Economic Impact of the 2001 Foot and Mouth Disease Outbreak in Scotland

FINAL REPORT

Report Commissioned by the Impact Assessment Group

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1. EXECUTIVE SUMMARY

In 2001 the UK experienced the worst outbreak of Foot and Mouth Disease (FMD) in recorded history. Scotland did not escape. The outbreak was principally contained in the Dumfries and Galloway and Borders regions. Some 187 farms were confirmed as being infected with Foot and Mouth disease, 1048 farms were affected by the 3km sheep and pig cull and in 28 farms animals were slaughtered on suspicion. In all, 735,000 animals were slaughtered in Scotland, with the greatest impact falling on the sheep population where 643,900 were culled. However, the disease had indirect consequences that were felt over a much wider area and it is this impact which this report attempts to quantify.

An explicit modelling approach has been employed, using a specially adapted version of the Fraser of Allander Institute's Computable General Equilibrium model, AMOS[1]. The adaptation gives particular emphasis to agriculture and tourism. Variants of the AMOS model have been successfully used in the past to analyse the effects of Regional Selective Assistance, Foreign Direct Investment and the policies of Scottish Enterprise.

Information required to identify the direct, regionally-disaggregated, impacts of the outbreak of Foot and Mouth Disease (FMD) in Scotland is taken from existing studies and official reports. The total impact on the Scottish economy - incorporating multiplier, labour market displacement and competitiveness effects - are then modelled. This modelling procedure produces national and regionally disaggregated results on a wide range of economic variables. The focus of this report is the employment and GDP information for the period 2001-2006; that is, for the five years after the FMD outbreak.

There are two main areas of activity which were adversely affected by the FMD outbreak. These were agriculture itself (and directly linked activities) and tourism expenditure. The direct agriculture impacts are generated by the cull of trading and breeding animals, the ban on exports of most meat products and the movement restrictions imposed to limit the spread of the disease. Government compensation, however, was paid to owners of culled animals. Tourist activity was reduced through the restricted access to the countryside imposed during the outbreak and the image of the country was adversely affected for foreign tourists.

[1] AMOS is an acronym for *A M*acro-Micro Model *O*f *S*cotland

However, in assessing the impacts of changed tourist expenditure, it is important to take into account any accompanying change in household consumption expenditure in Scotland. That is to say, in so far as reduced Scottish tourism and daytrip activity in Scotland leads to increased household consumption on other goods and services, this should be accounted for in the analysis.

The overall total impact of the FMD outbreak in the initial year was to reduce Scottish GDP by between £13.6 million and £29.8 million. This is between 0.02% and 0.05% of Scottish GDP (measured at 1999 prices).

Table 1.1 gives the total regionally disaggregated impacts in 2001/2002 of the direct agricultural changes. The area definitions are given below and a map is attached in Annex A:

- The urban region is the Area Tourist Boards of Angus and the City of Dundee, Argyll, the Isles, Loch Lomond, Stirling and the Trossachs, Ayrshire and Arran, Edinburgh and the Lothians, Greater Glasgow and Clyde Valley.
- The *infected rural* region comprises Dumfries and Galloway and the Scottish Borders.
- The *uninfected rural* is Aberdeen and Grampian, Highlands of Scotland, Kingdom of Fife, Perthshire, Shetland, Orkney and Western Isles.

Table 1.1: Scottish GDP changes as a result of Agriculture shock (£, millions)

Regions	Export Ban	Cull of Trading Animals	Compen-sation Payments for Trading Animals	Movement restrictions	Cull of Breeding Animals	Restocking Demand-shock	Total
Urban	-12.473	8.419	-1.279	-0.972	-0.042	0.645	-5.702
Uninfected Rural	-2.870	12.289	-0.394	-0.609	-0.026	1.077	9.467
Infected Rural	-8.316	-23.223	5.558	-2.056	-9.223	-0.042	-37.302
Total	-23.659	-2.515	3.886	-3.637	-9.292	1.680	-33.537

Perhaps the most important finding from the direct agricultural shocks is the relatively small value for the change in Scottish total GDP. The negative net impact on the Scottish economy as a whole of all the first year effects is £33.5 million (measured at 1999 prices). This represents 0.05% of Scottish GDP. Similarly the effects on employment are extremely small when measured in proportionate terms. The negative GDP impacts are clearly skewed towards the rural infected regions. Apart from benefiting from government intervention via compensation payments for trading animals, all the other elements associated with the impact of FMD on agriculture generate a negative GDP change in the rural infected regions. The restocking of farms after the cull of breeding animals generates a positive stimulus to the uninfected regions. Also the direct impact of the cull on restricting the animals coming to the market has a positive impact in uninfected areas. This is not enough to offset the negative impacts, primarily from the export ban, for the urban area but a small increase in activity is registered in the rural uninfected area.

Table 1.2 presents the comparable spatially disaggregated GDP changes associated with the central estimate of changes in tourism expenditure. In this case there is a very small reported increase in GDP equal to 0.03%. However, this primarily comprises a relatively large reduction in GDP in the uninfected rural area which is set against a relatively large increase in GDP in urban areas. The biggest negative overall impacts come from the fall of Scottish Tourism in Scotland: the largest positive impacts come from the stimulus to other household expenditure that accompanies the fall in Scottish Tourism in Scotland and Daytrip expenditures.

Table 1.2: Scottish GDP changes as a result of Tourism shock (£, millions)

Regions	ROW	RUK	Scottish in Scotland	Daytrips	Households	Total
Urban	-0.95	0.22	56.84	-3.00	18.30	71.40
Uninfected rural	-0.43	-4.14	-67.61	0.46	6.86	-64.86
Infected rural	-0.01	-0.63	0.50	3.34	2.26	5.46
Total	-1.39	-4.56	-10.26	0.80	27.42	12.00

Whilst the aggregate GDP impacts of the tourist expenditure changes are positive, the employment impacts are slightly negative, with total Scottish employment falling by 343. This represents a 0.02% fall in employment. The contrary movements in GDP and employment imply a shifting of labour towards higher value added activities, caused by the demand and labour market adjustment processes associated with the changed aggregate patterns of expenditure across different sectors.

We have run the model forward 5 years to 2006. Most of the direct effects of the FMD outbreak are in 2001 and whilst we still detect some changes in the Scottish economy in 2006 as a result of the FMD outbreak they are very small.

The report also summarises work on the social and environmental impacts of the FMD outbreak. With a few exceptions, existing work on the social impacts is based upon anecdotal, rather than scientific, evidence. However, two general findings emerge:

- The social impacts were far greater within the areas directly affected by FMD, with effects outside the infected regions generally limited.
- Some of the social impacts arising from the outbreak seem likely to be felt for considerably longer than the duration of the outbreak itself.

The work on the environmental impacts of FMD is much more science based. It suggests that for Scotland:

- General awareness of the potential environmental effects arising from the outbreak and control strategies was high and, as a consequence, all potential effects were/are monitored closely.
- The confinement of the outbreak to only two local authority areas in Scotland - Dumfries and Galloway, and the Borders – meant that the environmental effects were far less severe than they would have been if the disease had spread more widely.
- All evidence to date suggests that environmental effects have been negligible although some longer run impacts cannot be ruled out.

2. INTRODUCTION AND BACKGROUND

In 2001 the UK experienced the worst outbreak of Foot and Mouth Disease (FMD) in recorded history. Scotland did not escape the disease. The first case in Scotland was recorded on March 1st 2001 and occurred in sheep belonging to a livestock dealer in Lockerbie. The epidemic then spread rapidly but was principally contained in the Dumfries and Galloway and Borders regions. Some 187 farms were confirmed as being infected with FMD, 1048 farms were affected by the 3km sheep and pig cull and in 28 farms animals were slaughtered on suspicion. In all, 735,000 animals were slaughtered in Scotland, with the greatest impact falling on the sheep population where 643,900 were culled. However, the disease had indirect consequences that were felt over a much wider area, affecting rural businesses and tourism across Scotland, with the result that significant differences in urban-rural effects appear likely.

There have been a number of studies on the impact of the FMD outbreak on the UK economy as a whole. The Department of Environment Food and Rural Affairs and Department of Culture, Media and Sport (2002) report examines the economic impact of FMD on the agriculture and food sectors and on other sectors profoundly affected, such as tourism. At the UK level it was reported that the overall impact of the FMD outbreak was less than 0.2 per cent of GDP but that the impact on severely infected rural areas was much more pronounced. The report also acknowledges that the impact effects have been variable, producing both winners and losers.

A paper by the Christel DeHaan Institute uses a Computable General Equilibrium Model (CGE) for the UK economy to assess the economy wide effects of FMD and the policy implications arising from these, particularly on the tourism sector. The authors find that FMD had considerable effects on farming in various regions of the UK due to the nature of intersectoral linkages in the economy but much larger effects on tourism (Blake *et al*, 2002).

There is also a substantial amount of Scottish-specific work on the impact of FMD. This report itself is part of a series of studies carried out by the Impact Assessment Group (IAG) into FMD in Scotland[2]. The IAG draws together sectoral expertise and also includes representatives from geographic areas affected by FMD in Scotland. IAG-commissioned tracking surveys were conducted to assess the impact of non–agricultural business (George Street Research, 2001). Dumfries and Galloway were covered in a second survey that focussed on non-agricultural business as agricultural businesses were covered by other sources. Primarily these surveys found that the vast majority of business has seen no change either in turnover or in staff due to FMD, although there is obvious regional variation with more affect in the infected areas.

DTZ Pieda (2002a, 2002b) was commissioned by the Scottish Executive Environment and Rural Affairs Department (SEERAD) to undertake a study to assess the 'Economic Impact of Foot and Mouth Disease in Scotland'. Their primary aim was to synthesise all available data on the impact of FMD on communities and the economy of Scotland. Highlighting areas of insufficient data and using case studies, the report assessed the impact of FMD on 'fragile rural economies' and on particular sectors within Scotland.

The sector studies element of this two-part report evaluates the impact of FMD in Scotland on Tourism, Transport and Agri–Food. Tourism was found to be the most affected of the three, with the Agri–Food and Transport sectors suffering more from localised effects in the infected areas of Dumfries and Galloway and the Borders rather than significantly at the Scottish level.

At a more aggregate level, the FMD outbreak in Scotland has also been studied in a paper for The Royal Society of Edinburgh and the Scottish Economic Policy Network. In this paper, McDonald and Roberts (2002) use a Computable General Equilibrium (CGE) approach. This model separately distinguishes 36 commodities (including 11 farm commodities and 4 categories of tourist). It distinguishes between shocks affecting Scottish agriculture, Scottish tourism and the effects of government policies to control and compensate for the outbreak.

[2] The Impact Assessment Group was set up by the then Minister for Rural Development in response to the outbreak of Foot and Mouth Disease. Its remit was to assess the social and economic impacts of the outbreak and provide an evidence base for relief and recovery measures. Membership of the Impact Assessment Group comprises representatives of COSLA (Convention of Scottish Local Authorities), VisitScotland, Scottish Enterprise, Highlands and Islands Enterprise, Employment Service, Scottish Agricultural College plus officials from the Dumfries and Galloway Local Enterprise Company and Council and the Scottish Executive.

The focus was on distributional effects. The impact of FMD was found to vary across different farm types with cattle and sheep farmers experiencing a positive overall effect, while mixed farms were much more negatively affected. A second key result is that the limited overall negative effect on households was felt most by the wealthiest 20%.

Against this background, the aim of the study is to estimate the net impact of FMD on the Scottish economy. The specific objectives of the project are:

To estimate and quantify the economic impact :

a) On different sectors, regions and urban/rural areas.
b) Of control measures.

Fulfilment of this brief requires that the research takes account *inter alia* of the following issues:

- The direct impact on agriculture of the export ban, animal movement restrictions, livestock cull and compensation payments.
- The direct impact on tourism due to the fall in visitors from overseas and the rest of the UK and the reductions in domestic tourism and rural leisure trips.
- The net economic costs and impacts of carcass disposal and control measures such as compensation and welfare payments, marketing and advertising.
- The indirect economic effects – including substitution and displacement – elsewhere in the economy through product market, labour market, inter-sectoral and inter-regional linkages of the direct price and output changes in agriculture and tourism.
- The direct and indirect spatial impacts, particularly between urban and rural areas.
- The overall net economic impact in the Scottish economy on GDP, household income, prices, employment, exports and imports and trade balance.
- The social and welfare effects, including income distributional impacts.

2.1 Computable General Equilibrium modelling

The report tackles these issues through the use of Computable General Equilibrium (CGE) modelling. CGE models have a number of strengths for analysing and quantifying this type of external (or exogenous) shock to the regional economy (Greenaway, *et al*. 1993; Partridge and Rickman, 1998).

- CGE models use sectorally-disaggregated data. This means that it is possible to look at the effects of shocks to the regional economy whose direct impacts occur in one, or a small number of, industrial sectors. Clearly in the case of FMD, agriculture and tourist industries bore the brunt of the direct effects. The total impacts can also be reported disaggregated by sector. This sectoral disaggregation means that the CGE has an advantage over regional econometric models, which tend to be very aggregative.

- CGE models incorporate supply side changes. Such changes include restrictions to the total supply of particular commodities and changes in the efficiency of production in individual sectors. These are examples of effects that were produced by the FMD outbreak. This incorporation of supply-side effects means that the CGE model has an advantage over sectorally-disaggregated demand-driven models, such as Input-Output analysis.

- CGE models deal with the interaction between industrial sectors and economic agents in a theory-consistent manner. That is to say, generally the quantities and prices of inputs used and outputs produced are assumed to be determined by the operation of market forces. However, imperfections to the market mechanism and government intervention can also be modelled.

- Whilst sectoral detail is retained, CGE models also produce results for aggregate, macroeconomic variables, such as regional GDP, employment, unemployment and competitiveness.

- CGE models are ideal for scenario analysis which identify the impact of unusual events. For these types of external shock, it is not possible to rely on previous econometric evidence.

2.2 The AMOS CGE model

The specific model that is used is AMOS, a CGE model developed in the Fraser of Allander Institute, parameterised on Scottish data. A more detailed description is given in Annex B. In the analysis of the impact of FMD, we use the period-by-period version of the model. Important characteristics of the model are:

- Scottish wage rates are set through a regional bargaining function. This means that if the demand for labour rises, the real wage and total employment will rise.

- Labour is mobile between industrial sectors.

- In any one year, the capital stock is fixed, both in total and to particular industrial sectors. However, between years, the capital stock for individual sectors is adjusted following profitability criteria. Importantly, we assume the region is not constrained by its own savings but can borrow for capital expansion from the UK and international capital markets.

- In any one year population is fixed but adjusts from year to year in line with increases in the real wage and reductions in the unemployment rate.

These model characteristics imply that there is a degree of inflexibility in the short-run that is relaxed over the long run through investment and migration.

The model is not a forecasting one and with no changes in exogenous variables simply reproduces the base-year data. This means that all the simulations here are essentially variations from the counterfactual. The base-year data are for 1999, the last year for which there is a Scottish Input-Output table that provides key information on the inter-industry output flows (Scottish Executive 2002b). In this report, the nominal variables are therefore all given at 1999 prices. Results from previous work using the AMOS model have been published in high-ranking economic and regional science journals, so that the model has been subject to extensive peer review (Harrigan *et al*, 1991, 1996; McGregor *et al*, 1996). AMOS is particularly appropriate for analysis and evaluation of government policy. It has been employed to analyse the impact on Scotland of Regional Selective Assistance, Foreign Direct Investment and the policies of Scottish Enterprise (Gillespie *et al*, 2001a, 2001b, 2002).

In this particular application, we have made two important adjustments to the model. First, we have changed the industrial structure of the model in order to identify the effects in the "Agriculture" and "Hotels and Catering" sectors more accurately. Second, we have incorporated a mechanism to allocate changes in activity to individual regions[3].

2.3 Adjustments to the database

2.3.1 Disaggregation of the "Agriculture" sector

In the Scottish I-O table, all farming activities are aggregated under one industry – "Agriculture". This does not provide a suitable framework to evaluate impacts of exogenous shocks such as the FMD outbreak. McDonald and Roberts (2002) note that agriculture was affected directly by FMD but the disease did not have a blanket effect on all farm types, and that some farm types suffered more than others. This study follows McDonald's and Roberts' (2002) suggestion and keeps as much detail as possible regarding the structure of agriculture. Accordingly, the I-O sector "Agriculture" was disaggregated by farm type, separately identifying the different input and output patterns of each farm type. There were seven farm types:

- LFA: specialist sheep
- LFA: specialist beef
- LFA: cattle and sheep
- Cereals
- General cropping
- Dairy
- Mixed[4]

[3] The amended model was subject to the full range of validity checks. See Annex C.

The task of disaggregating "Agriculture" in the Scottish I-O table is accomplished by reconciling secondary databases from different sources. These are Farm Incomes in Scotland (Scottish Executive, 2001); the Farm Accounts Survey (FAS) database and the agricultural census (Scottish Executive, 2002a); the 1999 Scottish I-O tables (Scottish Executive, 2002b), and McDonald and Roberts (2002). Details of the data organisation and manipulation are outlined in seven separate stages and reported in Annex C.

2.3.2 Disaggregation of the "Hotels and Catering" sector

The "Hotels and Catering" sector is a major recipient of tourist expenditure. Following Jones and Roberts (2002), in the present study this sector has been disaggregated by type of accommodation. The six categories are:

- Large Hotels
- Other Hotels
- Bed and Breakfast Establishments and Guest Houses
- Self Catering
- Caravans and Camping
- Restaurants

The aggregate data for this disaggregation were taken from VisitScotland (2001) and the StarUK website. The pattern of inputs into the different disaggregated sectors was determined using information for Wales from Jones and Roberts (2002) and Scottish data from volume 2 of the Surrey Research Group's I-O study for Scottish tourism (Surrey Research, 1993). The information for the individual sub-sectors was made consistent with the aggregate information from the Input-Output table using the RAS technique. This is explained in greater detail in Annex C.

2.3.3 Disaggregating the elements of tourism final demand

[4] The choice of farm types was constrained by those available in the FAS database. FAS farm types indicate the main farming activity, not the sole farming activity.

In order to identify the impact of changes in different elements of tourism and day-trip demand, we needed to separately identify these elements of demand within the framework of the Scottish 1999 Input-Output Table. In this table, Scottish Tourism in Scotland and Day trips are included as part of Household final demand, while Rest of the UK (RUK) and Rest of the World (ROW) Tourism are represented as a combined separate entry. This required the disaggregation of RUK and ROW tourist expenditure and removal of Scottish Tourism in Scotland and Day trips from Household consumption data.

Table 2.1: Structure of Scottish tourism, 1999

	1999 Size of Final Demand (£m)	Source(s) of Control Total	Source(s) of Disaggregation
Rest of the World Tourism	859.55	Scottish Executive (2002b), VisitScotland (2001)	Surrey Research Group (1993), VisitScotland (2001)
Rest of the UK Tourism	2,538.75	Scottish Executive (2002b), VisitScotland (2001)	Surrey Research Group (1993), VisitScotland (2001)
Scottish Tourism in Scotland	1,368.63	Scottish Executive (2000), Office for National Statistics (2000b), StarUK website, Labour Force Survey (2001)	Scottish Executive (2000), Office for National Statistics (2000b), Labour Force Survey (2001)
Domestic Daytrips	4,726.00	Countryside Agency (1998)	Countryside Agency (1998), Surrey Research Group (1993)

For the purposes of this analysis we wanted to further separate these columns by location of expenditure. Again we required geographic disaggregation of expenditure into urban, uninfected rural and infected rural areas.

Table 2.1 identifies the broad structure of tourist expenditure in Scotland. It also shows the sources used to identify the aggregate expenditure totals and the breakdown of expenditure on different sectors exhibited by different forms of tourism. Note that by far the biggest expenditure comes from Daytrips, followed by RUK tourist expenditure, Scottish Tourist expenditure in Scotland and finally ROW tourist expenditure.

2.4 Regional distribution of impacts

In addition to quantifying the impact of the 2001 Foot and Mouth outbreak on the Scottish macroeconomy, a key aim of this project is to assess the extent to which the outbreak impacted on the different regions of Scotland.

As in most impact studies, the regional incidence of the *direct effects* of the outbreak are relatively well known. In particular, a number of impact studies, commissioned by SEERAD and others, have already detailed the extent to which the direct effects of the FMD outbreak were location-specific. In particular, the DTZ PIEDA study points out that the spatial distribution of agricultural effects were, in part, related to the three geographical policy designations adopted by SEERAD and similar to those used in this report. The same study indicated the extent to which different regions experienced a downturn in tourist numbers and day visits and also the spatial displacement of tourists within Scotland over the period. However, the spatial incidence of the overall impact of the outbreak has yet to be quantified. We begin by briefly considering alternative methods for estimating the spatial distribution of the total impact.

2.4.1 First-round impacts

Agriculture

Sectors both upstream and downstream from agriculture were affected by the change in farm-behaviour associated with the outbreak. In relation to these first-round impacts, a number of previous studies have considered the extent to which farm transactions are:

- with other businesses located in the same area as the farm, and
- with businesses located in rural areas.

One of the first of these studies was by Harrison (1993), and used the actual receipts and invoices of a number of farms participating in the Farm Business Survey to track the location of farm-related industries. Her findings indicated that farm type and size were both significant influences on the distance over which transactions occur, with the smallest farms and pigs and poultry farms having a higher degree of local transactions. Overall she found that approximately one quarter of the inputs of farms under analysis came from the most rural areas, whilst one sixth of outputs accrued to the most rural areas of the UK.

Crabtree *et al* (1999) adopted a similar technique to contrast the spatial pattern of agriculture and conservation related expenditures of farmers involved in the ESA scheme. The findings suggested differences in the source of inputs by input type and by location of farms. The study also estimated the location of farm household spend.

Tourism

Published evidence of the spatial pattern of spending by tourism providers appears more limited. A study by Essex and Treloar (1997) investigated the local purchasing patterns of accommodation suppliers in Newquay, Cornwall. It suggested that hoteliers had very little information or knowledge about the origin of their purchases. It also highlighted the fact that very few of the suppliers servicing the tourist sectors are exclusively dependent on the tourist market or locality. Relative to the agriculture sector, however, a higher proportion of total expenditure of tourist-related enterprises will accrue to employees in the form of wages and salaries. Since employees are likely to reside locally, one might anticipate the degree of local integration of tourist sectors would be high, even if input sourcing patterns are not locally-orientated.

2.4.2 Apportioning the wider economic effects across regions: the gravity model approach

One possible way of apportioning the total impact of the outbreak to various regions of Scotland would be to use a gravity model (Richardson, 1978). This is based on the principle that the likelihood of economic transactions between two places (and therefore also the spread of the impact of economic impact of the outbreak) is a function of both their proximity and their difference in economic size. The closer together the two communities are, and the greater the size difference in economic terms, the greater the flow of goods and services.

This approach was used by Doyle *et al*. (1997) to assess the spatial distribution of effects associated with a reduction in agricultural support. This particular study is interesting, not only because of the use of this method, but also because the empirical application focussed on Dumfries and Galloway – the area in Scotland most adversely affected directly by the FMD outbreak. Doyle *et al*. used the gravity approach to apportion the *total* estimated impact of the reduction in agricultural support, where the total was generated through Input-Output analysis. However, there is no reason why the same method could not be used to apportion the impacts from a CGE model after having allowed for the (known) spatial distribution of direct effects and, where possible, having estimated the spatial distribution of first-round effects.

2.4.3 The industry-modelling approach to estimating regional impacts

Another, very different, method for estimating the regional impact of the outbreak is that used in the MONASH-RES model of the Australian economy (Parmenter and Welsh, 2000). The MONASH-RES model translates the output from a CGE model of the Australian economy into either regional forecasts or regional policy impacts through a set of regional equations. Within the regional equation system, industries are classified as either national (producing commodities which are readily traded between regions) or local (producing goods which are not traded between regions). Outputs from the national regions are assumed to be independent of regional demand but the output of the local industries have to adapt to satisfy the regions demands.

The MONASH-RES approach is a top down approach that requires relatively little regional data. However, it does allow some capacity for changing some of the default assumptions according to known information about the direct impacts of a shock and/or including accurate information about the regional distribution of output in national industries in particular. Moreover, historical simulations suggest the performance of the system is satisfactory.

2.4.4 Local Keynesian multiplier methods

The methods described above are essentially top-down in that they are based on the premise that the total impact estimated by the CGE model needs to be apportioned to regions. An alternative, very different approach would be to concentrate on a small area, most directly affected by the outbreak, for example, the Castle Douglas and Dalbeattie area in Dumfries and Galloway, and use a local Keynesian multiplier analysis to estimate the total income and employment effects in these regions arising from the outbreak. This modelling exercise would be quite distinct from the CGE modelling, however it may be the only appropriate method for measuring the total impact of the outbreak at this level of geographical specificity. Recent estimates of parameters required to estimate Keynesian multipliers (e.g. marginal propensity to import) could be derived from recent studies of local rural economies in Scotland (e.g. Hill *et al*, 2002).

2.4.5 Adopted Approach

The procedure that we have adopted is a variant of the MONASH-RES approach. Using this method we generate total employment and GDP change figures for individual regions for each element of the FMD impact. Broadly this involves a top down approach. The direct impacts are allocated to the region receiving the shock. The changes in activity in non-local industries are then distributed across the regions in proportion to the region's initial employment shares in the relevant industries. Finally the national impacts for local industries are allocated across regions in proportion to the changes in direct and non-local activity.

The criteria for giving an industry local or non-local status is the share of its output going to RUK and ROW exports. Where this share is greater than 25% we count the sector as a non-local sector. Local sectors are therefore:

- Energy Distribution and Construction
- Wholesale and Retail
- The disaggregated Hotels and Catering sectors,
- Business and Communications,
- Public Administration and Education
- Health and Sanitary

All other sectors are non-local. Of course, the direct sectors vary, depending on the nature of the shock.

3. THE DIRECT SHOCKS ASSOCIATED WITH FOOT AND MOUTH DISEASE

In this section we identify the direct (exogenous) shocks to the Scottish economy that occurred as a result of the Foot and Mouth Disease (FMD) outbreak. These shocks are then entered into the model and the resulting impacts on the Scottish economy as a whole are reported in Section 4. The shocks occur in the Agriculture and Meat Processing sectors and to tourism demand. A qualitative summary of the nature of the exogenous changes that we are using to model the impact of FMD in Scotland is given in Table 3.1 below.

Table 3.1 identifies a number of general points. First, the impacts on “Agriculture” are varied: they include demand- and supply-side disturbances. On the other hand, the direct impacts generated via tourism are all of a demand-side nature. Second, the impacts of the agricultural direct effects fall almost exclusively on agricultural sectors, with “Meat Processing” also hit by the export ban. However, the direct impacts from changes in tourist behaviour are much more evenly spread across sectors.

Table 3.1: Summary of exogenous shocks to the model

Type of Effect	Exogenous Model Change	Time Period	Sectors
Agriculture			
Export ban	Reduced ROW export demand	1	Meat Processing
Cull of trading animals	Reduced output to market	1	All agricultural farm-type sectors
Compensation for trading animals	Increased exogenous government demand	1	All agricultural farm-type sectors
Movement ban	Reduced productive efficiency	1	All agricultural farm-type sectors
Cull of breeding animals	Reduced capital efficiency	2-5	All agricultural farm-type sectors
Restocking of breeding animals	Increased exogenous investment demand	2-5	All agricultural farm-type sectors
Tourism			
Reduced tourist expenditure	Reduced ROW, RUK and domestic consumption demand	1	All sectors
Displaced consumption expenditure	Increased exogenous consumption demand	1	All sectors

Most of the direct effects of the FMD outbreak are thought to last for only one period of the model. This corresponds to the year 2001. These effects are therefore modelled as a temporary, one-period shock. The only action that has a different time dimension is the direct impact of the loss of the breeding livestock. First of all, we here assume that the associated production and demand effects begin in year two, that is, 2002. Second, these direct effects continue to year four, given the time-scale of restocking.

3.1 The Shocks to the Agriculture and Meat Processing sectors

For agriculture there are four broad separate exogenous shocks associated with the outbreak of Foot and Mouth Disease (FMD). These are:

- The export ban
- The production implications of the cull and compensation payments made for trading animals
- The movement restrictions
- The production implications of the cull and compensation payments made for breeding animals

We will deal with these in turn.

3.1.1 Export ban

In identifying the impact of the export ban imposed as a result of FMD we assume that the impact is realised through its effect on the exports of Meat Processing. In effect, the export of live animals is small and was already affected by BSE. However, the importance of agricultural products as intermediate inputs into “Meat Processing”, a relationship which is captured in the model, means that there are powerful indirect effects on the demand for agricultural commodities. The strength of these indirect links is indicated in Tables 3.2 and 3.3.

Table 3.2 shows the proportion of output of each farm type sector that is sold as an intermediate input to the “Meat Processing” sector, so for example, 20.71% of the “Specialist Sheep” sector output is purchased by the “Meat Processing” sector. “Meat Processing” buys between 10% and 25% of the output of the seven disaggregated farming sectors. Table 3.3 gives the cost breakdown of the “Meat Processing” sector. This table reveals that the “Meat Processing” sector buys 52.11% of its total inputs from the seven farm-type agricultural sectors. We therefore expect strong backward linkages from “Meat Processing” to these farming sectors.

Table 3.2: Linkages between “Meat Processing” and other Agriculture sectors: percentage of farm-type output going to “Meat Processing” and exports

Farm Types	Meat Processing Sector	Exports to RUK	Exports to ROW
Specialist sheep	20.71%	50.01%	0.00%
Specialist beef	24.84%	4.99%	0.00%
Cattle and sheep	18.41%	27.50%	0.00%
Cereals	17.02%	14.93%	15.86%
General Cropping	18.27%	15.65%	14.40%
Dairy	16.10%	42.12%	0.00%
Mixed	10.39%	30.21%	25.44%

Source: Scottish Executive (2002b), Scottish Council for Development of Industry Database (2003)

Table 3.3: The share of total input costs of the “Meat Processing” sector taken up by each farm-type sector

Farm Types	Cost share
Specialist sheep	2.33%
Specialist beef	10.97%
Cattle and sheep	7.73%
Cereals	8.49%
General Cropping	10.99%
Dairy	7.75%
Mixed	3.84%
Total agriculture	52.11%
Total Intermediate Inputs	76.66%
Total Inputs	100.00%

Source: Scottish Executive (2002b), Scottish Council for Development of Industry Database (2003), Scottish Executive (1999)

To establish an estimate for the shock to ROW "Meat Processing" exports generated by the FMD export ban, we used the Scottish Council for Development of Industry Database (2003) figures for exports of Livestock and Products from the Primary Sector Exports (Table 9) from 2000 to 2001. These data indicate a 55% reduction in exports of these items, which we assume is all directed through the "Meat Processing" sector. The regional impact of this direct shock is assumed to be in proportion to the distribution of employment within this sector across the urban, uninfected rural and infected rural regions.

There is clearly uncertainty about the absolute size of the shock that accompanies the export ban. Further, the export ban is the agricultural shock that generates the largest impact on the Scottish economy. We have therefore subjected this simulation to sensitivity analysis. In section 4, we report results from high and low estimates corresponding to ROW export adjustments to the "Meat Processing" sector of 65% and 45% respectively.

3.1.2 Production implications of the cull and compensation payments made for trading stock animals

To estimate the effect of the cull and compensation payments made for trading stock animals, we begin with the total compensation payments of £171million paid to farmers. These payments were made either because the farm had confirmed cases of FMD, or because it fell within the contiguous cull boundaries (with animals destroyed due to the Livestock Welfare Disposal Scheme). The total payments were then split out across farm sector types, based on the different numbers of each type of animal that were destroyed in each farm type. The compensation payments per animal, obtained from data compiled for McDonald and Roberts (2002), are shown below.

Table 3.4: Compensation payments per animal

Animal type	Average compensation (£)
Cattle	761
Sheep	86
Pigs	185
Goats	81
Deer	55
Other	81

Source: Scottish Executive (2002a) (Tables C34 and C35), Scottish Executive (2001) (Table 5), cull statistics data from McDonald and Roberts (2002).

Based on data from the 1999 agricultural census on animal numbers across the sectorally disaggregated farm types and regions, these compensation payments were allocated across the sub-regions of Scotland – urban, uninfected rural and infected rural – for each of the seven disaggregated farm types. These total compensation payments to each farm type were then divided into compensation for breeding animals and compensation for trading animals. This division was based on the aggregate value of each type of animal in each farm-type sector. For instance, if 50% of the value of animals on a typical "Specialist Sheep" farm are breeding stock, then 50% of the compensation payments to that farm type are given to breeding stock, the remainder going to trading stock. In this section we discuss the direct impact of the cull and compensation payments for trading animals. In the next section we discuss the implications of the cull and compensation for breeding animals.

The figures for compensation for trading animals broken down by farm-type and region are given in Table 3.5 below. Total payments made under these two schemes for trading animals sum to just over £72 million in 1999 prices[5]. The largest payment by farm-type goes to "Dairy" farms, which receive over a third of all payments. The "Specialist Beef" and "Specialist Cattle and Sheep" farm types also get a significant share of this aid: "Specialist Beef" over a quarter and "Specialist Cattle and Sheep" over 15% of the total payments. As would be expected, over 99% of all the compensation payments are made to farms in the infected rural region.

[5] All nominal figures are converted into 1999 prices before being entered into the model, which is calibrated on 1999 data.

Table 3.5: Compensation payments for trading animals broken down by region and farm-type, 1999 prices (£)

Regions	Specialist Sheep	Specialist Beef	Specialist Cattle and Sheep	Cereals	General Cropping	Dairy	Mixed	Total
Urban	5,795	60,468	34,521	8,223	4,947	124,328	32,683	270,965
Uninfected rural	12,738	65,480	52,911	26,859	13,668	10,991	82,751	265,398
Infected rural	2,296,327	19,821,083	12,264,032	1,684,477	1,148,850	27,131,793	7,200,015	71,546,577
Total	2,314,860	19947031	12,351,464	1,719,559	1,167,465	27,267,112	7,315,449	72,082,940

Source: Regional Breakdown from Scottish Executive (2002a), cull information from McDonald and Roberts (2002).

We treat the impact of the cull of trading animals by imposing a corresponding reduction in the supply of animals to the market. This reduction in supply has a positive impact on prices. It implies that without compensation, farms suffering the cull would experience a reduction in income, but other farms would gain. The impact of compensation is modelled in a very straightforward way, as an exogenous demand injection. Essentially we treat the government as acting as the consumer for culled trading animals instead of private Meat Processing firms and final demand categories. This therefore accounts for the production cost of the traded animals which did not reach market. Both the supply restriction and demand shocks apply for only one period: that is, only operates in the year 2001. The impact of the cull and compensation for breeding animals is treated in a rather different way.

3.1.3: The production implications of the cull and compensation paid for breeding animals

In the previous section we outlined the way in which we model the impact of the cull and compensation payments that affected trading animal stock. In this section we explain how we model the effect of the cull of breeding animals. Essentially we treat such animals as elements of the capital stock of the relevant sectors. The effect of the cull on breeding animals is to reduce the productive capacity, and therefore subsequently output, in the infected farms. The first issue is therefore to identify the impact of the cull on capital stock in the different agricultural farm-type sectors. A second issue concerns the speed and extent of restocking. In so far as restocking replaces culled animals, the capital stock and productive capacity of affected sectors will be restored. However, there is also a demand impact of restocking, in that the demand for the output of some Scottish agricultural sectors will be increased as a result of the demand for replacement breeding animals.

The figure for the rate of capital stock decline was obtained by taking the value of destroyed breeding stock (defined as capital assets on the farm's balance sheet) as a proportion of the total assets held by farms. Total assets by farm type came from the Farm Accounts Survey and included all assets held by farms. The breeding stock were animals that, due to the length of the production cycle, would have been kept on the farm for more than one year, but were destroyed in the response to FMD.

Table 3.6 gives the total value of compensation payments made for breeding livestock, broken down by type of farm and region. For each farm-type sector we know the distribution of payments between trading and breeding animals. Similarly for each farm sector we know the distribution of total compensation payments between regions. The regionally disaggregated figures presented in Table 3.6 are calculated on the basis that within any one farm-type, the distribution of compensation payments between trading and breeding animals does not vary between regions. The final row of Table 3.6 expresses the total reduction in the value of breeding animals as a share of the total capital stock in that farm-type sector. This is the reduction in capital stock in each farm-type sector that is used to shock the model to replicate the capacity-reducing effects of the cull of breeding animals.

Table 3.6: The absolute values and percentage change in total capital stock as a result of the cull of breeding animals, 1999 prices (£)

Regions	Specialist Sheep	Specialist Beef	Cattle and Sheep	Cereals	General Cropping	Dairy	Mixed	Total
Urban	17,427	83,322	61,559	1,378	2,329	149,992	25,040	341,047
Uninfected rural	38,221	90,242	94,297	4,513	6,421	13,366	63,442	310,502
Infected rural	6,896,766	27,314,661	21,870,802	282,906	538,497	32,755,265	5,522,853	95,181,750
Total	6,952,414	27,488,225	22,026,657	288,796	547,247	32,918,623	5,611,335	95,833,299
% shock	-2.19%	-2.91%	-2.90%	-0.03%	-0.04%	-3.16%	-0.54%	

Source: Calculated from Scottish Executive (2001) (Tables 1 and 5), Scottish Executive (1999) and statistics from McDonald and Roberts (2002).

In the absence of more concrete figures we have taken expert advice about the extent of restocking[6]. We assume that in the period subsequent to the onset of FMD, that is year 2002, the decline in capital stock will be as in Table 3.6. That is to say, in 2001 there is a cull in the number of breeding animals which is carried forward to 2002 when restocking begins. However, this restocking is not assumed to affect production in the rural infected region until year 3 (2003). In this third year, we assume there is a 75% recovery in breeding stock levels. In the fourth and fifth periods, we assume further 10% and 7.5% recoveries, leaving a residual of 7.5%. It is thought that this residual will never be replaced. These estimates determine the extent and timing of the restocking supply- and demand-side impacts.

The restocking is associated with a demand injection in the form of an increase in exogenous investment demand. We assume that all restocking is domestic and comes from uninfected areas, though this assumption is probably not fully accurate in that a small proportion is thought to have been sourced from England, Wales and Holland. The time path of reinvestment in breeding animals determines the timing of these demand shocks.

[6] This information was provided by Stuart Ashworth formerly of Scottish Agricultural College, now of Quality Meat Scotland.

These exogenous changes are modelled as follows. For the supply side effects, in year 2 we introduce a capital augmenting reduction in productive efficiency in each farm-type sector[7]. The size of the reduction is equal to the figure given in the total column in Table 3.6. These adjustments act to reduce the capital efficiency in each sector and therefore are equivalent to corresponding reductions in the capital stock. In subsequent time periods, the efficiency loss is reduced as just outlined.

For the demand impacts, we assume that all farms are restocked from the uninfected regions of Scotland. This generates a demand for the output of the livestock sectors in Scotland whose timing is the same as the changes in the capital stock.

3.1.4 Estimating the costs of the movement ban – by farm type

Four types of cost are identified as being associated with the movement ban. These are:

- Retention Costs, which include the additional feed costs during the longer than normal period of retention.
- The Price Penalty from retaining fattened animals beyond their optimum sale date.
- The Capacity Costs, which reflect the additional feed costs resulting from shifting stock densities / patterns away from the optimum.
- The Production Inefficiencies, which reflect the lower fattening capability which arises during the longer period of retention of store animals.

Costings are estimated as gross before making any allowances for adjustments to business practices (to respond to the 20-day standstill) or before making any allowance for any offsetting gains. For example, there are cases where additional costs to one farm (i.e. in producing store animals) may be offset by gains to other (fatteners) farms.

Estimates of the size of these impacts are given by Animal Movement Standstill: Economic Assessment of the Impact Upon the Livestock Industry in England and Wales (DEFRA, 2001, Table 4). For Scotland, they are calculated by proportioning (by farm types) the English and Welsh costs to Scottish Farms, using the total number of holdings for Scotland

[7] Formally, this is Solow neutral technical progress and is explained in more detail in Annex B

and England (obtained from the regional trends database on http://www.statistics.gov.uk/CCInsclasp?ID =5019); and data on agricultural holdings by farm type, size and county (from http://www.defra.gov.uk/esp/work_htm/publications/cf/fiuk/current/chapter4/c4t5.xls).

Table 3.7: Direct costs of the livestock movement restrictions, broken down by farm-type and regions (£, millions)

Regions	Specialist Sheep	Specialist Beef	Specialist Cattle and Sheep	Cereals	General Cropping	Dairy	Mixed	Total
Urban	0.01	0.29	0.25	0.01	0.00	0.01	0.22	0.79
Uninfected rural	0.04	0.56	0.56	0.04	0.03	0.00	0.65	1.88
Infected rural	0.01	0.21	0.20	0.00	0.00	0.01	0.10	0.53
Total	0.06	1.06	1.01	0.05	0.03	0.02	0.97	3.21

Source: DEFRA (2001) (Table 4), Foot and Mouth Website. Regional trends database on http://www.statistics.gov.uk/CCInsclasp?ID=5019 and http://www.defra.gov.uk/esp/work_htm/publications/cf/fiuk/current/chapter4/c4t5.xls

The farm-type and regional disaggregation of the costs associated with the movement ban are given in Table 3.7. These show that the costs are concentrated almost wholly in three farm-type sectors. These are "Specialist Beef", "Specialist Cattle and Sheep" and "Mixed Farming". Note also that almost 60% of the costs associated with the movement ban are borne by farms in the Uninfected Rural region. This reflects the relative geographic size of this region.

The direct impact of the movement ban is simulated as a reduction in the efficiency of production in the individual farm-types. The shock enters as an improvement in technical progress that applies equally between all elements of value added, and takes a value equal to the estimated cost to that farm-type sector divided by the total value added of that sector.[8] Therefore, for example, if the cost of the movement ban to Specialist Beef is estimated to be

£1 million and the total value added in Specialist Beef is £20 million, the efficiency shock that would be administered would take the value 1/20, or 5%. The shock is run for one period only. This implies the ban operates only for 2001.

3.2 Tourism related shocks

The aggregate impact of the adjustment to tourist demand in Scotland generated by FMD is separated into five distinct elements. These are:

- Rest of the world (ROW) Tourism
- Rest of the UK (RUK) Tourism
- Scottish Tourism in Scotland
- Daytrips
- Displacement to Scottish Household Expenditure

The structure of tourism demand within Scotland is shown in Table 3.8 below. The regional and industrial disaggregation methodology is given in greater detail in Annex C, and copies of the disaggregated final demand columns are given in Annex D.

[8] Formally, this is a Hicks neutral technical progress, and is explained in more detail in Annex B

Table 3.8: Structure of Scottish tourism, 1999

	1999 Size of Final Demand (£m)	Source(s) of Control Total	Source(s) of Disaggregation
Rest of the World Tourism	859.55	Scottish Executive (2002b), VisitScotland (2001)	Surrey Research Group (1993), VisitScotland (2001)
Rest of the UK Tourism	2,538.75	Scottish Executive (2002b), VisitScotland (2001)	Surrey Research Group (1993), VisitScotland (2001)
Scottish Tourism in Scotland	1,368.63	Scottish Executive (2000), Office for National Statistics (2000b), StarUK website, Labour Force Survey (2001)	Scottish Executive (2000), Office for National Statistics (2000b), Labour Force Survey (2001)
Domestic Daytrips	4,726.00	Countryside Agency (1998)	Countryside Agency (1998), Surrey Research Group (1993)

Note: this table simply reproduces Table 2.1

Annual Tourism from the Rest of the World (ROW) was estimated to be £859.55 million, which was substantially less than the £2,538.75 million attributable to Rest of the UK (RUK) Tourism. The two types of tourism normally included within Household Consumption in the Input–Output Tables are Scottish Tourism in Scotland and Daytrips. These were identified as £1,368.63 million and £4,726 million respectively.

ROW and RUK tourism covers spending by non-Scottish tourists in Scotland. Scottish Tourism in Scotland is the expenditures of Scottish nationals on tourism in Scotland. Daytrip expenditures are also made by Scots, but whereas in domestic tourism an overnight stay must be involved, with daytrips an overnight stay does not occur.

The final element here is the displacement of household expenditure. There are two similar, but distinct, possible mechanisms here. The first is the substitution of some types of Scottish holiday or daytrip destinations for others. The second is the displacement of previous tourist and daytrip expenditure by Scots in Scotland by other forms of consumer expenditure. In this report we simply identify displacement expenditure: we have not attempted to calculate any location substitution.

In calculating the impacts of each of these tourist-related changes in demand, two aspects are important. These are:

- The absolute size of the demand shock.
- The distribution of the expenditure across different commodities.

In the case of tourism demand there is general uncertainty over the direct affect of FMD on tourist expenditures. We therefore provide a central estimate and a high-low band of alternative estimates of these direct impacts.

3.2.1 Absolute size of the shock

After looking closely at the trends identified in the available tourism data for Scotland and the judgements made in UK studies, a separate estimate is given for the impact of FMD on each tourism type, with upper and lower ranges. These figures are shown below in Table 3.9.

Table 3.9: Estimated exogenous shocks to tourism expenditures caused by foot and mouth disease, 2001 (£, millions, 1999 prices)

Tourism	Low (£m)	Central (£m)	High (£m)
Rest of the World (ROW)	-19.70	-24.62	-29.54
Rest of the UK (RUK)	-62.34	-74.80	-87.27
Scottish Tourism in Scotland	-118.76	-142.52	-166.27
Daytrips	-330.82	-425.34	-500.96
Displaced Consumption	400.08	518.36	617.72

Source: ROW figure from International Passenger Survey (2001), RUK and Scottish Tourism in Scotland figure from VisitScotland (2001), Daytrip data are based on estimates in MORI Leisure Survey Data (2002), Displaced Consumption data from VisitScotland (2001).

To make the ROW Tourism central estimate, we first identify the absolute fall in ROW tourist expenditure in Scotland between 2000 and 2001 from the International Passenger Survey (IPS) (2001). We then assume that 50% of the real (1999 prices) fall in ROW tourism expenditure in Scotland between 2000 and 2001 was due to FMD. For sensitivity analysis, we give a low figure where 40% of the fall is due to FMD and a high estimate where 60% of the fall is due to FMD.

For RUK and Scottish Tourism in Scotland we used the VisitScotland data on expenditure by these different types of tourists. Again the real changes from 2000 to 2001 (in 1999 prices) were calculated. However the central estimate assumed that 60% of this fall was due to FMD, with a low and high range of 50% and 70%. The larger percentage of the actual decline ascribed to FMD reflects the fact that the terrorist attacks of September 11th reduced American foreign tourism, therefore some of the reduction in ROW tourism should be attributed to this cause. However, this should not affect UK or Scottish Tourism in Scotland.

There is a lack of annual data on the size of expenditure for Daytrips. We therefore had to estimate the shock using the best of the available information. We used two methods. First, evidence from MORI Leisure Survey Data (2002) suggested that daytrips expenditure fell by 7% in Scotland due to FMD. Second, we assumed that the decline in daytrip expenditure due to FMD, as compared to the initial daytrip total expenditure, was equal to the corresponding impact on Scottish tourist expenditure in Scotland. Scottish tourist expenditure in Scotland was estimated to have experienced a 10.6% decline as a result of FMD. These two estimates were used to provide high and low bounds, with a central estimate of the decline in daytrips expenditure being taken as 9%.

Displaced Consumption was calculated using data from VisitScotland. The basic rationale was that consumption not spent by households on domestic or day tourism would be spent elsewhere in the economy in the pattern of typical, non-tourism, domestic household expenditure. While, in principle, this should be a positive shock to household consumption equal to the reduced value of Scottish tourist expenditure in Scotland and Scottish daytrips expenditure, indications are that there was some substitution of increased tourism expenditure overseas.

Data are given in the IPS (2001) for visitors expenditure abroad by Scottish residents from 2000 to 2002, quarter by quarter. For both the second and third quarter of 2001 we calculated a counterfactual total expenditure based on the average expenditure in the corresponding quarter in 2000 and 2002. The actual expenditure was compared to this counterfactual. In the second quarter of 2001, the actual was greater than the estimated counterfactual by £42 million. For the third quarter, the difference is not so great, with an expenditure of £7.5 million greater than the counterfactual. We therefore estimated a combined total of £49.5million that was not spent by households in Scotland, but was a leakage to overseas destinations.

The total positive shock to households is therefore the reduced daytrips expenditure plus the reduced Scottish tourist expenditure in Scotland, minus the expenditure lost to overseas (£49.5million), giving a central estimate of £518.36million. The high and low estimates of this shock were taken from summing the high and low domestic and daytrips shocks and subtracting the lost £49.5million in each case.

3.2.2 Regional breakdown

Information on the geographical pattern of tourist expenditures within Scotland came from VisitScotland (2001, 2002). These give expenditure for both ROW and RUK tourists broken down by the 11 area tourist boards for both 2000 and 2001. For modelling purposes we require the proportionate changes in demand for each of the 25 industrial sectors for the three sub-regions of Scotland. The geographical regions are shown diagrammatically in Annex A and specified in Annex B.

The changes in expenditure by different types of tourist, in each of the three areas, are obtained in two steps. First, the VisitScotland figures for the change in expenditure between 2000 and 2001 were calculated in real terms (1999 prices) using the GDP deflator from the UK Treasury. The share of the reduction between the three geographical areas is then applied to the estimated IPS (2001) figure for the total Scottish reduction in ROW tourist expenditure. The result is shown in Table 3.10.

Table 3.10: Tourism expenditure changes due to FMD by type and sub-region of Scotland (£, millions)

Region (destination)	ROW Tourism	RUK Tourism	Scottish Tourism in Scotland	Daytrips	Displaced Consumption (by region of origin)	Total
Urban	-14.75	-14.7	-28.01	-83.6	323.4	182.34
Uninfected rural	-9.36	-51.87	-98.83	-294.96	172.71	-282.31
Infected rural	-0.51	-8.23	-15.62	-46.78	22.25	-48.89
Total	-24.62	-74.8	-142.46	-425.34	518.36	-148.86

Source: International Passenger Survey, 2001 and VisitScotland (2000/2001)

As is seen above, the impact of the decline in ROW tourism was especially felt in the urban region, although a significant portion was also experienced in the uninfected rural area. This area includes the Highlands of Scotland, an especially popular destination for overseas visitors to Scotland, third in expenditure terms for 2000 behind only Edinburgh and Glasgow. Indeed, overseas expenditure in 2000 in the Aberdeen and Grampian and Highland Area Tourist Boards (ATBs) was greater than Glasgow receipts from overseas tourism in the same year.

To identify the particular demand impacts generated by the change in ROW tourist expenditure, the figures for each region gave the aggregate change. This was allocated across commodities using the disaggregation identified in Annex D. Note expenditure patterns for each type of tourist vary across the sub-regions. These expenditure changes were then expressed as a percentage of the total figure for exports to the Rest of the World from each of the sectors, giving us percentage shocks to apply to the model to simulate the effects of the decline in overseas visitors to Scotland.

The same general procedure was then used for the other types of tourist expenditure (RUK Tourism, Scottish Tourists in Scotland and Daytrips). The regional breakdowns from VisitScotland, and the change in receipts in 1999 prices, were scaled to the central estimates we have calculated for tourism.

A major difference was that the VisitScotland figures do not separately identify RUK and Scottish Tourism in Scotland figures: rather these data are aggregated under the heading "UK tourism". This required the assumption that RUK and Scottish Tourism in Scotland have the same geographical dispersion. Given the lack of any other reliable data, this seems a reasonable assumption. We have made a similar assumption for Daytrips. That is to say, the regional distribution of changes in UK tourism in Scotland is taken to be the same as the regional distribution of changes in daytrips. This seems a little more questionable, but appears unavoidable, given the lack of alternative data. These results are given in Table 3.10.

The fall in tourist expenditure from RUK, Scottish Tourism in Scotland and Daytrips is much more heavily concentrated in the uninfected rural region: over 70% of the reduction is identified as being in this region. However, the geographic distribution of the increased household expenditure, is assumed to match the regional distribution of GDP, so that over 60% is in the urban region.

Again the estimates achieved in this way for RUK, Scottish Tourism in Scotland and Daytrip expenditure by region were used as control totals and proportioned out across the 25 sectors using the corresponding expenditure patterns which are given in Annex D.

4. THE IMPACT ON THE SCOTTISH ECONOMY

In this section we report the results of the simulations using the model and exogenous shocks described in Sections 2 and 3 of this report. The total impact is found by summing the individual effects. This is acceptable given the small scale of the proportionate effects on the aggregate economy generated by each of the individual agricultural and tourism disturbances. It is also convenient in that it is not possible to simultaneously impose some of the efficiency adjustments required to replicate the agricultural exogenous shocks.

The overall total impact of the FMD outbreak in the initial year was to reduce Scottish GDP by between £13.6 million and £29.8 million. This is between 0.02% and 0.05% of Scottish GDP. The effect on employment is a fall of between 966 and 1554 which represents between 0.05% and 0.08% of Scottish total employment. We begin with more detail on the impact on the Scottish economy as a whole.

4.1 National results

For the national (Scottish) results we separately identify the impact of the exogenous shocks to the agricultural sectors and the tourism demand changes. These figures are further disaggregated by the individual elements of these changes. Results are given for 2001 and 2006.

4.1.1 Agricultural results

The agricultural simulation results are broken down into six separate components:

- the export ban
- the production implications of the cull of trading animals
- the compensation payments for trading animals
- the implications of the movement restrictions
- the production implications of the cull of breeding animals
- the demand implications of the restocking of breeding animals

A summary of the year-one agricultural results is given in Table 4.1. In all cases except for the production implications of the cull of breeding animals and demand-side effects of restocking, the impacts are for the year 2001. The direct effects of these shocks were wholly, or primarily, felt in the year of the outbreak. For the supply impacts of the cull on breeding animals and the demand impacts of restocking, the figures are for the year 2002.

Focusing first on the total effects, what is most striking is the very small scale of the effects when measured against the national aggregates. The negative net impact on Scottish GDP of all the first year effects is £33.88million (measured at 1999 prices). This represents 0.05% of Scottish GDP. Similarly the effects on employment are extremely small when measured in proportionate terms.

Table 4.1: Year one (2001) results of Agriculture simulations – national level

	Export Ban	Cull of Trading Animals	Compen-sation Payments for Trading Animals	Movement restrictions	Cull of Breeding Animals	Restocking Demand-shock	Total
GDP (£, millions)	-23.66	-2.56	3.88	-3.66	-9.30	1.42	-33.88
Total employment	-1416	-1021	1104	15	-181	533	-896
Agriculture employment	-913	-2441	1343	57	-123	770	-1307
Hotels and Catering employment	35	176	-33	0	5	-15	168

Note: By year one we imply the first year that the measure is in operation. For most of the measures this is 2001 but for the Cull of Breeding Animals and Restocking Demand-shock effects will begin in 2002.

We now consider the individual measures in turn. The export ban generated an estimated fall in Scottish total GDP and employment of £23.66 million and 1416 jobs. The fall in total employment is greater than the fall in agricultural employment, which is estimated as 913. This is primarily because the ban affects “Meat Processing” exports so that there are significant job losses in this sector also. The direct incorporation of the “Meat Processing” sector in this ban plays a part in the relatively high GDP impact here.

The supply impact of the cull of breeding animals is to reduce GDP, total employment and agricultural employment. In this case agricultural employment is hit the hardest, with a much smaller reduction in total employment. The smaller fall in the total employment is a consequence of the easing of the labour market and the implied income effects on unaffected farms of reduced supply from farms subject to the cull.

We treat the compensation payments as a demand shock: that is to say, the government purchases the animals that have to be culled. This has a sizeable impact on employment, particularly in agriculture. This treatment captures the payments to intermediate inputs and wages that would be made for these animals that fail to reach the market. This has an implied positive impact on GDP of £3.88million and leads to an increase in agriculture employment by 1343.

Movement restrictions are the third effect that would operate in the first year (2001). These have a negative impact on Scottish GDP of £3.66 million. However, the reduced efficiency produces an increase in agricultural employment. This is the expected result if the demand for labour is inelastic, which is often the case for individual sectors in the short run. The reduced efficiency requires more intensive use of labour but also higher costs. The net effect is therefore the impact of offsetting factors. There is some crowding out of employment in other sectors so that in total the increase in employment in Scotland as a whole is very small.

The cull of breeding animals as a result of FMD produces a reduction in the capital stock in agricultural sectors and a resulting fall in Scottish GDP of £9.30 million. The fall in capital stock reduces the physical marginal product of labour product and generates a fall in agricultural employment of 123. The decline in total Scottish employment is greater at 181. However, restocking produces a major demand boost to the agricultural sector, increasing agricultural employment by 770, and total Scottish GDP by £1.42 million. The total increase in Scottish employment is smaller at 603 implying some crowding out. The restocking effects begin to operate in 2002. They produce a net boost to the economy in that year. Broadly the net combined impact on employment and GDP of all the agricultural shocks in the year 2001 is negative but will be positive when the restocking effects begin to take place.

The compensation policy and the restocking of breeding animals produce significant positive employment effects, but these are not large enough to offset the combined effect of the export ban and the cull so that a year one reduction of 1307 in "Agricultural" employment and 896 in total employment is recorded.

Table 4.7 below shows the results from some sensitivity analysis applied to the export ban. The central estimate took the reduction in exports from the "Meat Processing" sector to the rest of the world to be 55%. Here we give the results from a low estimate and a high estimate of the reduction in exports to the rest of the world being 45% and 65% respectively. These results show a large variation in GDP and total employment between these limits.

Table 4.7: High and low year one estimates of the impact of the export ban

	Low estimate	Central estimate	High estimate
GDP (£, millions)	-18.17	-23.66	-28.17
Total employment	-1092	-1416	-1679
Agriculture employment	-704	-913	-1082
Hotels and Catering employment	26	35	41

Table 4.2: Results for the Agricultural simulations by 2006 – national level

	Export Ban	Cull of Trading Animals	Compen-sation Payments for Trading Animals	Movement restrictions	Cull of Breeding Animals	Restocking Demand-shock	Total
GDP (£, millions)	-4.86	-2.04	2.69	-0.52	-2.5	3.43	-3.79
Total employment	-116	-2	33	-15	-68	144	-24
Agriculture employment	-5	-65	-19	-5	-26	124	4
Hotels and Catering employment	-7	-4	2	-1	-1	-4	-15

Note: The Restocking Supply-side and Restocking Demand-side results for year five are for the fourth year of operation.

Year 5 simulation results are given in Table 4.2. This is the impact in 2006, against the counterfactual of what would have occurred if the FMD outbreak had not taken place. Recall that most of the direct effects only apply in the years 2001 and 2002, with even the restocking of breeding animals subsequent to the cull mainly occurring in 2002. The only continuing direct impact of FMD is a small reduction in capital stock due to incomplete replacement of breeding animals. However, there are capital stock and population adjustments that will continue over time, so that there is some persistence in effects (but note that these are very small).

4.1.2 Tourism results

The period 1 results for the individual tourism shocks are given in Table 4.3. Again the central point to emphasise is the very small proportionate changes at the national level. Overall, the simulations identify a 2,134 fall in employment in Hotels and Catering, which is a 1.9% reduction in this sector. However, the total employment fall is very small, at 305. There are two reasons for the relatively small number. First, as the demand for labour falls in the Hotels and Catering sector as a result of the fall in tourist expenditure, there will be a weakening in the labour market and some crowding in of employment as the wage rate falls. Second, some of the fall in expenditure on Scottish tourism in Scotland and on daytrips will be replaced by general consumption expenditure. This expenditure shifting is one of the factors producing the positive GDP impact.

Table 4.3: Year one (2001) results of the Tourism simulations – national level

	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
GDP (£, millions)	-1.40	-4.59	-10.26	0.84	27.37	11.97
Total employment	-248	-595	-690	-1127	2355	-305
Agriculture employment	5	9	-50	99	-113	-50
Hotels and Catering Employment	-365	-756	-642	-324	-47	-2134

If we look at the individual columns in Table 4.3, it is useful to initially separate out the tourist expenditure from daytrips. For tourist expenditure, the impact on total employment is greatest for the reduction in Scottish Tourism in Scotland, then RUK Tourism and finally ROW Tourism. The same ordering applies to the impact on Scottish GDP, where again the reduction in domestic tourism has the biggest negative impact. However, we need to remember that reduced Scottish Tourism in Scotland will be at least partly offset by increased general (non-tourist) consumption expenditure as frustrated domestic tourists spend their income on other commodities and services. This is incorporated as part of the expansion in household expenditure.

The result for Daytrips is the least straightforward. Although the estimated reduction in expenditure is large, its commodity composition is very different from the other tourism categories. The daytrips expenditure pattern is much less concentrated on “Hotels and Catering” and more focussed on the “Retail and Wholesale” and “Business and Communications” (essentially transport) sectors. There is therefore a relatively small fall in employment in Hotels and Catering, but accompanied by a much larger fall in “Retail and Wholesale” and a small rise in GDP.

To derive the net impact of the changes in expenditure on Scottish Tourism in Scotland and Daytrips, the impact of the expenditure displaced to other types of consumption should be added. Summing the employment results in these three columns – Scottish Tourism in Scotland, Daytrips and Displaced Household Consumption - reveals an employment surplus. The employment impact of the Displaced Household Consumption is greater than that of the reduced expenditure on Scottish Tourism in Scotland and Daytrips[9]. There is a sizeable positive GDP effect as well.

The sectorally disaggregated impact of the displaced Household Consumption is shown in Table D.2 in Annex D. Generally the sectors which benefit are primarily Wholesale and Retail and Recreation.

[9] The Input-Output Type II employment/expenditure multiplier for Displaced Household Consumption at 27.8 is greater than the corresponding multipliers for Scottish Tourism in Scotland and Daytrips, which are 26.2 and 26.6 respectively.

Table 4.4: Results of the tourism simulations by 2006 – national level

	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
GDP (£, millions)	-1.06	-3.00	-6.52	-22.66	25.20	-8.05
Total employment	-44	-111	-178	-694	761	-266
Agriculture employment	0	-1	-6	-9	12	-4
Hotels and Catering Employment	-23	-45	-42	-87	73	-124

Table 4.4 gives the impact of the changes in tourist expenditures related to the FMD outbreak on the Scottish economy in 2006. Again it is important to remember that this is against the counterfactual of the operation of the economy without FMD. Also, in this case there are no continuing exogenous impacts on tourist expenditure after 2001. While evidence on tourism expenditure in Scotland appears to indicate that there has generally been a return of aggregate tourism activity to levels similar to before the FMD outbreak, current regional results suggest that some regions have gained at others expense. As can be seen in the table, the changes in “Hotels and Catering” are, by 2006, very small. Any impact on the economy is coming from persisting capital stock and population adjustments. It is perhaps appropriate to mention also that if firms and individuals thought that the FMD outbreak would only imply a temporary shock to the economy, the 2006 results would be even smaller.

4.2 Regionally-disaggregated results

4.2.1 Agriculture results

The regionally-disaggregated employment impacts in year one are given in Table 4.5. The infected rural region is hardest hit by the impact of the cull of trading animals and the supply implications of the cull of breeding animals. Also, whilst this region benefits most from the compensation payments it does not experience the positive demand stimulus received from restocking. There are employment gains associated with the agricultural disturbances linked to FMD coming primarily from the spillover effects from the cull of trading animals and the restocking of breeding animals.

Table 4.5: Scottish employment changes as a result of Agriculture shock

Regions	Export Ban	Cull of Trading Animals	Compen-sation Payments for Trading Animals	Movement Restrictions	Cull of Breeding Animals	Restocking Demand-Shock	Total
Urban	-639	665	-80	4	1	248	199
Uninfected Rural	-531	773	-23	5	1	289	514
Infected Rural	-251	-2458	1208	9	-181	-4	-1677
Total	-1421	-1020	1105	18	-179	533	-964

Table 4.6 shows the regionally-disaggregated year one GDP impacts for agriculture. The negative GDP impacts are clearly skewed towards the infected rural regions. Apart from benefiting from cash injections via compensation payments for trading animals, all the other elements associated with the impact of FMD on agriculture generate a negative GDP change in the rural infected regions. The uninfected rural region experiences an increase in GDP overall as a result of the agricultural elements of the FMD outbreak.

Table 4.6: Scottish GDP changes as a result of Agriculture shock (£, millions)

Regions	Export Ban	Cull of Trading Animals	Compen-sation Payments for Trading Animals	Movement restrictions	Cull of Breeding Animals	Restocking Demand-shock	Total
Urban	-12.47	8.42	-1.28	-0.97	-0.04	0.65	-5.70
Uninfected Rural	-2.87	12.29	-0.39	-0.61	-0.03	1.08	9.47
Infected Rural	-8.32	-23.22	5.56	-2.06	-9.22	-0.04	-37.30
Total	-23.66	-2.52	3.89	-3.64	-9.29	1.68	-33.54

4.2.2 Tourism results

Table 4.7 gives the total employment change, broken down by region and tourism type, generated by the tourist adjustments in Scotland following the outbreak of Foot and Mouth disease. This is for the year 2001. In aggregate there are employment losses in the two rural regions, but a significant employment gain to the urban region. The explanation is that if we simply consider the tourism changes, that is the RUK, ROW, Scottish Tourism in Scotland and Daytrips, then the net impact in all regions is negative. However, the impact on urban region is small, reflecting gains from crowding-in in the labour market in that region. However, once the impact of increased displaced household consumption is included, there is a net benefit to the urban region. What is evident is the large relative negative impact on the non-infected rural region. This is due to the high initial incidence of tourism and daytrip expenditure in this region.

Table 4.7: Scottish employment changes as a result of Tourism shock

	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
Urban	-119	-76	73	89	1403	1370
Non-infected rural	-130	-460	-669	-1098	676	-1681
Infected rural	-6	-65	-100	-126	265	-32
Total	-255	-601	-696	-1135	2344	-343

Table 4.8 presents the same information except for changes in GDP. In this case urban and the infected rural area is identified as receiving an increase in GDP. This comes from adjustments in the composition of output as well as the overall level of activity. Again the uninfected rural regions experience a fall in GDP.

Table 4.8: Scottish GDP changes as a result of Tourism shock (£, millions)

Regions	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
Urban	-0.95	0.22	56.84	-3.00	18.30	71.40
Non-infected rural	-0.43	-4.14	-67.61	0.46	6.86	-64.86
Infected rural	-0.01	-0.63	0.50	3.34	2.26	5.46
Total	-1.39	-4.56	-10.26	0.80	27.42	12.00

It needs to be understood that a degree of imprecision is associated with all modelling work, particularly of this scenario type. However, in this case we also had difficulty in accurately determining the direct external shock to the model associated with the impact of FMD on tourist expenditure. It was difficult to disentangle the various influences on tourism, including the fall out from the September 11^{th} terrorist attack. We therefore have given explicit high and low estimates for the GDP impacts – the magnitude of which are shown in Table 3.8.

Results using low estimates of the direct exogenous shock to tourism expenditure are shown in Table 4.9 below. With lower direct losses from all forms of tourism spending, and thus lower positive displaced household consumption, the overall impact on GDP is smaller than for the central estimate, but remains positive.

Table 4.9: Year one (2001) results of the Tourism simulations – national level - low estimates

	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
GDP (£, millions)	-1.12	-3.82	-8.54	0.64	21.15	8.32
Total employment	-198	-496	-575	-876	1820	-325
Agriculture employment	3	7	-40	77	-88	-41
Hotels and Catering employment	-293	-630	-534	-253	-37	-1747

Table 4.10: Year one (2001) results of the Tourism simulations – national level – high estimates

	ROW	RUK	Scottish in Scotland	Daytrips	Displaced Consumption	Total
GDP (£, millions)	-1.68	-5.36	-11.98	1.00	32.59	14.57
Total employment	-298	-695	-806	-1328	2803	-324
Agriculture employment	6	10	-57	117	-132	-56
Hotels and Catering employment	-439	-882	-748	-379	-52	-2500

For the high estimate, the larger shock to both Scottish Tourism in Scotland and Daytrips leads to larger displaced consumption, resulting in a positive shock to GDP of £14.6 million. Overall, employment change remain very small at the national level, but households' increased spending on consumption at the expense of tourism spending leads to a fall in employment in the "Hotels and Catering" sectors of 2500, or 2.2% of employment in this sector.

5. THE ENVIRONMENTAL AND SOCIAL IMPACT ON SCOTLAND

The 2001 Foot and Mouth outbreak in Scotland led to a number of social and environmental impacts which are difficult to quantify. These impacts are not taken into account in the economic modelling approach described elsewhere in this report. The aim of this section is to redress this situation by summarising existing literature and information on the nature and scale of social and environmental impacts so as to provide a more appropriate context within which the economic impacts can be assessed.

5.1 Social implications

Nearly all of the major inquiries into the impact of Foot and Mouth published to date have commented to some extent on the social effects of the outbreak, often distinguishing between effects on individuals and families and effects on rural communities (Countryside Agency, 2001a; Royal Society Edinburgh, 2002; House of Commons, 2002; Royal Society, 2002; Rural Task Force, 2001). With few exceptions, the discussion on social impacts is based on anecdotal rather than scientific evidence. However two general findings emerge:

- The magnitude of social impacts were far higher within the areas directly affected by FMD, with effects outside the infected regions generally limited.
- Although the duration of impacts remains unclear, some of the social impacts arising from the outbreak are likely to be felt for considerably longer than duration of impact itself and may outlive the more obvious financial impacts of the outbreak.

5.1.1 Individuals and families

Farmers and farming families

Not surprisingly, most of the studies have focussed on the effects on the farming community and, in particular, the psychological impacts on farmers and their families (see for example, Countryside Agency, 2001a, 2001b; Royal Society Edinburgh, 2002). The main issues identified as giving rise to concern to farmers are:

- Bereavement over losing animals (in some cases bloodlines which had been established over many generations).
- Concern over animal welfare (associated with lack of feed and poor conditions in the fields at a time coinciding with the lambing season).
- Loss of control over lives and, in the case of farms experiencing a cull, a feeling of redundancy.
- Isolation arising from both the legislative restrictions on movements and self-imposed restrictions on movements through fear of spreading the disease.
- Short term financial concerns (associated with both the need to purchase feed, and, on a different point, inability to access benefits) and long tem financial worries.

Even prior to the FMD outbreak, the farming community was recognised as being particularly vulnerable to psychological morbidity. Hawton *et al* (1998) cite agriculture as having the fourth highest occupational ratio for suicides and open verdicts. Similarly, statistics from the Samaritans indicate that the suicide rate in the agricultural sector is not only high but on an upward trend since the beginning of the 1990s (Countryside Agency, 2001a).

Through a comparison of farmers in a badly infected area (Cumbria) and an uninfected area (Scottish Highlands), Peck *et al* (2002), quantified the additional psychological impacts on farmers associated with the FMD outbreak. Farmers were contacted by post and asked to complete a 12-item version of the General Health Questionnaire, some limited personal and farm details and finally some questions relating to the personal support networks.

Farmers in Cumbria were found to have higher levels of psychological morbidity than farmers in the Highlands, consistent with the argument that FMD increased levels of morbidity over and above background levels in the general farming community. More interestingly, they also found only moderate differences in the morbidity levels of farmers who had actually had their animals slaughtered and those who had not. They attributed this to the compensation regulations which meant the latter, despite experiencing financial hardships, did not receive compensation. It could also be associated with the longer duration of uncertainly faced by uninfected farmers. However the results from the study need qualification. There was a relatively low response rate to the questionnaire and a concomitant small sample size of respondents in each case study area: a total of eighty farmers replied to the questionnaire from the Highlands (response rate 28%) and 188 from Cumbria (response rate 29.5%).

In terms of other farm household members, studies cite the trauma effects on children caused by:

- the slaughter of stock, in some cases family pets, and
- seeing parents and relatives in distress (Countryside Agency, 2001a).

In some cases children from farms were moved from their homes for certain periods to allow them to continue to go to school. While this caused short-term distress, it may have been judged by parents to be less severe than remaining on the farm and observing the slaughter and disposal of animals. Where farming families kept children at home, this lead to feelings of isolation (Countryside Agency, 2001a). As argued in the Royal Society of Edinburgh report (2002), the central argument in both cases is that "Children and families directly affected could not conduct normal lives, or engage in social exchange…this will have a long-term impact on those affected".

Deaville and Jones (2001) undertook a telephone survey of organisations supporting individuals. They established that while farmers' wives and their children used health services to discuss issues arising from the FMD outbreak, that farmers generally did not. However, one farming organisation found that 7 out of 10 farmers' wives had severe anxiety about their husband's state of mind during the outbreak. The authors concluded that the family was seeking support from health services to take back to the farm.

Several other studies also considered the support mechanisms used by farmers during the outbreak. This information was used as a means both of gauging the magnitude of social impacts of the outbreak and of assessing the implications for the development of effective support mechanisms in the future. Peck *et al* (2002) found that farmers predominantly turn to their own local farming community for help and, beyond this, prefer anonymous forms of support, such as advice via the internet and self help booklets, rather than visits from health or social workers. Calls to certain networks, most notably the Rural Stress Information

Network (RSIN), the Royal Scottish Agricultural Benevolent Institution increased dramatically (Countryside Agency, 2001a; Church of Scotland Committee on Church and Nation, 2002).

Importantly, Peck *et al* (2002) and Deaville and Jones (2001) identify veterinary surgeons as a crucial source of support. This was attributed to two factors:

- the long established relationships vets often have with members of the farming community
- shared feelings about the loss of livestock (Deaville and Jones, 2001).

It is generally accepted that the outbreak was dealt with more effectively in Scotland than in areas of England and Wales. Certainly, some of the situations cited as causing distress south of the border (such as carcasses waiting on the farm for some time while disposal sites were negotiated) were largely avoided in Scotland. This will have helped to minimise the distress caused to farm families directly effected by the cull.

Other owners of rural businesses and rural inhabitants

Although it is widely recognised that the direct effects of FMD outbreak extended beyond the farm sector, very little has been written about the social impact of the outbreak on rural non-farming inhabitants.

The Countryside Agency report (Countryside Agency, 2001a) and Rural Health Institute report (Deaville and Jones, 2001) both suggest that in the case of business owners, the effects were largely stress-related impacts associated with the financial problems and uncertainly caused by the outbreak. The Countryside Agency report goes as far as saying that the trauma caused by Foot and Mouth may be less severe in some cases than for farmers because such owners identity might be less tied up with the business than is the case for farmers.

Certainly the media coverage of the crisis focussed on farmers, rather than other rural entrepreneurs. The Church of Scotland report argues that this is partly because the burning of sheep and cattle is a more emotive image than, for example, empty hotels and pubs (Church of Scotland, Committee on Church and Nation, 2002). However, it should be noted that in addition to short-run and long-run financial worries, owners of non-farm businesses and other local inhabitants in affected areas will have felt a similar lack of control over their livelihoods. And, of course, unlike those farmers directly impacted by the FMD outbreak, no financial compensation was available.

Frontline workers

The other group of individuals recognised as being adversely affected by the outbreak were those working to implement the control policies. Those directly involved in the cull, were not all used to slaughtering animals and dealing with distraught people (Countryside Agency, 2001a). Moreover, they will have had to handle this whilst working extremely long hours in difficult working conditions. It was these people who were most at risk from developing FMD-related health problems, as discussed further below.

Secondly, both SEERAD's and the Scottish Environment Protection Agency's (SEPA) own reviews into the handling of the Foot and Mouth outbreak in Scotland drew attention to the stress caused to SEERAD, State Veterinary Services (SVS) and SEPA staff. This originated in the long hours worked and/or in the nature of the work. As a response SEERAD, suggest a need for a corporate stress strategy so that, in similar circumstances in the future, mangers will be better placed to deal with both their own personal stress and that of their staff (Scottish Executive, 2003). Within SEPA, a planner has been appointed to oversee potential future emergency situations[10].

5.1.2 Community life

One of the main effects of the FMD outbreak for rural communities was the cancellation of social and community group meetings and activities. Initially, such activities were cancelled throughout rural Scotland. However, they were restarted quite quickly in uninfected areas as the course of the epidemic became clearer. However members from farming families often stayed away from such events, even when they re-started (Countryside Agency, 2001a). In

[10] Personal communication, Rob Morris

areas directly infected by the outbreak (Dumfries and Galloway and the Borders), the scale and duration of impact on community life was greater.

The curtailment of social and community activities would have been felt most severely by those considered vulnerable in rural area, that is, the elderly, women with young children and youths (Shucksmith *et al*., 1996). Initially there was concern that the outbreak would have a long-term effect on the viability of community groups and resources. However, subsequent reports have suggested that the outbreak actually helped to validate the important role played by social and community groups in rural areas (National Council for Voluntary Organisations, 2002). In England and Wales, there is even evidence of new community groups forming in response to the crisis. An example is the Forest of Dean Foot and Mouth Action group. Such groups might form a lasting basis for rural regeneration (Countryside Agency, 2001a).

The SEERAD-funded case study analyses of the impact of foot and mouth showed that the effect of the outbreak at the community level was highly diverse across space. For example, both Castle Douglas and Kelso communities were directly affected by the outbreak. However, while in Kelso the community remained close knit and very supportive of local farmers, in Castle Douglas the outbreak created tensions both within the farming community and between farmers and other businesses affected. Similarly, the social impacts in the two Highland areas were very different. In the Black Isle, a general feeling of sympathy about the plight of the agricultural community was sustained. On the other hand, in Skye, at the height of the outbreak, there were reports of conflicts between the tourism and crofting interests. This was attributed to tourism businesses being run by "incomers" who did not understand the importance of crofting to the local community. Such differences confirm that generalisation about the social impacts of Foot and Mouth are difficult to sustain.

Finally, an important social impact referred to in some, but not all, of the studies is that of increased tensions within the farming community. In some cases these were related to financial aspects and in particular differing livestock valuations and the details of compensation rules. In other cases, tensions arose from perceptions of how the disease was being spread and accusations of bad husbandry practices. However, it should be noted that the literature suggests such tensions were insignificant compared to the way in which the farming community pulled together in difficult times.

At society level, the outbreak served to bring to the fore the issue of the role of agriculture and rural areas in contemporary life. In Scotland, the perception of farming and rurality is very different and, arguably, less contentious than it is in England and Wales (Slee *et al*., 2001). Even so, it is likely that the main long-lasting social impact of the Foot and Mouth crisis will arise from the new public awareness of the complexities and interconnectedness of rural economies (Donaldson *et al*., 2002).

5.2 Environmental Implications

As with the social impacts, most of the published reports on the 2001 Foot and Mouth outbreak have commented on its environmental impacts. Not surprisingly, scientific evidence is far more abundant concerning the environmental, as against social, impacts of the outbreak. For example, the Environmental Agency published a 51-page report considering the environmental effects of the Foot and Mouth outbreak in England and Wales up to December 2001 (Environmental Agency, 2001).

The literature relating to Scotland suggests the following general findings:

- General awareness of the potential environmental effects arising from the outbreak and control strategies was high and, as a consequence, all potential effects were/are monitored closely.
- The confinement of the outbreak to only two local authority areas in Scotland - Dumfries and Galloway, and the Borders – meant that the environmental effects were far less severe than they would have been if the disease had spread more widely.
- All evidence to date suggests that environmental effects have been negligible although some longer run impacts cannot be ruled out.
- The shorter lines of communication that existed between relevant organisations in Scotland, and the willingness of those involved to work closely together, greatly increased the rate at which the disease was brought under control.

Most of the environmental issues discussed in the literature concern:

- The disposal of carcasses.
- The effects on biodiversity and landscape associated with both removal of animals from landscape and changes in farmer behaviour as a results of the outbreak.

Both are discussed briefly below.

5.2.1 Disposal of carcasses

The Government's policy throughout the crisis was to use the safest and most effective means of carcass disposal. However, there was an ongoing debate throughout the crisis about what constituted the safest means. Initial advice was that, after rendering, incineration was preferred because of the threat of burial to aquifers in Dumfries and Galloway. This was later amended to relegate incineration to the third preferred option because of both toxin threats and the growing public revulsion to the sight and smell of pyres (Royal Society Edinburgh, 2002).

Within Scotland, four types of disposal took place:

- incineration on infected farms.
- incineration at a remote site in a large scale pyre (of which there were three at Eastriggs, Hoddom Quarry, both in Dumfries and Galloway, and Crook Knowes, near Jedburgh).
- burials on farm. A total of 9 on-farm burial sites were used in total during the outbreak. This compares with over 900 such sites in England and Wales.
- burying in a large scale burial site (of which there was only one in Scotland, at Birkshaw forest).

Incineration

The key environmental issue arising from the burning of carcasses was the potential impact on air quality. Air quality monitoring was carried out on a small pyre, co-ordinated by the Dumfries and Galloway Council, so as to respond to concerns on both contaminants and odours. The main conclusions were as follows (Glasgow Scientific Services, 2001):

- Various sulphur and oxygen-containing compounds were detected that would contribute to the odour. However, while recognised as affecting quality of life, odour annoyance was not regarded as an adverse health effect.
- Apart from the odour concentration, the concentrations of other potential contaminants was well within air quality guidelines and no toxic effect would be expected from them.

Although it was intended that such air sampling would be replicated to cover the three larger pyres, success in controlling the spread of disease was such that the pyres were extinguished before the programme could be extended. Similar low health risks from pyres were found in England and Wales. In all cases, the level of exposure of particularly inhaling toxins was obviously far higher for those tending the pyres.

Another public concern associated with carcass incineration was the potential exposure to dioxin emissions via the food chain (through deposition on grass, crops and soil downwind). As a precaution, the Food Standards Agency monitored dioxin concentration in soils, crops and milk from animals grazing near to pyres. The Agency originally conceded that there might be a slightly higher, although still very small, health risk for people who exclusively consume whole milk and whole-milk products only from animals within 2km of pyres (Food Standards Agency, 2001a). Subsequent analysis concluded, however, that there was no additional risk to health through the food chain and no need for anyone to change their diets (Food Standards Agency, 2001b).

Finally, the disposal of ash from pyres created a risk of leaching into water courses. As a result, such pyres were located as far as possible from water courses and ash from the sites transported and buried in a landfill site engineered to receive controlled waste (Scottish Environment Protection Agency (SEPA), 2001; Royal Society Edinburgh, 2002).

Burial

The main environmental risk associated the burial of carcasses was the impact on ground water. Ground water could be infected by the release of

- micro organisms such as E coli, campylobachter or cryptosporidium
- the abnormal prion protein thought to cause BSE/CJD
- chemicals, such as ammonia or phosphates, released through the decomposition of carcasses (Scottish Centre for Infection and Environmental Health website).

Within Scotland SEPA had the role of ensuring that the quality of Scotland's watercourses was protected. In conjunction with the British Geological Survey, SEPA undertook risk assessments so as to advise SEERAD and the Scottish Veterinary Service on the suitability of burial sites and, in particular, the location of the mass burial site at Birkshaw forest.

Government instructions were that confirmed cases of FMD had to be reported to slaughter within 24 hours, adjoining properties, within 48 hours. SEPA therefore had to respond with advice on carcass disposal within extremely short time scales. Fortunately, due to the poor market conditions for cast ewes in the preceding 2 to 3 years, the Agency had recently developed policy and guidance for staff on animal burial. This greatly assisted field staff in undertaking burial site assessments. Not surprisingly, however, there were occasions when apparent conflicts between agencies emerged. For example, the December report on Foot and Mouth by SEPA (SEPA, 2001) notes four cases where the agency threatened to serve a notice under the Groundwater regulation to prevent burials at specific sites. As a result, the recent Royal Society of Edinburgh inquiry recommends that in future SEPA's role in protecting the environment be incorporated more formally into contingency planning and the management of the crisis at the highest level (Royal Society of Edinburgh, 2002). This, again, has been reflected in the Scottish Executive's recently published Foot and Mouth Contingency Plan (Scottish Executive, 2003).

Following the initial risk assessment, an ongoing programme of groundwater monitoring has been initiated at the mass burial site in Scotland. This is co-ordinated by SEERAD, with reports from the monitoring programme publicly available. All evidence to date suggests that the site is well contained and that no leaching is occurring.

In relation to the impact on drinking water, the Public Health Laboratory Service published guidance on the possibility of human gastro-intestinal infection from polluted ground water.

Private water supplies, which are largely untreated, were the most vulnerable. As a result, a sampling programme for those private and public water supplies considered most at risk was initiated. Again results to date suggesting no need to expand such monitoring programmes.

5.2.2 Biodiversity and landscape

The Countryside Agency report (2001a) suggests several potential impacts of the outbreak on biodiversity and landscapes. These can be summarised as follows:

- negative impact on the livestock gene pool due to the loss of certain breeds
- overgrazing and heavy poaching of pastures, arising from the restrictions on animal movements during the outbreak.
- delay of capital works associated with agri-environmental schemes.
- improvement in the establishment of nesting sites for ground nesting birds arising from the closure of rural footpaths.

The report also highlights the fact that there might be longer-term impacts on biodiversity and landscapes associated with both agricultural restructuring and changes in agricultural policy following the outbreak.

6. LIMITATIONS OF THE MODELLING APPROACH

In this report we have attempted to identify and to quantify the Scottish-wide impacts of the FMD outbreak using a specially adapted variant of the Scottish Computable General Equilibrium (CGE) model, AMOS. Whilst there are clear strengths in this approach, there are limitations too, and these need to be identified and taken into account when interpreting the results.

6.1 All economic models simplify reality

The most general point is that economic models, of necessity, simplify reality. They focus on what are taken to be key causal relationships driving particular economic interaction whilst ignoring those variables which are thought to have a negligible effect. For example, it is often necessary to assume all agents within a particular category (firms in individual sectors, households in individual regions) are identical. Whilst we know that this is not strictly true, the additional information is either not available or would generate model results that are too complex to handle effectively. In short, there is no benefit from a 1-to-1 map. Of course, the simplifying assumptions should be made with care. But in practice there is always a trade-off between greater detail (which is often interpreted as representing greater "reality") and model tractability and data availability.

6.2 Model parameterisation

The CGE model requires many individual relationships to be specified in a precise manner. This often means both identifying exactly how individual markets are assumed to operate and fixing the value of key parameter values, such as the various demand elasticities. The model also has a fully identified supply side so that individual production relationships have to be chosen.

Where possible we have used Scottish-specific data to parameterise this model. We have also taken great care in attempting to separately identify sectors of the economy that were thought to be particularly affected by the FMD outbreak. However, a full econometric parameterisation of the model is simply not possible. Moreover, data restrictions mean that it is often necessary to take parameter values that have been determined using UK regional data, or from similar studies in other countries. In some cases, values are simply best-guess estimates. In this particular study, key assumptions that underpin the model affect the product market, labour market and the investment decisions.

6.2.1 The product market

In the variant of the model used in these simulations, all commodity markets are taken to be perfectly competitive. This simply means that no individual firm (or consumer) can influence the market price and that all firms are taken to be attempting to maximise profits in each time period. This assumption is restrictive but not as restrictive as it might at first appear. For example, we do not ignore the presence of government subsidies or taxes on production or other effects of government intervention into markets. In fact many of the simulations we perform are attempting to replicate these interventions. Also we do not assume that there is a world market for any of the commodities identified in the model. Products from different countries are not taken to be perfect substitutes for one another.

6.2.2: The labour market

This is perhaps the most difficult market to successfully model. In the variant of AMOS used in this report we impose:

- A unified Scottish labour market. That is to say, the wage rate in all sectors modes in line with one another, and there is no skill disaggregation.
- The Scottish real wage is determined by bargaining, where the wage level is negatively related to the Scottish unemployment rate.
- On the supply side, changes in aggregate employment are made up:
    - changes in the unemployment rate.
    - changes in the participation rate.
    - migration into and out of Scotland in response to tightness of the labour market.
- There is perfect mobility of labour between industrial sectors in response to variation in labour demand.

These assumptions mean that where labour demand rises in one industrial sector, there is some crowding out of employment in other sectors. Essentially the real wage rises, leading to employment falling in some sectors not strongly directly or indirectly affected by the demand increase. This means that, in the short-run anyway, the net increase in aggregate employment is typically much lower than the employment increase in the sectors directly affected. This is a result that contrasts with the typical Input-Output or Keynesian multiplier approach (McGregor *et al*, 1996).

However, the reverse occurs where the initial shock to the economy is a reduction in labour demand (which is typically the situation that we encounter in these simulations). The fall in employment leads to a weakening of the labour market, a fall in the real wage and a marginal improvement in the competitiveness of sectors not directly or indirectly strongly affected by the initial reduction in demand. In this case the net employment fall will, at least initially, have a much smaller absolute size than the direct reduction.

The shift of activity into other sectors as a result of labour market “crowding out” or “crowding in” can have implications for the effect of GDP. If labour is taken to move from lower to higher added value sectors as a result of the initial reduction in demand, GDP can potentially rise, even though employment falls.

6.2.3 Investment

The demand for a change in capacity in an individual sector is determined in the AMOS model as an adjustment to a perceived mismatch between the desired and actual capital stock. Changes in output and labour costs are the prime determinants of capital stock adjustment.

6.3 Short-run adjustment

The AMOS model assumes that the economy is initially in equilibrium and any exogenous change, say the export ban, sets in motion adjustments to the endogenous variables, such as the output and employment levels in individual industries. One might want to challenge the general assumptions concerning the adjustments in the capital and labour market. It is econometrically very difficult, given the limited available data, to be sure of the detailed determinants of regional employment and investment. However, in this case the employment and capital stock adjustments might be limited for another reason.

The FMD outbreak might have been thought, from the outset, to have been a short run phenomena. If this is so, because of hiring and firing costs, workers might have been retained, rather than made redundant, by firms directly hit by the FMD outbreak. Hiring and firing costs would include factors such as skill retention, worker goodwill, search costs etc. The existence of such costs would limit the initial reduction in employment and the subsequent redeployment of released workers in other sectors. Similarly, the potentially complex set of capital stock adjustments set in train as a result of FMD in Scotland might not have occurred if firms perceived the problem as being purely temporary.

There appears to be evidence that employment adjustment in the agricultural sector is limited and the change in the labour supplied in this sector is made through changes in the hours worked (or intensity of work). It is also a low wage sector, so that wage rate reductions within the sector itself might be limited by minimum wage legislation. (The average wage in the disaggregated agricultural sectors is given in Table D.3 in Annex D[11]). If this is so, then some of the wage effects identified in the model are likely to be overstated.

6.4 The Scottish specific focus

In this report, we identify the impact of FMD in one region of the UK, Scotland. However, the disease also affected agriculture and tourism simultaneously in the Rest of the UK (RUK). There are clearly strong trading links between the two economies. Ideally the impacts on the Scottish and RUK economies should be modelled simultaneously. Although we have attempted to minimise the distortions in the results that arise from analysing Scotland in isolation, some inaccuracy is unavoidable.

6.5 Regional disaggregation

The AMOS model gives results for the Scottish economy, disaggregated to individual sectors. A fully consistent regional disaggregation within Scotland, would require

[11] Table D.3 in Annex D also gives value added per employee for the disaggregated agricultural sectors.

information on commodity, migration and commuting flows between regions within Scotland and a modelling of the labour market at a much lower level of spatial aggregation than that of the Scottish economy as a whole. These data and analysis do not exist at present.

The procedure that has been adopted to identify the regional impact of the FMD outbreak essentially distributes the Scottish impacts across regions on the basis of the initial spatial impact of the direct effects and the local or national/international orientation of individual sectors. As such, this top-down method is very much a second-best procedure and a bottom up modelling approach would be very much preferred.

The procedure we have adopted distinguishes between local and national/internationally traded sectors. We assume that local industries are affected solely by local activity, either through consumption or intermediate demand. The activity in national/international sectors, on the other hand, is determined by national forces. An alternative would have been to adopt a gravity approach. In that case, the activity of all sectors in one region would be affected by the activity in all other regions. Those sectors that we have identified as local sectors would be less influenced by purely local affects. However, those sectors which we have identified as national/international sectors would be more influenced by purely local effects.

6.6 The modelling of the direct shocks

All practical applications of a CGE approach to modelling policy intervention involves some ingenuity in attempting to use the exogenous variables available to match the action of policy instruments. In this case, for example, modelling the impact of the cull of trading animals and the subsequent compensation payments is tricky. Whilst the cull keeps the animals off the market, it does not stop their production. We have therefore modelled the impact of the cull as a supply restriction, but the compensation for trading animals as a demand shock. The compensation therefore covers the cost of production of the output that did not reach the market. Clearly, whilst this does not perfectly capture the effects of this policy combination, it attempts to get at the key forces at play.

Also where the system-wide impacts of changes in exogenous variables are being modelled, the overall results are only as good as the estimates for the exogenous changes. In this report, we have had to make a number of assumptions about the impact of FMD on exogenous demand, such as the change in tourist activity and the direct impact of the export ban that occurred as a result of the FMD outbreak and subsequent restrictions. The sensitivity of the results to changes in these assumptions has been given in Section 4 of the report. However, similar sensitivity of outcomes would follow changes in assumptions concerning other direct impacts associated with FMD.

Finally, for certain shocks, the desired regional and sectoral distributions of the initial impacts are simply not available. In these cases, we have to make the best estimates possible. For example, we take the regional distribution of RUK Tourism, Scottish Tourism in Scotland, and Daytrips to have the same initial geographical dispersion. In the absence of better information, this is the best that can be achieved but clearly some imprecision attaches to the results.

7. REFERENCES

Armington, P. (1969), "A Theory of Demand for Products Distinguished by Place of Production", *IMF Staff Papers*, vol.16, pp. 157-178.

Blake, A., Sinclair, M.T (2003), "Quantifying the Impact of Foot and Mouth Disease on Tourism and the UK Economy", forthcoming in *Tourism Economics*

Blake, A., Sinclair, M.T. and Sugiyarto, G. (2002), "The Economy-Wide Effects of Foot and Mouth Disease in the UK Economy", Cristel DeHaan Tourism and Travel Institute, Nottingham Business School, http://www.nottingham.ac.uk/ttri/

Blanchflower, D., and Oswald, A. (1994), *The Wage Curve*, MIT Press: Cambridge, MA.

Chapman, P., Phimister, E., Shucksmith, M., Upward, R. and Vera–Toscano, E. (1996), "The Dynamics of Low Income and Social Exclusion in Britain", Working Paper 98/02, The Arkleton Centre, University of Aberdeen

Church of Scotland, Committee on Church and Nation (2002), "Report to The General Assembly, 2002: Foot and Mouth Disease", Edinburgh

Countryside Agency (1998), *United Kingdom Day Visit Survey*, HMSO, London

Countryside Agency (2001a), "Foot and Mouth Impact Study", Report by DTZ PIEDA Consulting.

Countryside Agency (2001b), "Foot and Mouth Disease: the State of the Countryside" http://www.countryside.gov.uk/stateofthecountryside/

Crabtree, J.R., Thorburn, A., Chalmers, N., Roberts, D., Wynn, G.M., Jo-Barron, N., Macmillan, D. and Barroclough, F. (1999), "Socio-economic and Agricultural Impacts of the Environmentally Sensitive Areas (ESA) Scheme in Scotland", Report for the Scottish Executive Rural Affairs Department.

Deaville, J. and Jones, L. (2001), "The Health Impact of the Foot and Mouth Situation on People in Wales: The Service Providers Perspective", A Summary Report to the National Assembly for Wales by the Institute of Rural Health.

Department of Environment Food and Rural Affairs (2001), "Animal Movement Standstill: Economic Assessment of the Impact Upon the Livestock Industry in England", http://www.defra.gov.uk/animalh/diseases/movements/info/econanaly.pdf

Department of Environment Food and Rural Affairs and Department of Culture Media and Sport (2002), "Economic Cost of Foot and Mouth Disease in the UK: A Joint Working Paper",
http://www.defra.gov.uk/corporate/inquiries/lessons/fmdeconcost.pdf

Donaldson, A., Lowe, P. and Ward, N. (2002), "Virus-Crisis-Institutional Change: The Foot and Mouth Actor Network and the Governance of Rural Affairs in the UK", *Sociologia Ruralis*, vol 42, pp. 201-214.

Doyle, C., Mitchell, M., and Topp, K. (1997), "Effectiveness of Farm Policies on Social and Economic Development in Rural Areas", *European Review of Agricultural Economics*, vol. 24, pp. 530 – 546.

DTZ Pieda (2002a), "Report for the Executive on the Impact of FMD (Economic Impact of FMD): Sector Studies", Report for the Scottish Executive Environment and Rural Affairs Department.

DTZ Pieda (2002b), "Report for the Executive on the Impact of FMD (Economic Impact of FMD): Case Studies", Report for the Scottish Executive Environment and Rural Affairs Department.

Environmental Agency (2001), *The Environmental Impact of the Foot and Mouth Disease Outbreak: An Interim Assessment*, The Stationary Office, London

Essex, S. J. and Treloar, D. (1998), "Local Purchasing in Tourism: the Newquay Experience", in M. Blacksell, J. A. Matthews and P. C. Sims (eds), *Environmental Management and Change in Plymouth and the South West*, University of Plymouth, Plymouth.

Food Standards Agency (2001a), "New Advice on Milk from Animals Grazing Near to Pyres: Friday, 25 May 2001", http://www.food.gov.uk/scotland/pressreleases/pyreanimalmilk.

Food Standards Agency (2001b), "Dioxins and Dioxin-like Polychlorinated Biphenyls in Foods from Farms Close to Pyres. Third Report", 20 September 2001.

George Street Research (2001), "Business Tracking Survey: Scotland", Report to the Impact Assessment Group.

Gibson, H. (1990), "Export Competitiveness and UK Sales of Scottish Manufactures", Paper delivered to the Scottish Economists Conference, The Burn.

Gillespie, G., McGregor, P. G., Swales, J.K. and Yin Y.P. (2001a), "A Regional Computable General Equilibrium Analysis of the Demand and 'Efficiency-Spillover' Effects of Foreign Direct Investment" in N. Pain (ed), *Inward Investment, Technological Change and Growth*, Palgrave, Basingstoke, London.

Gillespie, G., McGregor, P. G., Swales, J.K. and Yin Y.P. (2001b) "The Displacement and Multiplier Effects of Regional Selective Assistance: A Computable General Equilibrium Analysis", *Regional Studies*, vol. 35, pp. 125-139.

Gillespie, G., McGregor, P. G., Swales, J.K. and Yin Y.P. (2002) “A Computable General Equilibrium Approach to the Ex Post Evaluation of Regional Development Agency Policies”, in B. Johansson, C. Karlsson and R. Slough ed. *Regional Policies and Comparative Advantage*, Edward Elgar Publishing Ltd.

Glasgow Scientific Services (2001), “Analyses of Ambient Air from Birkshaw Forest Landfill Site and its Environs”, Report for Dumfries and Galloway Council.

Greenaway, D., Leyborne, S.J., Reed, G.V. and Whalley J. (1993), *Applied General Equilibrium Modelling: Applications, Limitations and Future Developments*, HMSO, London.

Greenwood, M.J., Hunt, G., Richman, D., and Treyz, G. (1991), "Migration, Regional Equilibrium, and the Estimation of Compensating Differentials", *American Economic Review*, vol. 81, pp.1382-90.

Harrigan, F., McGregor, P., Perman, R., Swales, K. and Yin, Y.P. (1991), “AMOS: A Macro-Micro Model of Scotland”, *Economic Modelling*, vol. 8, pp.424-479.

Harrigan, F., McGregor, P.G. and Swales, J.K. (1996) "The System-Wide Impact on the Recipient Region of a Regional Labour Subsidy", *Oxford Economic Papers*, vol. 48, pp. 105-133, reprinted in H. Armstrong and J. Taylor eds., *The Economics of Regional Policy*, Edward Elgar Publishing Ltd., Cheltenham, 2000.

Harris, J. R. and Todaro, M. P. (1970), "Migration, Unemployment, and Development: A Two-Sector Analysis", *American Economic Review*, vol. 60, pp. 126-142.

Harrison, L. (1993), “The Impact of the Agriculture Industry on the Rural Economy – Tracking the Spatial Distribution of Farm Inputs and Outputs”, *Journal of Rural Studies*, vol. 9, pp. 81-88.

Hawton, K., Simkin, S., Aslog, M., Fagg, J. and Harris, L. (1998), *Suicide and Stress in Farmers*, The Stationary Office, London.

Hill, G., Countney, P., Roberts, D. and Shannon, P. (2002), "Local Economic Linkages and the Natural Heritage", Report for Scottish National Heritage.

HM Treasury (2001), *Executive Summary of FMD in Scotland, UK Treasury Pre–Budget Report on the Impact of FMD, 2001*, London, The Stationary Office.

House of Commons (2002), *Foot and Mouth Disease 2001: Lessons to be Learned Inquiry Report*, London, The Stationary Office.

International Passenger Survey (2001), 'Overseas Visits to the UK 1997 to 2001', *Travel Trends: 2001*, Office of National Statistics, http://www.nationalstatistics.gov.uk/downloads/theme_transport/TTrends02.pdf

Jones, C. and Roberts, A. (1992), "The Regional Tourism Satellite Accounts and Input Output: Methodological Issues", Cardiff Business School.

Labour Force Survey (2001), Employment from Scottish Tourism, 2000, Office of National Statistics

Layard, R., Nickell, S., and Jackman, R. (1991), *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press, Oxford.

McDonald, S. and Roberts, D. (2002) "A Computable General Equilibrium Model for Scotland: Technical Documentation", Report for the Royal Society of Edinburgh

McDonald, S., Roberts, D. and Kay, A. (2003), "The Economy–Wide Impacts of the Foot and Mouth Disease Outbreaks in Scotland", Report for Scottish Economic Policy Network.

McGregor, P.G., Swales, J.K. and Yin, Y.P. (1996) "A Long-Run Interpretation of Regional Input-Output Analysis", *Journal of Regional Science*, vol. 36, pp. 479-501.

Minford, P., Stoney, P., Riley, J., and Wedd, B. (1994), "An Econometric Model of Merseyside: Validation and Policy Simulations", *Regional Studies*, vol. 28, pp. 563-575.

MORI Leisure Survey Data (2002),
http://www.mori.com/pubinfo/pdf/leisure_brochure.pdf
http://www.mori.com/about/morinews.shtml

Morrison. A. (1998), "The Tourist Accommodation Sector in Scotland", in R. Mclellan and R. Smith, eds., *The Scottish Tourism Industry*, International Business Press, London

National Council for Voluntary Organisations (2002), "Foot and Mouth Disease 2001: The Impact on the Voluntary Sector", http://www.ncvo-vol.org.uk/

Office for National Statistics (2000a), "Scottish Household Survey: Survey of Travel, Tourism and Work, 2000", London.

Office for National Statistics (2000b), "Family Expenditure Survey", London

Parmenter, B. and Welsh, A. (2000), "Historical Simulations with the MONASH Regional Equation System", Working Paper No. OP-95, Centre of Policy Studies and the IMPACT project, Monash University.

Partridge, M.D. and Rickman, D.S. (1998), 'Regional Computable General Equilibrium Modelling: A Survey and Critical Appraisal', *International Regional Science Review*, vol.21, pp.205-248.

Peck, D.F., Grant, S., McArthur, W. and Godden, D. (2002), "Psychological Impact of Foot-and-Mouth Disease on Farmers", *Journal of Mental Health*, vol. 11, pp.523-531.

Policy Commission on the Future of Farming and Food (2002), *Farming and Food: A Sustainable Future*, Report of the Policy Commission on the Future of Framing and Food.

Regional Trends Database (2002), Office of National Statistics, http://www.statistics.gov.uk/statbase/Product.asp?vlnk=836&More=N

Richardson, W.H. (1978), *Regional and Urban Economics*, Harmondsworth, Penguin.

Royal Society (2002), *Infectious Diseases in Livestock: Scientific Questions Relating to the Transmission,Prevention and Control of Epidemic Outbreaks of Infectious Disease in Livestock in Great Britain*, London.

Royal Society of Edinburgh (2002), *Inquiry into Foot and Mouth Disease in Scotland*, Edinburgh.

Rural Task Force (2001), *Tackling the Impact of Foot and Mouth Disease on the Rural Economy*, Report of the Rural Task Force, Department of Environment Food and Rural Affairs.

Scottish Centre for Infection and Environmental Health Website, *Environmental Monitoring and Impact: The Foot and Mouth Outbreak in Scotland*, http://www.fmd-enviroimpact.scieh.scot.nhs.uk/

Scottish Council for Development of Industry (SCDI) Database (2003), http://www.scdi.org.uk/policy.htm

Scottish Economic Statistics (2002), "Farm Accounts Survey Database", Scottish Executive Environment and Rural Affairs Department.

Scottish Environment Protection Agency (2001), "Foot and Mouth Weekly Briefing", http://www.sepa.org.uk/board/west/2001/papers/20042001_9.pdf

Scottish Executive (1999), "Agricultural Census", Scottish Executive Environment and Rural Affairs Department.
http://www.scotland.gov.uk/agri/documents/agcs-00.asp

Scottish Executive (2000), “Scottish Household Survey”, Social Research

Scottish Executive (2001), “Farm Incomes in Scotland 1999/00”, Scottish Executive Environment and Rural Affairs Department.

Scottish Executive (2002a), “Economic Report on Scottish Agriculture”, Scottish Executive Environment and Rural Affairs Department.

Scottish Executive (2002b), *Input-Output Tables and Multipliers for Scotland 1999, I x I Table (Industry by Industry)*, Office of the Chief Economic Adviser, Edinburgh

Scottish Executive (2003), *Scotland’s Foot and Mouth Disease Contingency Plan* http://www.scotland.gov.uk/agri/documents/CP26Feb.pdf

Scottish Executive Environment and Rural Affairs Department (2001), “Description of Emergency Measures Introduced during FMD”

Scottish Tourist Board (1999), “Employment in Tourism Related Industries in Scotland”, Edinburgh.

Scudamore, J.M., Trevelyan, G..M.., Tas, M.V., Varley, E.M., and Hickman, G.A.W. (2002), “Carcass Disposal: Lessons from Great Britain Following the Foot and Mouth Disease Outbreaks of 2001”, *Revue Scientifique et Technique de L’Office International des Epizooties*, vol 21, pp. 775-787.

Shucksmith, M., Roberts, D., Scott, D., Chapman, P. and Conway, E. (1996), *Disadvantage in Rural Areas*, The Rural Development Commission, Rural Research Report Number 29, London

Slee, B., Roberts, D., Barnes, A., Thomson, K. and Wright, I. (2001), *The Role of Agriculture in Scotland’s Economy, Society and Environment: A Literature Review*, Report for the Scottish Executive and published by the Department of Agriculture and Forestry, University of Aberdeen.

Slee, B., Farr, H. and Snowden, P. (1997), 'The Economic Impact of Alternative Types of Rural Tourism', *Journal of Agricultural Economics*, vol. 48, pp. 179 –92.

Slee. B. (1998), 'Tourism and Rural Development in Scotland', in R. Mclellan, and R. Smith, eds., *The Scottish Tourism Industry*, International Business Press, London

StarUK Website http://www.staruk.co.uk/

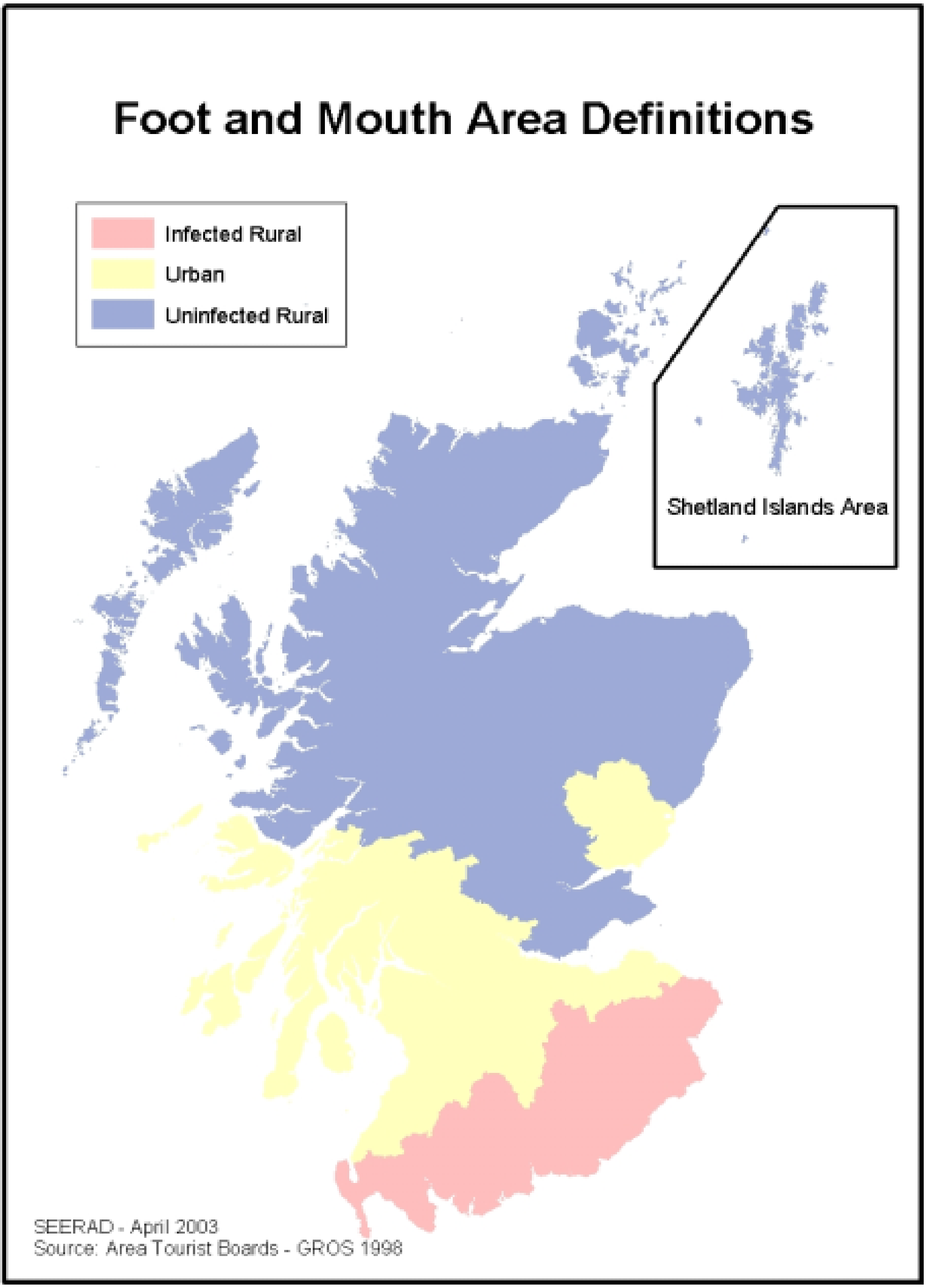
Surrey Research Group (1993), *Scottish Tourism: Multiplier Study*, Volumes 1-3, Report for the Scottish Office, HMSO

Treyz, G.I., Rickman, D.S., Hunt G., and Greenwood, M.J. (1993), "The Dynamics of US Internal Migration", *Review of Economics and Statistics,* vol. 75, pp.209 –214

VisitScotland (2001), "Tourism in Scotland 2000"

VisitScotland (2002), "Tourism in Scotland 2001", Visit Scotland. http://www.scotexchange.net/Downloads/TourisminScotland2001.pdf

ANNEX A: FOOT AND MOUTH AREA DEFINITIONS



ANNEX B: THE MODELLING FRAMEWORK

The modelling results given in this report are generated using a specially constructed variant of AMOS, a computable general equilibrium (CGE) modelling framework that is parameterised on 1999 data for Scotland.[12] A very brief description is presented in this section: a full listing of the AMOS model is provided in Harrigan *et al* (1991).

The current version of AMOS has 3 transactor groups: households; corporations; and government.[13] There are 25 commodities and activities and two exogenous external transactor groups, namely the rest of the UK (RUK) and the rest of the world (ROW). There are four major components of final demand: consumption; exports; government expenditure; and investment. Of these, consumption is a linear homogeneous function of real disposable income. Exports (and imports) are generally determined via an Armington link (Armington, 1969) and are therefore relative-price sensitive with trade substitution elasticities of 2.0 (Gibson, 1990). Real government expenditure in Scotland is taken to be exogenous. Investment is initially set equal to depreciation although, as explained later in this annex, in subsequent periods investment demand in each sector is generated through a capital stock adjustment process, where net investment is a proportion of the difference between actual and desired capital stock.

Production is determined through cost minimisation with multi-level production functions. These are generally of a CES form but with Leontief and Cobb-Douglas available as special cases. For simplicity, all domestic intermediate transactions are assumed to be of the Leontief form in this paper. Otherwise we assume CES technology (notably for the production of value-added from capital and labour services).

In CGE models, market processes are specifically modelled. A wide variety of forms of product or factor market are possible. In this report, commodity markets are taken to be competitive (though potentially subject to government intervention). By this we mean that product prices are determined by the interaction of supply and demand, although production

12 AMOS is an acronym for a macro-micro model of Scotland.

13 AMOS treats Scotland as a self-governing economy, in the sense that there is only one consolidated government sector. Central government activity is partitioned to Scotland and combined with local government activity.

and consumption can be taxed or subsidised, and existing taxes and subsidies are automatically incorporated in the cost structure of individual industries. We do not explicitly model financial flows, our assumption being that Scotland is a price-taker in competitive UK financial markets and, under the small open economy assumption, the Bank of England's Monetary Policy Committee's interest-rate-setting decisions are taken to be exogenous to Scotland.

In all of the simulations in this report we impose a single Scottish labour market characterised by perfect sectoral mobility. The Scottish wage is determined through a bargaining function in which the regional real consumption wage is directly related to workers' bargaining power, and therefore inversely to the regional unemployment rate (Minford *et al*, 1994). This hypothesis has received considerable support in the recent past from a number of authors. Here we take the bargaining function from the regional econometric work reported by Layard *et al* (1991):

$$w_{s,t} = a - 0.068u_{s,t} + 0.40w_{s,t-1} \qquad \text{(B.1)}$$

where w_s and u_s are the natural logarithms of the Scottish real consumption wage and the unemployment rate respectively, t is the time subscript and a is a calibrated parameter.[14] Empirical support for this "wage curve" specification is now widespread, even in a regional context (Blanchflower and Oswald, 1994).

A key implicit assumption made concerning the operation of the labour market is that a change in the demand for labour will be translated into a change in the number of workers employed, rather than an adjustment in the actual or effective average number of hours worked. Given that there are hiring and firing costs, it might be that model therefore overestimates the employment change generated by what are perceived to be temporary economic shocks. That is to say, firms might chose to maintain employment levels in the face of temporary downturn in activity in order to maintain worker goodwill, firm-specific skills, etc.. The model also assumes that labour is mobile between sectors so that where labour is

[14] The calibration is so that the model, together with the set of exogenous variables, will recreate the base year data set. This calibrated parameter plays no part in influencing simulation outputs but the assumption of initial equilibrium is crucial.

released from one sector, downward pressure is put on the wage rate and some of that labour is re-employed in other sectors.

We report the results for period by period simulations, where each period is interpreted as a year. In each period, all commodity markets are assumed to clear and the wage is determined by the bargaining function, with a fixed population. In any one period, the capital stock is fixed, not just in aggregate but to individual sectors. Between periods, we have population updating, via migration, and capital updating, through investment.

The population adjustment is driven by a relationship whereby Scottish net migration is positively related to the real wage differential and negatively to the unemployment rate differential with the rest of the UK (RUK). This variant of the Harris and Todaro (1970) model is commonly employed in studies of US migration (e.g. Greenwood *et al*, 1991; Treyz *et al*, 1993). It is parameterised here from the econometrically estimated model reported in Layard *et al* (1991):

$$m = b - 0.08(u_s - u_r) + 0.06(w_s - w_r) \qquad \text{(B.2)}$$

where m is the net in-migration rate (as a proportion of the indigenous population); w_r and u_r are the natural logarithms of the RUK real consumption wage and unemployment rate and b is a calibrated parameter.[15]

In some of the agriculture simulations, the particular disturbances are modelled as efficiency changes. In AMOS these operate in the production of value-added. Three options are available: Hicks-, Harrod- or Solow-neutral technical change. Hicks-neutral technical change affects the efficiency of both capital and labour equally. Harrod-neutral technical change only changes the efficiency of the labour input. Solow-neutral technical change only changes the efficiency of the capital input.

The parameter values used in the model are either based on econometric work or are our standard "best guess" estimates. The key differences in the parameters used in these

[15] Again, the calibrated parameter is to ensure population equilibrium (zero net migration) in the base year.

simulations come from the database, and these are explained in more detail in the next chapter.

One important point concerning the model is that it is not a forecasting model, but rather a model for scenario experiments. The model assumes that the region is in equilibrium in the base period. It then identifies comparative static impacts of changes in exogenous variables or parameters. This means that with unchanged parameters and exogenous variables, the model replicates the base values continuously. The model is also an economic, rather than financial model. It is tracking the real impacts on economic activity.

When the model reacts to a change in demand, it is most appropriate to think about it as an Input-Output (I-O) model except with supply constraints, competitiveness effects and production and consumption flexibility. The model has the same multi-sectoral focus as I-O but attempts to more realistically replicate market mechanisms. Therefore unlike the I-O case where an increase in exogenous demand benefits activity in all sectors, here wage and price increases will reduce the competitiveness of the economy as a whole and adversely effect some sectors. Therefore, especially over relatively short time periods as discussed here, there would be crowding out in some sectors. For supply-side changes the inter-relationships are more complex and the analysis more involved.

ANNEX C. ADJUSTMENT TO THE DATABASE

The main adjustments to the AMOS model for the simulations in this report involve the database. Essentially this means adjustments to the Input-Output (I-O) table that provides the sectorally disaggregated cost and supply data that are used by the AMOS model. Key sectors for the analysis of the impact of the Foot and Mouth Disease (FMD) identified from the Scottish I-O table have been disaggregated. These are as follows:

- The “Agriculture” sector, which was directly affected by the outbreak of FMD and subsequently controlled by government regulation.
- The “Hotels and Catering” sector, with large sales to tourist demand, which was indirectly affected due to the reduced access to the countryside and the negative perception of the country for foreign tourists.
- Several final demand vectors, which are disaggregated to identify Scottish Tourism in Scotland and Daytrip expenditure.

C.1 Disaggregation of the “Agriculture” sector

In the Scottish I-O table, all farming activities are aggregated under one industry – “Agriculture”. This does not provide a suitable framework to evaluate impacts of exogenous shocks such as the FMD outbreak. McDonald and Roberts (2002) note that agriculture was affected directly by FMD but the disease did not have a blanket effect on all farm types, and that some farm types suffered more than others. This study follows McDonald’s and Roberts’ (2002) suggestion and keeps as much detail as possible regarding the structure of agriculture. Accordingly, the I-O sector “Agriculture” was disaggregated by farm type, separately identifying the different input and output patterns of each farm type.

This section discusses the data sources and methods used to disaggregate the 1999 Scottish I-O “Agriculture” sector into the seven farm types identified in the Farm Accounts Scheme (FAS) database.[16] The task of disaggregating “Agriculture” in the Scottish I-O table is accomplished by reconciling secondary databases from different sources. These are the FAS database, the agricultural census, the 1999 Scottish I-O tables, and McDonald and Roberts

(2002). Details of the data organisation and manipulation are outlined in seven separate stages.

Stage 1*: The FAS database is used to determine average output composition and input structure for farm types.*

Table B1 of the Economic Report on Scottish Agriculture (Scottish Executive, 2002a) provides a useful summary of estimated average output and input per farm for 1999 for the following seven farm types. These are the farm classifications by main type of activity. However, farms under each main activity may undertake a mixture of various activities.

- LFA: Specialist sheep
- LFA: Specialist beef
- LFA: Cattle and sheep
- Cereals
- General Cropping
- Dairy
- Mixed

Data obtained from this source are adjusted to establish consistency between input and output classifications. For instance, the FAS data (Scottish Executive, 2001) provides average expenditure per farm on 'seed' or 'feed' input but without a breakdown by crops or animals on the representative farm in the sample. Such aggregate input figures are allocated to each output category according to the share of each crop output or animal category in the corresponding total value of production.

Stage 2*: The FAS based estimates are reconciled with the agricultural census data*

The sample survey based FAS input and output data is grossed-up to get *ad-hoc* totals for the output composition and input structure for each farm type at the national level. This is done by multiplying the average input and output for the representative farm by the corresponding total number of farms in Scotland as given in Scottish Executive (2001), Table 1. While the

[16] The choice of farm types was constrained by those available in the FAS database.

grossed-up FAS data provides details of output and input by farm types, the figures obtained in this manner need to be consistent with official aggregate data given in Scottish Agricultural Statistics (agricultural census data). Table A1 of Economic Report on Scottish Agriculture (Scottish Executive, 2002a) provides summary agricultural census-based data for this purpose. Thus, the *ad-hoc* totals obtained by aggregating I-O data from FAS are adjusted and reconciled with the agricultural census data. The adjusted data are then categorised into farm input categories.

Stage 3*: The FAS and agricultural census based estimates are adjusted to the control figures in the I-O table.*

The FAS data adjusted to agricultural census needs to be further modified to be consistent with the control totals in the 1999 Scottish I-O table. In this table, the value of total agricultural output (and total cost of production) is given as £2,595.6 million. This control total is disaggregated to farm types using the shares of each farm type in total agricultural output (as identified at the end of stage 2). The adjusted control totals for each farm type are then allocated to different output and input categories according to ratios calculated from data organised up to stage 2. At the end of this stage, we obtain the following level of disaggregation for cost of production by farm types:

- Feed: purchased
- Feed: home produced
- Seed: purchased
- Seed: home produced
- Fertilisers
- Other intermediate inputs
- Labour
- Other value added

Stage 4*: Re-organise data to estimate inter-farm commodity flows.*

Although the data organised in the previous stages provide output and input details for each farm type, destinations of output sales and sources of input purchases are yet to be determined. McDonald and Roberts (2002) is the only source that provides estimates for commodity flows based on farm-types, and hence we have relied on this source to estimate flows of commodities between farms. In order to be able to use McDonald's and Roberts' data, we need to re-classify our farm data into similar commodity categories. Accordingly, farm commodity outputs are classified into the following 11 categories:

- Cereals
- Oilseed rape
- Potatoes
- Other crops:
- Cattle rearing and fattening
- Milk
- Sheep and wool
- Pigs
- Poultry and eggs
- Miscellaneous livestock
- Miscellaneous agricultural output

This gives a 7x11 matrix: seven farm types by eleven commodity outputs. Similarly, commodity inputs are re-classified into 11 categories. Hence, we obtain an 11x7 matrix (11 commodity inputs by 7 farm types).

Stage 5*: Estimate inter-farm commodity flows.*

This stage is devoted to estimating flows of intermediate commodity inputs between different farm types. First, from the 7 x 11 commodity output matrix, we calculate the share of each farm type in total production of each agricultural commodity. This gives a coefficient form of the make-matrix, based on the industry-based technical coefficient matrix. Second, we multiply the 7x11 technology-based coefficients by the 11x7 commodity-industry matrix. This gives a 7x7 matrix with flows of intermediate inputs between different farm types.

Stage 6*: Account for "home-produced" inputs.*

From the data organised up to stage 3, on-farm use of 'home produced' seed and feed is known. Thus, the diagonal elements in the 7x7 flow matrix (estimated in stage 5) are replaced by the sum of home produced seed and feed for each farm types because this information, obtained from sample surveys, is superior to any estimate. Input purchases between farms are adjusted to account for any discrepancy caused by these changes in the diagonal elements.

Stage 7*: Determine output sales to, and input purchases from, non-agricultural sectors for each farm type*

The difference between a row sum in the 7x7 inter-farm flow matrix (from stage 6) and total sales (value of output) of the corresponding farm type (determined at stage 3) gives sales of that farm type to non-agricultural sectors and final demand sectors. Similarly, the difference between a column sum in the 7x7 inter-farm flow matrix (from stage 6) and total input purchases (i.e., total cost of production) for the corresponding farm type (determined at stage 3) gives the purchase of inputs by that farm type from non-agricultural sectors and gross value added. The following paragraphs highlight the procedures employed in introducing the seven farm types in the 1999 Scottish I-O framework and the determination of actual flows between farms and the rest of the economy.

C.1.1 Value-added rows

Labour cost by farm type is already determined at stage 3 and this is directly incorporated into the Input-Output table. The other value-added component is given as an aggregate figure for each farm type (stage 3). This is allocated to different components using the proportions from the aggregate "Agriculture" sector in the I-O table.

C.1.2 Farm output exports

Since no other sources were available, the allocation of aggregate agricultural exports in the 1999 Input-Output table to different farm types is based on expert opinion.[17] This involves imposing the following key assumptions:

- No live exports of either sheep, beef or pigs from Scotland to the ROW, either before or after the FMD outbreak.
- Roughly half of Scottish lambs were exported live to the RUK but only 5% of beef animals were exported live to abattoirs in the RUK, with the rest being slaughtered in Scotland.
- The remaining exports of non-processed agricultural products to ROW and RUK is primarily made up of potatoes, cereals, poultry, eggs, etc.

Using these assumptions, exports of raw farm products to RUK and ROW are estimated as follows. "LFA specialist sheep" and "LFA specialist beef" sectors have no exports to ROW and their exports to RUK are 50% and 5% of their total outputs respectively. The "LFA cattle and sheep" sector is assumed to have an export pattern that is the average of the beef and sheep specialist farms. They therefore are taken to export 27.5% of their total output to RUK and nothing to ROW. Similarly, we have assumed that there is no Scottish raw dairy products exported to the ROW region. Exports by other sectors to the RUK and the ROW regions are estimated employing these assumptions and imposing the requirement that exports by all farm types sum to the control total given in the 1999 I-O table.

C.1.3 Imports by farm types from RUK and ROW

There is no information to guide us in allocating the total imports to agriculture by farm-type sector from these sources. We therefore have allocated the aggregate figure in the 1999 I-O table to farm-type sectors according to the share of that sector in the total costs of production of the "Agriculture" sector.

[17] Informal discussions with Stuart Ashworth.

C.1.4 Determination of other flows between domestic sectors and farm types

These include sales by farms to other Scottish institutions (non-farm industries and domestic final demand sectors) and purchases by farm types from non-farm industries. We have applied a constrained optimisation model to determine these flows, imposing the following constraints:

- The sum of intermediate input purchases by a farm-type sector from non-farm domestic industries equals total cost of production less the sum of purchases from other farm-type sectors, factor costs, and imports from RUK and ROW.
- The sum of intermediate input purchases by all farm types from a particular non-farm domestic industry equals the value of purchases by agriculture from that sector in the 1999 Scottish I-O table.
- The sum of output sales by a farm-type sector to non-farm domestic sectors equals total value of production less the sum of sales to farm-sectors and exports to RUK and ROW.
- The sum of output sales by all farm types to a particular non-farm domestic industry equals value of sales by agriculture to that sector in the 1999 Scottish I-O table.
- All flows are non-negative[18].

C.2 Disaggregation of the "Hotels and Catering" Sector

In the 1999 Scottish I-O table, the "Hotels and Catering" sector is a major component of tourist expenditure, accounting for almost 70% of the (non-day-trip) expenditure by tourism in Scotland (International Passenger Survey, 2001). In order to increase the precision of our analysis, we have disaggregated the "Hotels and Catering" sector by specific type of accommodation. This was thought to be particularly important because the nature of tourist expenditure within "Hotels and Catering" is likely to differ both across regions within Scotland and across different types of tourist.

[18] Changes in stocks are estimated separately applying the average rate for agriculture to all farm types.

Six categories were separately identified. These are:

- Large Hotels
- Other Hotels
- Bed and Breakfast Establishments and Guest Houses
- Self Catering
- Caravans and Camping
- Restaurants

The rationale behind this specific breakdown was an existing Input-Output tourism study undertaken for Wales which collected disaggregated information using these categories (Jones and Roberts, 2002). Again we explain the stage-by-stage process by which the "Hotels and Catering" sector is disaggregated.

Stage 1: Disaggregate employment totals.

In disaggregating the "Hotels and Catering" sector by accommodation type, the first step is to identify the total employment, measured as Full Time Equivalents (FTEs), of the separate accommodations sectors.[19] VisitScotland data does not disaggregate hotel employment and therefore does not separately identify the different size categories that we apply. We therefore augment the VisitScotland employment information with data from the Labour Force Survey (LFS). Using 'Hotels with Bars' (to represent 'Large Hotels'), 'Hotels without Bars' (to represent 'Other Hotels') and 'B&B and Guest House' figures, we were able to disaggregate the VisitScotland employment figures. 'Self Catering' was calculated as a percentage remainder and then applied through the VisitScotland accommodation data to arrive at an overall employment estimate.

[19] In undertaking the disaggregation of the Hotel and Catering sector we are constrained to use employment figures which exclude the self employed, though in the model simulations, data for the self employed are used and allocated to individual sectors.

Stage 2: Disaggregate output totals.

From the employment broken down by accommodation category we can estimate disaggregated gross output figures and the appropriate disaggregated output per FTE figures. This estimation uses data from VisitScotland (2001, Table 3), the existing Scottish 1999 Input-Output I x I matrix and the Welsh tourism study (Jones and Roberts, 2002). The following formula was used in this calculation.

$$\hat{Q}_i^S = \left[\frac{Q_i^W / L_i^W}{Q^W / L^W}\right]\left[\frac{Q^S}{L^S}\right]L_i^S \qquad \text{(C.1)}$$

where Q represents gross output, L employment (FTEs) and the superscripts *S* and *W* refer to Scottish and Welsh figures respectively. The *i* subscript indicates data from accommodation type i, and unsubscripted variables refer to the whole of the Hotels and Catering sector. The hat indicates an estimated figure.

Essentially, the procedure shown in equation (3) means that we start by calculating the relationship between gross output per employee in a particular accommodation-type sector relative to the average for the "Hotels and Catering" sector as a whole for Wales. This is given in Jones and Roberts (2002). We then use the same relative ratio to calculate the gross output per employee in each accommodation-type sector in Scotland. This is possible because we have the average figure for the aggregate "Hotels and Catering" sector in Scotland from the I-O table. We then use the accommodation-type sectorally-disaggregated employment figures estimated in stage 1 to derive the corresponding estimated gross output figures.

The estimated gross output results from equation (3) are not necessarily consistent with the total gross output for the aggregate "Hotels and Catering" sector in the 1999 I-O table. To maintain consistency, the disaggregated gross output figure, Q^S_i, is calculated as:

$$Q_i^S = \left[\frac{\hat{Q}_i^S}{\sum_i \hat{Q}_i^S}\right]Q^S \qquad \text{(C.2)}$$

Total "Hotels and Catering" gross output from the I-O table is distributed amongst the individual accommodation-type subsectors in proportion to their estimates given using equation (3).

Table C.1: Estimates of Employment, output and output per FTE in Scotland 1999 for Hotels and Catering broken down by accommodation type.

	Output (£m)	**Employment**	**Gross output per FTE**
Large hotels	579	22,234	26,022
Other hotels	214	8,801	24,269
B&Bs/Guest houses	150	8,060	18,639
Self catering	80	3,706	21,697
Caravan and camping	136	4,300	31,610
Restaurant and bars	2,066	79,000	26,148
TOTAL	**3,225**	**126,101**	**25,574**

Source: Data from VisitScotland (2001/2) and Labour Force Survey (2001)

Stage 3: Disaggregating the "Hotels and Catering" Sector Column

We make the key assumption that Scotland and Wales have similar input expenditure compositions within accommodation-type Hotel and Catering sectors. We therefore make use of Welsh technology information in the disaggregation of the Scottish I-O table. The overall pattern of expenditure is not dissimilar in terms of overall structure or output per FTE to the 1993 Surrey Research Group Input-Output study for Scottish Tourism (Surrey Research, 1993).

In order to construct the disaggregated table it is necessary to convert from the Scottish 128 sector to the Welsh 70 sector I-O format. Further, the Welsh data are for 1996 whilst the Scottish figures are for 1999. First, by comparing SIC codes the Scottish I-O table was converted to the Welsh 70 sector format for both intermediate and final demands. Secondly, the extensions to the Scottish I-O table from "Agriculture" given in Section C.1 were converted to the same format and added into the matrix. This gives a balanced table in the same format as the Welsh table but with additional disaggregation in "Agriculture".

In order to complete the (unbalanced) table we disaggregated the "Hotels and Catering" column using the Welsh technology proportions but constraining the figures to sum to the control totals already established in Stage 2. These had been calculated by proportioning each column entry by the overall sum of the column within the Welsh data for each of the disaggregated "Hotel and Catering" industries and then multiplying through by the control totals in Table C.1.

The additional rows for the accommodation-type disaggregated "Hotels and Catering" sectors were then created. These used the proportions from the Welsh data and then multiplied by the value for each row entry for the appropriate accommodation-type sector. This then gave us an unbalanced Scottish table in the Welsh 70 sector format, with additional disaggregations for "Agriculture" and "Hotels and Catering" and an additional row and column for fishing and forestry, making it an 82 sector table.

C.3 Disaggregating Final Demand

Expenditure on Daytrips and Scottish Tourism in Scotland is already included within the household expenditure column of the Scottish 1999 I-O table. For the purposes of this analysis we wanted to separately identify these Daytrip and Scottish Tourism in Scotland expenditures. We then wish to subdivide these expenditures further by the geographical location of the expenditure. The geographical areas are FMD-infected rural, FMD-uninfected rural and urban. These disaggregations involve adding additional final demand vectors and modifying the household expenditure column. This was undertaken in a number of stages.

Stage 1: Calculating the Scottish Tourism in Scotland expenditures.

This vector is calculated from data drawn from the Scottish Household Survey (Scottish Executive, 2001), Family Expenditure Survey (Office for National Statistics, 2000b), the StarUK website and the Labour Force Survey (2000) using 1999 data and is in a format directly comparable with the Scottish 1999 I-O matrix.

Stage 2: Calculating the Daytrips expenditures.

The control total for daytrips is calculated from the UK Day Visit Survey that shows that some £4,800 million, or around £1,000 per person per year, was spent on Daytrips within Scotland in 1998 (Countryside Agency, 1998). This expenditure was scaled using a price inflator, then allocated across commodities using the 1993 Scottish Tourism Multiplier Study. Within this study there are several surveys (Surrey Research Group, vol. 2, 1993, pp. 39 – 48) which ask specifically about day trip expenditure. These were put into a common format, based around that used in the largest and most complete survey. The proportionate expenditure on different commodities was then scaled up by the day trip final demand total.

When the Scottish Tourism in Scotland and Daytrip expenditures are removed from the household expenditure column, what is left is household expenditure on non-tourism related activities. This expenditure column is useful when we come to identify the impact of Displaced Consumption expenditure.

Stage 3: Division of the existing Input-Output tourism demand vector into demand from ROW and RUK.

In the Scottish 1999 I-O table the tourism column within final demand includes all RUK and ROW tourist expenditure in Scotland. That is all tourist expenditure in Scotland, outside of Daytrips and Scottish Tourism in Scotland. Control totals are important within this context. These are provided by VisitScotland (£2,260 million) for the RUK and the International Passenger Survey on StarUK website (£859.55 million) for ROW. The allocations of expenditures between commodities were then determined using additional sources of information (Surrey Research Group, 1993). The proportions between the two columns were then scaled to match the overall tourism column entries in the Scottish I-O table.

Stage 4: Disaggregating tourism expenditure by area

An initial urban/rural split was identified in order to optimally use the information from the 1993 Scottish tourism multiplier survey using data from the largest samples (Surrey Research Group, 1993, vol. 3, pp. 56 – 70). For each area these were 'expenditure for visitors at entertainment attractions in urban and rural centers' 'expenditure for visitors at industrial centers', and 'expenditure for visitors at industrial heritage attractions'. The rural areas were then disaggregated to infected and uninfected areas. Using Area Tourist Boards as the appropriate spatial building blocks, the specific area definitions are given as follows:

- The *urban* region is Angus and the City of Dundee, Argyll, the Isles, Loch Lomond, Stirling and the Trossachs, Ayrshire and Arran, Edinburgh and the Lothians, Greater Glasgow and Clyde Valley.
- The *infected rural* region comprises Dumfries and Galloway and the Scottish Borders.
- The *uninfected rural* is Aberdeen and Grampian, Highlands of Scotland, Kingdom of Fife, Perthshire, Shetland, Orkney and Western Isles.

This may seem rather a strange geographical division but it has two important features. First, the data are available within the 1993 Tourism Survey for this disaggregation. Second, the key division is the infected rural area and the other two areas. The infected rural area has been identified as the Borders and Dumfries and Galloway. The urban belt is actually formed from a collection of Area Tourist Boards that contain some rural, as well as urban, areas. However, the main criterion for the designation 'uninfected rural' is that such a region was not infected by FMD and that these areas lie to the north of the broad region of the central belt.

Following this, the overall data for each region type was split into expenditures and allocated to I-O rows within final demand. This allows us to create varying expenditure patterns within final demand for three identifiable areas of interest.

There are four forms of tourist demand: Scottish Tourism in Scotland; RUK and ROW Tourism; and Daytrips. There are three separately identified geographical areas: urban; infected rural; and uninfected rural. Therefore in the final disaggregated I-O table, there are 12 tourism-related final demand columns as well as a modified household demand column which has all Daytrips and Scottish Tourism in Scotland stripped out. These figures are given in Annex D.

Stage 5: Regionally-differentiated accommodation-type "Hotels and Catering" data construction:

The overall expenditures for each type of accommodation within each area were calculated from VisitScotland residency figures multiplied by a room stock figure. This allows an estimate that is more accurate than a simple residency rate or room stock alone. It was this value which was then combined with the data we had estimated for the split between urban, infected rural and uninfected rural data.

At this stage we had a full, albeit unbalanced, 82 sector I-O table. This was constructed using Scottish data, based on the Welsh I-O format and incorporates additional vectors for farm-types in "Agriculture" and accommodation-types in "Hotels and Catering" within intermediate demand. It also incorporates additional vectors for urban, infected rural and uninfected rural areas for Scottish Tourism in Scotland, RUK and ROW tourism and Daytrips.

C.4 Aggregating the I-O table

The AMOS CGE model operates on a 25-sector disaggregation. The particular sectoral disaggregation is determined by the purpose for which the model is being used and in this application this is shown in Table C.2. In this case, the 6 accommodation-type "Hotels and Catering" sectors are retained, as are the 7 farm-type "Agriculture" sectors. Those sectors regarded as being particularly important, such as "Recreational Services", "Chemicals" and "Wholesale and Retail", were also identified separately and the rest of the table was then collapsed or aggregated around these. Once again these columns were compressed so that the number of rows in final demand quadrant corresponds to that of the intermediate quadrant.

This table was then balanced using the RAS process, with the unbalanced rows constrained to the columns.

Following this the matrix was then set up to calculate both output and employment Type I and II Leontief multipliers. This was simply to check that the disaggregation is identifying differences in production structure within the previously aggregated "Agriculture" and "Hotels and Catering" sectors. This is revealed by differences in the multiplier values. We do not use these multipliers as predictions of the impact of expanding employment in individual sectors.

For the calculation of the employment multipliers we use sectoral employment figures which have been 'backed out' from the employment multiplier values in the 1999 Scottish I-O Table[20]. Type I and II employment and output multipliers for the disaggregated Agricultural and Hotels and Catering sectors are given in Tables C.3 and C.4. Note that there is a very wide range of multiplier values across the agricultural sectors whilst the range for the Hotels and Catering sectors is rather more compressed.

Having completed these stages the I-O table was then ready to be transformed into a SAM (Social Accounting Matrix) and the database read into the AMOS software. The resulting model was tested, using our standard set of test simulations. These are that:

- the model recreates base when the exogenous variables are set to their base year levels
- in the period-by-period model, values remain unchanged over time if the exogenous variables maintain their base year values
- the real variables are unaffected by simply nominal changes in all exogenous variables (a homogeneity test)
- the model replicates long-run I-O results in response to a demand disturbance.

The model passed all these tests.

[20] The employment figures used here do not include the self-employed, which are important in these sectors. However, the full CGE modelling results incorporate self-employment in the employment data.

Table C.2: The sectoral disaggregation used in the model

Model sector numbers	AMOS 25 sectors	IOC 1992 codes
1	LFA: Specialist sheep	1
2	LFA: Specialist beef	1
3	LFA: Cattle and sheep	1
4	Cereals	1
5	General Cropping	1
6	Dairy	1
7	Mixed	1
8	Meat Processing	8
9	Dairy Products	11
10	Miscellaneous Foods	17
11	Energy Distribution & Construction	35, 85-88
12	Chemicals	36-42,45
13	Machinery	62-67
14	Manufacturing	2-7,9-10,12-16,18-34,43-44,46-61,68-84
15	Wholesale & Retail	89-91
16	Big Hotels	92
17	Small Hotels	92
18	B&B and Guest Houses	92
19	Self Catering	92
20	Caravan And Camping	92
21	Restaurants, etc	92
22	Business and Communications	93-114
23	Public Administration & Education	115, 116
24	Health and Sanitary	117, 118, 119
25	Recreational and Other Services	120-123

Table C.3: Type I and II Leontief Multipliers for Employment

	Type I	Type II
Agriculture		
LFA: Specialist sheep	1.45	1.98
LFA: Specialist beef	1.73	2.12
LFA: Cattle and sheep	1.62	2.11
Cereals	1.53	1.92
General Cropping	1.65	2.13
Dairy	1.80	2.32
Mixed	2.02	2.55
Hotels and Catering		
Big Hotels	1.11	1.45
Small Hotels	1.09	1.43
B&B Guest House	1.08	1.34
Self Catering	1.08	1.36
Caravan And Camping	1.12	1.52
Restaurants Etc	1.13	1.37

Table C.4: Type I and II Leontief Multipliers for Gross Output

	Type I	**Type II**
Agriculture		
LFA: Specialist sheep	1.64	1.95
LFA: Specialist beef	1.54	1.77
LFA: Cattle and sheep	1.60	1.89
Cereals	1.44	1.66
General Cropping	1.57	1.85
Dairy	1.63	1.94
Mixed	1.81	2.12
Hotels and Catering		
Large Hotels	1.35	1.95
Small Hotels	1.30	1.96
B&B Guest House	1.30	1.95
Self Catering	1.39	1.98
Caravan And Camping	1.27	1.96
Restaurants Etc	1.43	1.94

ANNEX D: BREAKDOWN OF DIFFERENT TYPES OF TOURISM BY TYPE AND DESTINATION

Table D.1: Households and Daytrips expenditure (£, millions) at 1999 prices

	Households			Daytrips		
	Urban	Uninfected Rural	Infected Rural	Urban	Uninfected Rural	Infected Rural
LFA : Specialist Sheep	1.02	0.38	0.13	0.18	0.08	0.01
LFA: Specialist Beef	3.92	1.45	0.50	0.68	0.30	0.05
LFA: Cattle and Sheep	3.84	1.42	0.49	0.67	0.29	0.05
Cereals	4.40	1.63	0.56	0.77	0.33	0.05
General Cropping	5.51	2.04	0.70	0.96	0.42	0.07
Dairy	4.41	1.63	0.56	0.77	0.33	0.05
Mixed	3.20	1.19	0.41	0.56	0.24	0.04
Meat Processing	25.15	9.32	3.21	6.86	0.67	0.54
Dairy product	19.72	7.31	2.52	5.38	0.53	0.42
Miscellaneous Foods	26.70	9.90	3.41	7.29	0.71	0.57
Energy Distribution and Construction	71.46	26.49	9.12	6.91	8.58	0.72
Chemicals	0.62	0.23	0.08	0.04	0.05	0.00
Machinery	2.22	0.82	0.28	0.22	0.27	0.02
Manufacturing	377.34	139.88	48.17	75.71	23.85	6.54
Wholesale and Retail	5447.33	2019.28	695.40	956.52	400.04	105.94
Large Hotels	126.83	47.02	16.19	40.53	16.63	2.67
Other Hotels	48.76	18.07	6.22	10.78	6.67	3.15
B and Bs, Guest Houses	34.37	12.74	4.39	16.30	2.45	0.18
Self Catering	19.70	7.30	2.51	4.30	3.23	0.75
Caravan and Camping	28.64	10.62	3.66	6.15	5.00	0.82
Restaurants	411.60	152.58	52.54	131.40	54.10	8.58
Business and Communications	4097.62	1518.96	523.10	765.26	321.32	41.27
Public Admin and Education	1107.68	410.61	141.41	59.27	14.43	2.82
Health and Sanitary	628.63	233.03	80.25	0.00	0.00	0.00
Recreation and Other Services	795.68	294.95	101.58	153.43	23.58	6.86
Total Inputs	13296.35	4928.85	1697.41	2250.93	884.10	182.17
Imports from the RUK	5969.94	2213.01	762.12	443.34	174.13	35.88
Imports from the ROW	4556.72	1689.14	581.71	194.80	76.51	15.77
Taxes less subsidies on Products	1549.52	574.39	197.81	317.57	124.73	25.70
Taxes less Subsidies on Production	0.00	0.00	0.00	0.00	0.00	0.00
Compensation of Employees	0.00	0.00	0.00	0.00	0.00	0.00
Gross Operating Surplus	0.00	0.00	0.00	0.00	0.00	0.00
Total Primary Inputs	12076.17	4476.54	1541.64	955.71	375.38	77.34
Totals	25372.52	9405.40	3239.05	3206.64	1259.48	259.51

Table D.1 (continued): Scottish Tourism in Scotland and Rest of the World (ROW) Tourism expenditure (£, millions) at 1999 prices

	Scottish Tourism in Scotland			ROW Tourism		
	Urban	Uninfected Rural	Infected Rural	Urban	Uninfected Rural	Infected Rural
LFA : Specialist Sheep	1.27	0.50	0.39	0.03	0.00	0.00
LFA: Specialist Beef	4.87	1.93	1.49	0.10	0.00	0.00
LFA: Cattle and Sheep	4.78	1.89	1.46	0.09	0.00	0.00
Cereals	5.48	2.17	1.68	0.11	0.00	0.00
General Cropping	6.86	2.72	2.10	0.14	0.00	0.00
Dairy	5.49	2.17	1.68	0.11	0.00	0.00
Mixed	3.99	1.58	1.22	0.08	0.00	0.00
Meat Processing	1.62	0.37	0.50	0.18	0.01	0.00
Dairy product	1.27	0.29	0.39	0.18	0.01	0.00
Miscellaneous Foods	1.72	0.39	0.53	0.01	0.00	0.00
Energy Distribution and Construction	0.02	0.05	0.01	5.81	0.07	0.03
Chemicals	0.25	0.72	0.10	1.55	0.02	0.01
Machinery	0.04	0.11	0.02	0.14	0.00	0.00
Manufacturing	52.90	32.46	11.77	34.69	0.79	0.26
Wholesale and Retail	3.37	4.67	1.14	21.41	2.89	0.76
Large Hotels	21.51	16.40	5.85	27.78	23.50	3.62
Other Hotels	8.27	6.30	2.25	7.39	9.43	4.28
B and Bs, Guest Houses	5.83	4.44	1.58	5.06	8.48	1.34
Self Catering	3.34	2.55	0.91	2.95	4.56	1.01
Caravan and Camping	4.86	3.70	1.32	9.31	2.89	0.20
Restaurants	69.79	53.22	18.97	89.27	77.15	11.76
Business and Communications	221.37	234.70	59.50	60.16	3.76	3.76
Public Admin and Education	0.44	0.35	0.09	3.62	0.00	0.00
Health and Sanitary	0.23	0.08	0.04	6.74	0.29	0.29
Recreation and Other Services	0.46	0.16	0.08	17.90	0.00	0.00
Total Inputs	430.01	373.94	115.07	294.80	133.88	27.34
Imports from the RUK	86.87	75.54	23.25	121.50	55.18	11.27
Imports from the ROW	55.20	42.73	14.53	33.29	15.12	3.09
Taxes less subsidies on Products	74.36	57.55	19.58	106.07	48.17	9.84
Taxes less Subsidies on Production	0.00	0.00	0.00	0.00	0.00	0.00
Compensation of Employees	0.00	0.00	0.00	0.00	0.00	0.00
Gross Operating Surplus	0.00	0.00	0.00	0.00	0.00	0.00
Total Primary Inputs	216.43	175.82	57.36	260.87	118.47	24.19
Totals	646.45	549.75	172.43	555.67	252.35	51.53

Table D.1 (continued): Rest of the UK Tourism expenditure (£, millions) at 1999 prices

	RUK Tourism		
	Urban	Uninfected Rural	Infected Rural
LFA : Specialist Sheep	0.06	0.05	0.02
LFA: Specialist Beef	0.22	0.17	0.06
LFA: Cattle and Sheep	0.22	0.17	0.06
Cereals	0.25	0.20	0.07
General Cropping	0.31	0.25	0.08
Dairy	0.25	0.20	0.07
Mixed	0.18	0.14	0.05
Meat Processing	0.56	0.13	0.17
Dairy product	0.56	0.13	0.17
Miscellaneous Foods	0.03	0.01	0.01
Energy Distribution and Construction	6.36	18.75	2.52
Chemicals	1.69	5.00	0.67
Machinery	0.15	0.46	0.06
Manufacturing	64.33	79.40	21.16
Wholesale and Retail	55.23	33.50	13.06
Large Hotels	75.81	64.13	9.89
Other Hotels	20.16	25.75	11.69
B and Bs, Guest Houses	30.49	9.46	0.65
Self Catering	8.05	12.45	2.77
Caravan and Camping	11.50	19.28	3.04
Restaurants	247.98	210.54	32.09
Business and Communications	135.28	122.91	27.76
Public Admin and Education	11.20	4.10	1.91
Health and Sanitary	20.87	7.62	3.55
Recreation and Other Services	55.42	20.24	9.43
Total Inputs	747.21	635.03	141.01
Imports from the RUK	122.31	103.95	23.08
Imports from the ROW	33.51	28.48	6.32
Taxes less subsidies on Products	342.31	290.92	64.60
Taxes less Subsidies on Production	0.00	0.00	0.00
Compensation of Employees	0.00	0.00	0.00
Gross Operating Surplus	0.00	0.00	0.00
Total Primary Inputs	498.14	423.35	94.01
Totals	1245.35	1058.38	235.02

D.2: Displacement Effects

Table D.2 below shows the impact across sectors of the displaced Household Consumption shock. As is seen, the most significant positive GDP and employment effect occurs in the "Wholesale and Retail" sector, while there is also a positive impact on both these variables in the "Public Administration and Education", "Health and Sanitary" and "Recreation and Other Services" sectors. Negative effects occur in "Manufacturing" and "Energy Distribution and Construction" sectors.

Table D.2: Sectoral impact of displaced household consumption

Sectors	Model Sector Numbers	GDP (£, million)	Employment
Agriculture	1- 7	-0.97	-112
Other production	8-10	-1.01	-38
Energy distribution/construction/chemicals	11-12	-9.22	-457
Machinery/manufacturing	13-14	-24.77	-938
Wholesale and retail	15	55.25	3563
Hotels and catering	16-21	-0.62	-56
Business and Communications	22	-7.79	-299
Public Admin/Education and Health and Sanitary and Recreation and other services	23-25	16.57	695

See Table C.2 in Annex C for explanation of breakdown of Model Sectors in terms of Scottish 1999 Input Output Classifications (IOCs).

Table D.3: Value Added Per Employee and Average Wage per Employee in Types of Agricultural Employment

	Value Added Per Employee (£)	Average Wage Compensation Per Employee (£)
LFA: Specialist sheep	8546.47	3771.59
LFA: Specialist beef	27432.87	6036.22
LFA: Cattle and sheep	21378.27	8218.05
Cereals	46361.98	11426.91
General Cropping	34046.00	12512.62
Dairy	23486.38	9721.17
Mixed	23134.73	7408.13
Scottish All Industry	33948.46	21421.19