall in imports due to the loss of competitiveness vis-à-vis domestic commodities is more than offset by the fact that Irish exports are very import intensive, so we require an increase in imports to achieve the required increase in exports. Given that manufacturing is highly export orientated in Ireland, the real output of that industry increases by 0.33%. Put simply, we have to export more as the amount of money we were earning per unit of export has fallen due to the taste shift away from the Irish "tourism" product. This reallocation from services to manufacturing is reflected in the occupational changes shown in Table 6 below, with service-intensive occupations generally falling.

Shock 3: The Impact of Government Spending

The increase in government expenditure (extra policing etc.) of 100m has a relatively minor impact in the sense of providing a demand injection into the economy. Given that aggregate output is tied down to a large extent, the balance of payments fixed and the level of investment determined mostly by the exogenously fixed world interest rate, the increase in government expenditure merely crowds out domestic expenditure, with household saving increasing significantly. In particular, household spending on services reduces as the main component of government expenditure is in services (veterinarians and security).

Shock 4: The Impact of The Replacement Tax

When each of the previous three shocks were run, the final shock was to make up for the deterioration in government revenue and expenditure, which added up to 169m. The general sales tax levy imposed to recoup this money results in a significant reduction in activity generally. Remembering that capital is fixed, in simple notation, the increase in the tax on both inputs and outputs is in effect simply a tax on value added, which falls on the mobile factor – labour. Therefore we see employment fall by 0.17%, with wages down 0.33%. Capital rents (not reported) are also down, by around 1%. Both employment and capital rent falls are more

noticeable in tradeable industries, with a very elastic demand curve, than in non-tradeables where demand is fairly inelastic.

Table 5: Macro Results

			Government		
	Agriculture Shocks	**International Tourism Shocks**	**Government Spending Shocks**	**Replacement Tax Shock**	**Total**
Agricultural Prices	3.88	-0.42	-0.07	-0.71	2.68
Manufactured Prices	0.08	-0.08	0.00	-0.13	-0.13
Service Prices	0.11	-0.30	0.00	-0.18	-0.37
GDP deflator	0.11	-0.27	0.00	0.01	-0.14
Real Devaluation	-0.05	0.27	0.00	-0.01	0.21
CPI	0.13	-0.26	0.00	0.00	-0.12
Nominal GNP	0.05	-0.30	0.00	-0.07	-0.32
Employment	-0.07	-0.02	0.01	-0.17	-0.24
Labour					
Average Tax	0.01	0.05	0.00	0.06	0.11
Wage Rate	0.00	-0.30	0.02	-0.33	-0.61
Labour Income	-0.07	-0.32	0.03	-0.50	-0.85
Real Output					
Agricultural	0.00	0.00	0.00	0.00	0.00
Manufactures	-0.09	0.39	-0.03	-0.31	-0.04
Services	-0.01	-0.15	0.00	-0.05	-0.22
Imports	-0.01	0.07	-0.05	-0.36	-0.35
Real Consumption					
Investment	-0.34	0.22	-0.01	-0.37	-0.50
Household	0.14	-0.24	-0.19	-0.03	-0.31
Exports	-0.12	0.10	-0.04	-0.30	-0.36
Government	-0.04	0.26	0.82	0.08	1.12
Real Pub. + Priv. Consumption	0.11	-0.15	-0.12[1]	-0.01	-0.16

[1] See text for a discussion of how government expenditure is treated for the purpose of this variable.

Table 6

Employment by Occupation

			Government		
	Agriculture Shocks	International Tourism Shocks	Government Spending Shocks	Replacement Tax Shocks	Total
Farming, fishing and forestry	0.79%	0.08%	0.06%	-0.11%	0.82%
Manufacturing workers	-0.19%	0.44%	-0.05%	-0.40%	-0.20%
Building and construction	-0.12%	0.19%	-0.03%	-0.25%	-0.20%
Communication and transport	-0.09%	0.55%	-0.06%	-0.26%	0.14%
Clerical, managing and gov	-0.05%	0.07%	0.05%	-0.11%	-0.03%
Sales and commerce workers	-0.04%	-0.33%	-0.10%	-0.28%	-0.74%
Service workers	0.00%	0.17%	0.20%	0.10%	0.47%
Proff., technical and health	-0.03%	-0.69%	0.02%	-0.03%	-0.74%
Other workers (incl not stated)	-0.07%	0.28%	0.07%	-0.14%	0.14%

In table 7 we show the changes in the output of selected industries for each shock. Turning first to the food industry results, the impact of the agricultural shock on the meat processing sector is driven by the assumption that some of the increased exports to the UK and the EU take the form of live exports and thus lead to a reduction in processing throughput. However, the initial impacts of the agricultural shock are magnified considerably by the knock-on effects of the fall-off in tourism numbers and the changes in government expenditure and tax. For the beef industry, for example, the total effects are some six times the impact arising from the agricultural shock alone. The animal feed industry benefited from the increased demand for feed arising from the movement restrictions. The other food industry also suffered from the outbreak, despite increased export sales arising from the real devaluation brought about the fall-off in international tourism.

Of particular interest are the effects on those industries most affected by the reduction in international tourism. For example, output of the catering and accommodation sector is estimated to have fallen by over 3% (compared to an overall fall in real GDP of just under 0.2 per cent). The trade margin (reflecting distribution services) was also hit disproportionately hard.

Table 7

Industry Results

			Government		
	Agriculture Shocks	International Tourism Shocks	Government Spending Shocks	Replacement Tax Shocks	Total
Real Output – Food Industries					
Beef Products	-0.29	-0.52	-0.40	-0.54	-1.75
Sheep Meat	-0.94	0.01	-0.23	-0.16	-1.31
Pig Meat	-0.70	0.09	-0.11	-0.50	-1.23
Milk Prods	0.01	-0.01	0.00	0.01	0.01
Animal Feed	2.59	0.18	0.00	-0.12	2.64
Other Food	-0.31	0.61	-0.03	-0.77	-0.50
Real Output – Tourism Industries					
Beverage & Tobacco	0.00	-0.13	-0.01	0.01	-0.12
Trade Margin	-0.02	-0.52	-0.08	-0.20	-0.83
Lodging & Catering	0.03	-3.29	-0.06	0.12	-3.20
Other Services	0.01	-0.06	0.00	0.04	-0.01
Other Food	-0.28	0.50	-0.03	-0.84	-0.66

5 Conclusion

This paper has examined the impact of the recent outbreak of foot-and-mouth disease on the Irish economy. In particular, it has identified four separate mechanisms by which the economy was affected – firstly the impact on agriculture, primarily through higher prices brought about by the impact of livestock culling in Britain, secondly the impact of the fall in international tourism numbers, thirdly the impact of increased government expenditure and finally the effect of a replacement tax to ensure the governments budget remains unaffected. The results of the simulations suggest that the onset of foot and mouth had little impact on the quantity of output of agricultural produce in the short run, but that the beneficial price increases were considerable, and led to an economy wide increase in private and public expenditure of 0.11%. The dominant shock was the fall off in international tourism numbers which caused a switch from non-tradeables to exportables in an effort to maintain the balance of trade.

The impacts of government spending and tax raising were of a smaller magnitude than the first two sets of shocks. The simulation highlights the significance of the distortionary impact of the

replacement tax. In all, the government spent around 106m but lost a further 63m in lost tax revenue, and therefore this replacement tax had to bridge a gap of 169 in the governments finances. The burden falls heaviest on tradeable goods which face a very elastic demand curve. We estimate that the output in the accommodation and catering sector fell by more than 3% as a result of the measures taken to control the FMD outbreak, while output of distribution services fell by just over 0.8%. It is likely that these output reductions were unevenly spread throughout the country, and that the impacts on these industries in rural areas were even greater. However, with our national model we cannot say anything in quantitative terms about these regional impacts.

The results are dependent on the assumptions made regarding the values of the many behavioural parameters required for the model. In future work, it will be useful to test the sensitivity of these results to changes in the key parameters. As a particular issue we would highlight the need for firmer estimates of appropriate labour supply elasticities, ideally by occupation. There is some evidence that skilled Irish workers are in more elastic supply than unskilled workers, a factor that could have an important bearing on simulations such as contained in this paper.

This paper has provided a breakdown of the various impacts that the FMD outbreak had on the Irish economy. It did not undertake to provide an evaluation of this response– indeed, such an undertaking would be difficult for economists given that the scientists do not agree on a number of crucial issues such as the ability to identify vaccinated from infected cattle. In so far as a retrospective study such as this is used as a guide to the appropriate response to a future outbreak, consideration must be given to developments which might impact on the possible spread of the disease. First, the greater geographic mobility of humans which may have played a part in making the 2001 UK outbreak worse that the 1967 one is likely to increase over time. Second, the reduction of trade barriers, including the eastern enlargement of the EU, with the resultant rise in trade potentially raises new risks. Other issues that arise from either a policy of vaccination or culling not considered in this study. These include ethical doubts with regard to the mass culling of animals, the negative 'PR' for farming of carcass disposal, and the impact of carcass disposal on the environment. Coming so soon after the BSE scare, the foot-and-

mouth outbreak cast doubt on the safety of food though there might be a potential for misunderstanding of the safety of products from vaccinated animals.

Appendix 1

	Industry/Commodity Listing
1	Milk
2	Cattle
3	Sheep & Wool
4	Other Livestock
5	Cereals
6	Fruit & Vegetables
7	Root & Green
8	Other Crops
9	Forestry
10	Fishing
11	Petrol & Coal
12	Electricity & Gas
13	Non-Metallic
14	Chemicals
15	Metal
16	Beef Products
17	Milk Prods
18	Animal Feed
19	Other Food
20	Beverage & Tobacco
21	Textiles
22	Wood & Paper
23	Rubber & Plastics
24	Construct
25	Trade Margin
26	Lodging & Catering
27	Transport
28	Sheep Meat
29	Communications
30	Credit & Insurance
31	Other Services
32	Public Services
33	Pig Meat
34	Dwellings

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