SCOTTISH FORESTRY: AN INPUT-OUTPUT ANALYSIS

MACAULAY LAND USE RESEARCH INSTITUTE

with
JOHN CLEGG & CO.
and the
UNIVERSITY OF ABERDEEN

MAY 1999

SCOTTISH FORESTRY: AN INPUT-OUTPUT ANALYSIS

Editor: Deborah Roberts

MLURI

Deborah Roberts

Neil Chalmers

Bob Crabtree

Andrew Thorburn

Dan Van der Horst

JOHN CLEGG & CO

Guy Watt

UNIVERSITY OF ABERDEEN

Ken Thomson

MLURI
Macaulay Land Use Research Institute
Environmental & Socio-Economics Group
Craigiebuckler
Aberdeen
AB15 8QH

JOHN CLEGG & CO
John Clegg & Co
2 Rutland Square
Edinburgh
EH1 2AS

UNIVERSITY OF ABERDEEN
University of Aberdeen
Department of Agriculture
MacRobert Building
581 King Street
ABERDEEN
AB24 5UA

Contents

Acknowledgements

This study was undertaken as a contract for the Forestry Commission. The research team wishes to thank Michael O'Neill and staff at the Commission for their assistance throughout the study and the provision of data. Other members of the steering group, Archie Prentice (HIE), Bob Henderson (SOAEFD) and Ben Gunneberg (TGA) are also thanked for the extremely useful comments they provided at various stages of the study.

Gratitude is expressed to Alison Donkin, Elisabeth Osborne, Linda Massey, and Bruce Reay for their contribution to survey design and field work. We are of course also indebted to all those people involved in the Scottish forestry sector who gave up time to take part in interviews: Without their co-operation the study would have been impossible. Finally thanks are due to Carol Smith for dramatically improving the presentation of the report and to Euan for providing emergency childcare when needed.

Executive Summary

This study quantifies the magnitude of the forestry sector's contribution to the Scottish economy. By confining the analysis purely to the links arising from production and processing and ignoring the other benefits provided by Scottish woodlands (such as recreation, biodiversity, tourism and enhanced landscapes), the study is limited in scope. However, it focuses on an important component of the sector's overall contribution to the Scottish economy, and one which is essential to a more comprehensive assessment of the value of Scottish forestry.

1. Aims of the study

The specific aims of the study were:

a) to investigate, through multiplier analysis, the backward and forward linkage effects of a number of different generic forest types in Scotland
b) to improve understanding of the contribution of the sector at a sub-national level, ideally identifying the impact on both local areas and regions of a change in forestry activity
c) to investigate a number of alternative forestry-based scenarios including the total removal of the sector from the Scottish economy, the doubling of timber harvesting levels, import substitution by downstream processing firms, the effects of removing grant-aid to the sector, and finally changes in labour productivity.

2. Methodological approach

Given the aims of the study, an input-output approach to the analysis was adopted. However, certain methodological issues arising from the nature of the forestry industry had to be taken into account in analysis. These included the length of the production cycle, the particular patterns of trade in timber, the extent of self-employment and labour mobility, and finally the rapid rate of technological change within the sector over the last few decades. Whilst some of these were accommodated through adjustments in the modelling framework, others were less easy to reconcile with the underlying technical assumptions of the input-output model and thus need to be borne in mind when interpreting the empirical findings.

On the basis that different types of woodlands have different management and input requirements as well as different patterns of output distribution, four different generic forest types were distinguished in the analysis: Existing Native Woodlands; New-planted Native Woodlands; Commercial Conifer Plantations; and Farm Woodlands. A well defined "multi-benefit" forest might contain a combination of these forest types but they were separated in this exercise for analytical purposes. The split between the planting and maintenance, and harvesting stages of the production cycle used in the Scottish input-output tables was retained resulting in a total of eight forestry-related activities in the input output analysis.

Further, based on the hypothesis that multiplier effects are regionally differentiated, four region-specific forestry input-output models were developed in addition to the Scottish-level model. The choice of regions – Southern Scotland, Tayside, Grampian, and Highlands - was based on a combination of factors including peripherality, population density and forest type.

To complement the findings of the multiplier analysis, the first and second-round flows upstream and downstream from forestry were spatially "tracked" through Scotland to establish whether the income and employment effects associated with forestry activity are retained locally, within rural areas, or leaked further afield.

3. A survey-based approach to the construction of the input-output table

A disaggregated input-output table emphasising forestry was constructed using the findings from an extensive survey of private woodland owners and managers and forest enterprise managers during winter 1998/99. A total of 81 face-to-face interviews were carried out with analysis based on the returns relating to a representative sample of 78 woodlands across Scotland. The total area of woodland covered by the sample was 350,633 ha, or 28% of the total forested area of Scotland in the base year of the study, 1995. The main forestry survey was followed up by a survey of upstream input suppliers to forestry and downstream timber processors to verify and supplement analysis relating to the spatial distribution of forestry related expenditures.

The results of the survey indicated significant differences in the patterns and levels of expenditures of different woodland types. Returns to scale for certain of the input costs were very evident from the survey returns, as was a large variability in some of the costs due to site-specific factors. Farm woodlands were found to have the highest average input costs per hectare, existing native woodlands the lowest. The use of contractors and subcontractors was widespread in all stages of the woodland production cycle.

Conifer plantations dominate the sector in terms of area, input expenditures and timber output. Apart from conifer plantations, the proportion of woodlands that were being managed for commercial timber reasons was low. Instead many interviewees cited environmental or recreational reasons for the establishment and maintenance of the woodlands, supported by the availability of grant income.

Having generated average costs per hectare and returns from each woodland type, the next step in constructing the input-output table involved reclassifying these flows onto an input-output basis and aggregating the survey results up to the industry level. Data from the National Inventory of Woodlands and Trees were used to aggregate the survey findings to sector level, and standard input-output techniques were used to generate the final balanced input-output table.

4. Key findings from the multiplier analysis

Multiplier analysis at the Scottish level indicated that the different woodland types generate very different levels of output, income and employment effects in the Scottish economy per unit change in demand. The output multipliers presented in Table E1 show the total increase in gross output in Scotland arising from a unit increase in demand for output from each of the sectors. The employment effects show the impact on the number of FTE jobs in the economy associated with the new level of economic activity, whilst the income effects show the estimated impact on the level of gross income in the Scottish economy.

As indicated in Table E1, the results suggest that in terms of planting and maintenance, a unit increase in the value of output from commercial conifer plantations appears to offer the greatest potential benefits for the Scottish economy. In particular, a £1m increase in final demand for output from conifer plantations is estimated to generate a total increase of £2.18m in the value of Scottish output, just under 45 additional FTE jobs and an increase in Scottish income of £878,000. The benefits associated with establishment and maintenance of new native woodlands are also shown to be significant.

In terms of harvesting, the table indicates that commercial conifer plantations are associated with the largest total output and income multiplier effects in the economy but that additional harvesting of native woodlands gives rise to greatest employment effects per unit of additional demand. This arises from the survey finding that harvesting in existing native woodlands tends to be more labour intensive per unit output harvested than conifer plantations, thus the direct employment effects of native harvesting are large. In contrast, conifer plantations have higher direct requirements for material inputs and thus generate greater indirect effects in the economy.

The results presented in Table E1 include the induced effects (effects arising from the expenditure of employees) as well as the direct and indirect effects associated with the sector. Allowing for induced

effects within the analysis was found to significantly increase the magnitude of all forestry multipliers due to the labour intensity of the planting and harvesting stages of the production cycle.

Table E1 Summary of demand-driven (backward linkage) forestry multipliers

	Type II Output multiplier	Employ. effect per £1m increase in demand (FTE)	Income effect per £1m increase in demand (£m)	Type II employ. multiplier	Type II income multiplier
Woodland types					
Existing native woodland planting/maint.	1.585	15.078	0.282	2.088	1.941
New native woodland planting & maint.	2.037	23.445	0.450	2.559	2.442
Commercial conifer plant/ maint.	2.183	44.918	0.878	1.584	1.539
Farm woodland planting and maint.	1.708	15.454	0.297	2.789	2.669
All Scottish forestry Planting/maint.	*1.928*	*29.061*	*0.564*	*1.805*	*1.744*
Existing native woodland harvesting	1.683	40.639	0.424	1.319	1.809
Commercial conifer harvesting	2.056	33.521	0.440	1.860	3.211
All Scottish forestry Harvesting	*2.015*	*34.304*	*0.438*	*1.766*	*2.966*

Forward linkage multiplier analysis again indicated significant differences between woodland types. In this case, native woodland harvesting was found to generate slightly higher benefits for the wider Scottish economy per unit of additional activity than conifer harvesting. This is due to the fact that a higher proportion of output from coniferous plantations is exported than output from native woodlands and thus generates no indirect effects for other sectors in the economy. The forward linkage multipliers associated with forest planting and maintenance were lower than anticipated. This was traced to the way in which "output" from this sector is accommodated within input-output accounting procedures.

5. Results from the impact analysis

Removal of the sector

Analysis suggested that the total removal of the forestry sector in Scotland would result in a total drop of £442m gross output, and a loss of 6,906 FTE jobs. Only 47% of the total fall in gross output was due to the removal of forestry itself, the remaining 53% coming about as a result of effects on other sectors in the economy. One of the characteristics of the forestry industry is that certain timber-using sectors are totally dependent on output from domestic forestry since, for either economic, technical or locational reasons they are unable to use imported timber within their production processes. Allowing for critical supply dependence showed that the total removal of the forestry sector in Scotland would result in a fall in gross output estimated at £811m and a total loss of 12,130 FTE jobs.

These results, like those of all the simulations are based on the usual input-output assumptions of fixed relative prices and fixed technology. In reality, factor and output prices would adjust to create new output and employment opportunities in the economy.

Doubling of timber harvesting and import substitution by downstream processors

As a consequence of a surge in afforestation during the 1980s, the volume of coniferous timber ready for harvesting from Scottish plantations is set to increase dramatically in the near future. Using an appropriately modified version of the input-output model, the economy-wide effects of doubling the volume of timber harvested from commercial conifer plantations were investigated assuming prices remain constant.

The additional timber output, valued at £98.8m, was shown to result in a total increase of £203m in the value of gross output in Scotland from backward linkage effects, £192m from forward linkage effects. The respective estimates of the employment generated from the increased timber harvesting are 3,310 FTE jobs from backward linkages and 3,210 jobs through forward linkage effects in the economy. 1,780 of these additional jobs are in the coniferous harvesting sector itself, the remaining 1,530 (backward) and 1,430 (forward) jobs are created in other sectors of the economy. A sectoral breakdown of the impact indicates that, excluding the increase in the value of timber itself, the vast proportion of benefits through demand-driven effects accrue to the construction and transport sectors whilst the main beneficiary from supply-driven effects is, as anticipated, the timber and wood product sectors that use coniferous roundwood.

Additional analysis was carried out to estimate the potential magnitude of economy-wide benefits if, in the light of increased domestic supplies, downstream firms were to source a higher proportion of their timber purchases from Scotland woodlands as opposed to the rest of the world. Allowing for import substitution was found to substantially increase the level of forward linkage effects in the economy without significantly effecting the backward (demand-driven) multiplier effects. In particular, a doubling of timber harvesting and associated import substitution by downstream processors could lead to a total of 3,343 FTEs jobs being created in Scotland through backward linkage effects, 3,992FTEs jobs through forward linkages although both estimates may be affected by increased labour productivity (see below). Thus, whilst less than estimates from other recent studies, the results suggest substantial potential benefits for the Scottish economy as a result of additional forestry related activity in the next two decades.

The effect of removing of grant aid

The vast majority of new planting of woodlands in Scotland currently receives grant-aid support. The effects of this can be assessed by using the model to test what would happen if grants were withdrawn. The removal of grant aid is thus likely to reduce new planting and, through links between forestry and the wider economy, have negative repercussions for other sectors in the economy.

Under the assumption that the removal of grant-aid would reduce the area of planting and maintenance by 90%, the magnitude of effects following the removal of grant were estimated. The results suggest that, in terms of demand-driven effects, the removal of grant aid could lead to a fall of £182.5m in the value of Scottish gross output and a loss of 2,526 FTE jobs. 1,451 if these jobs would be lost from the planting and maintenance sector itself, the remaining 1,075 from other sectors of the economy. The economy-wide supply-driven effects of grant removal were minimal as might be anticipated given that there are no close links with other sectors downstream from forest planting and maintenance.

Increased labour productivity

There have been dramatic increases in labour productivity in the forestry industry over the last few decades which have reduced the number of people employed in the industry. The effects of simulating further increases in labour productivity within forestry were shown to decrease the linkages between forestry and the wider economy through a reduction in the magnitude of induced multiplier effects. Taking just one example, the employment effects associated with additional conifer harvesting would fall by 7% and the economy-wide income effects by 9%. This implies that if historic rates of increases in productivity are maintained, the economy-wide benefits from increased forestry activity will be more limited than intimated in the other simulations.

6. Regional multiplier analysis

Multiplier analysis at the regional level indicated that the relative importance of the sector is closely related to the economic structure of a regional economy and, in particular, the extent to which the forestry sector is more or less "contained" within the region.

In terms of new planting, Southern Scotland appears to offer the greatest potential economic benefits with a £1m increase in demand for output from the planting and maintenance sector generating a total

increase of £1.943m gross output, 30 FTE jobs and £567,000 income in the region. In contrast, marginal increases in demand for output from the harvesting sectors is estimated to generate the largest impacts in the Grampian and Highlands regions. For example, in the case of the Highlands, a £1m increase in demand is estimated to increase gross output in the Highlands by £1.96m, create 27 new jobs and add a total of £424,000 to income in the region.

The forward linkage effects relating to forestry were found to be low across all regions. Indeed, contrary to expectations, the timber and wood products sectors were found to have higher forward linkage effects than the harvesting sectors in all regions. This suggests that there is a greater percentage of raw timber exported from a region than the percentage of first-stage processed timber.

7. The spatial distribution of input and output flows from forestry

Whilst input-output multiplier analysis provides an indication of the links between forestry and the wider Scottish economy, it does not reveal whether the income and employment multiplier effects associated with the sector are retained within the locality of the woodland giving rise to the effects, or, alternatively, leaked to other areas. Likewise, the analysis does not reveal whether the benefits from increased forestry activity would accrue to rural or urban areas. Thus, using data collected as part of the main survey of woodland owners and managers, road distances between a woodland and its source (destination) of inputs (outputs) were calculated. Thus the flows of income and employment associated with forestry activity were spatially "tracked" through the Scottish economy and, in some cases, into other areas of the UK. In addition, GIS methods were used to assess whether the source and destination of each transaction was based in a rural or non-rural area and whether flows were contained within regions or across regional boundaries.

The results indicated considerable variability in the distances over which inputs were sourced depending on both the type of woodland and the type of input being purchased. Of all inputs, fencing materials were typically sourced from firms closest to a woodland, on average 87 km from the woodland. Plants, another significant expenditure, tended to be bought from further afield with an average 147km between the source of plants and the woodland in which they are used. In terms of woodland types, farm woodland owners/managers are more likely to source their inputs from local suppliers than native or commercial conifer woodland owners/managers: 57% of all farm woodland related input expenditures were sourced from suppliers living within 100 km of the woodland, almost 20% being based within 20 km of the woodland. However, whilst commercial conifer plantations have a lower proportion of transactions with firms within 100 km, these same transactions account for a far higher proportion of total input expenditure than in the case of farm woodlands.

The nature of the product and associated transportation costs ensure that, on average, output flows from forestry are over much smaller distances than input flows. 75% of the value of timber from woodlands covered by the survey was processed within 100 km of the source of the timber. Taking into account the labour-intensive nature of first-stage timber processing and information on the residence of employees, a large proportion of the value downstream multiplier effects from forestry would appear to be contained within a relatively small geographical area. In contrast, analysis suggested that the upstream multiplier effects are less well contained.

Firms and businesses based in rural Scotland were shown to receive 61% of the value of all direct input expenditure, 60% of the value of all timber output, and 98% of the value of all contract-related flows. Whilst the majority of flows from forestry are to businesses located in rural areas, a relatively high percentage of value appears to "leak" from the rural economy to urban areas of Scotland. Some 17% of money associated with downstream output transactions leaked from the Scottish economy into the rest of the UK.

Finally, to supplement the findings from the regional multiplier analysis, regional differences in the source and destination of forest-related flows were investigated. Even allowing for flows into the rest of the UK, forest-related flows in the Highland region were found to take place, on average, over significantly longer distances than flows in the Southern region of Scotland. They were also more likely to be "cross-border", that is with firms or companies based in other regions of Scotland.

The results from the tracking analysis provide new insights into the spatial pattern of forestry-related flows, complementing information provided from the multiplier analysis of the sector, and thereby proving a fuller understanding of the role of forestry in the rural and wider Scottish economy.

1. Introduction

1.1 Background to the study

Focussing on the linkages arising from timber production and processing, this study aims to quantify the magnitude of forestry's contribution to the Scottish economy. Occupying 1.2 million hectares (16% of total land area of Scotland), and employing over ten thousand people, the forestry industry clearly plays a significant role within Scotland. However, the direct statistics relating to the sector mask important links with other sectors in both the national and rural economy. In particular, through the demand for inputs and labour, and through the supply of wood downstream, the forestry sector gives rise to output, income and employment multiplier effects for the wider Scottish economy.

Through multiplier analysis, the study provides a greater understanding of the nature and strength of linkages upstream and downstream from the sector. By confining the analysis purely to the links arising from production and processing, and ignoring the other benefits provided by Scottish woodlands (such as recreation, biodiversity, tourism and enhanced landscapes), the study is clearly limited in scope. However, it focuses on an important component of the sector's overall contribution to the Scottish economy, and one which is essential to a more comprehensive assessment of the value of Scottish forestry.

1.2 Aims of study

Specifically, the aims of the study were defined as follows:

i) To investigate, through multiplier analysis, the output, income and employment effects associated with the planting, maintenance and harvesting of woodlands in Scotland. The different multiplier effects (direct, indirect and induced) associated with forest establishment, management and harvesting were to be distinguished for a number of generic forest types as well as overall multipliers for "all types" of Scottish forestry.

ii) On the basis that the level of output from forestry influences the level of activity downstream in the Scottish economy, the forward linkage effects of the sector were to be investigated. This was to be achieved through the generation of supply-driven multipliers to complement the demand-driven multipliers estimated in (i).

iii) A subsequent stage of the analysis would estimate the contribution of the sector at a sub-national level. Ideally this would allow one to identify the impact on "local" areas, rural and non-rural areas of the rest of Scotland of a change in forestry activity.

iv) In addition to the multiplier analysis, a number of alternative scenarios, including the potential benefits of an expansion of forest harvesting activity, changes in labour productivity, and the impact of import substitution were to be investigated using input-output techniques

1.3 Structure of report

The following chapter sets out the methodological approach to the study and explains why input-output techniques were adopted. Whilst input-output methods are well suited to measuring the role of the forestry in the wider economy, there are certain characteristics of the sector which have implications for the validity of this modelling approach. Having discussed these characteristics and the findings of previous input-output studies of forestry, the four stages of the study are outlined.

Chapter 3 provides some context for the analysis by describing the nature of the Scottish forestry industry and key changes that have taken place over the last few decades. The shift in forestry policy is used to explain an increasing diversity of woodland types which has implications for the sector's links with the wider Scottish economy. Chapter 4 describes in some detail the way in which a survey

of Scottish woodland owners and managers was used to generate balanced disaggregated input-output tables for Scotland and four regions of Scotland. It also describes how this table relates to the existing 1995 Scottish input-output table.

The empirical results of the study are presented in Chapters 5 and 6, the former focussing on multiplier analysis, the latter on the estimated income of various different forestry related scenarios. Findings from regional multiplier analysis (reported in Chapter 4) are supplemented in Chapter 7 by a more detailed analysis of the spatial distribution of flows to and from different forest types using GIS techniques. Finally, Chapter 8 presents the conclusions from the study.

2. Methodological approach to the study

2.1 Input-output analysis

Given the objectives of the research, in particular the aim to quantify the links upstream and downstream from the Scottish forestry sector, an input-output approach to the analysis was adopted.

The strength of input-output analysis lies in its ability to take into account the importance of interdependencies that exist between sectors in an economy. It is these interdependencies that give rise to economy-wide multiplier effects when there is a change in economic activity. For example, a 10% increase in forest planting in Scotland would bring benefits to those industries directly catering for the planting sector such as the fertiliser industry and tree nurseries. Since these industries would have to increase their output to accommodate the extra demand, they would require additional inputs from other industries. For example, the fertiliser industry would increase its demand for chemicals. In turn, chemical manufacturers would increase their demand from the mining and extraction industry, and so on. The benefits from increased forest planting would thus extend far beyond those sectors directly affected by the increase. Likewise a reduction in planting levels will have ramifications on more than just those sectors directly involved in forestry, the extent of these ramifications depending on the strength of the inter-sectoral linkages extending out from the initial "impact".

Previous studies have adopted input-output techniques to measure the full contribution of forestry to an economy taking into account not only the direct effects (that is, the "first-round" effects on forestry input suppliers and wood processors) but also the multiplier effects associated with the industry (Sullivan and Gilless, 1990; McGregor and McNicoll, 1989; Thomson and Psaltopoulos, 1993; Flick *et al*., 1989; Elrod *et al*., 1972; Aldwell and Whyte, 1986). In this way they have been able to indicate the degree of structural dependence of an economy on forestry and the sector's relative potential for generating additional economic activity through investment. However there are certain important methodological issues associated with using input-output techniques to analyse the forestry sector that needed to be highlighted. These issues had to be taken into account when developing the approach to this study but should also be borne in mind when analysing the results from the study.

2.2 Methodological issues arising from the nature of forestry

2.2.1 Length of production cycle

A distinctive feature of forestry is its extremely long production cycle, which varies from 35 years (new coniferous softwood) to 100 years (native hardwood). In contrast, input-output analysis is based on a "snapshot" picture of the economy indicating the flows that take place typically during a period of a year – the so-called base year of the analysis. Thus the multipliers derived from an input-output study are critically dependent on the structure of the forestry sector in the base year, including the maturity of forests in the presence or absence of domestic processing capacity. In particular, the multipliers should be interpreted as indicating the impact on the economy of a balanced increase in forestry activity assuming that the levels of plantings, stocks, harvesting and processing are in line with those of the base year.

In some cases, this is clearly problematic. For example, the benefits of new investment in the sector may be felt in terms of additional planting. However, unless forest planting is separated from other forest activities, the multipliers from the model will relate to the effects associated with the whole production process. In their study of forestry in the UK economy, McGregor and McNicoll (1991) circumvent this problem by focussing on the impact on the economy of the complete removal of forestry rather than the impact associated with marginal changes in the sector. In the case of Scotland the problem is less severe to the extent that the sector is split into two - forest planting and

maintenance, and forest harvesting. Thus it is at least possible to differentiate between the impacts associated with the two most critical stages of the production cycle, and, if appropriate, different scenarios relating to the development of forest and/or changes in the underlying technical data can be accommodated in the analysis. This study thus maintains the split between forest planting and maintenance and forest harvesting and, through altering the technical data in the model, explores the implications of certain forest types reaching maturity.

2.2.2 Trade patterns in timber and wood products

There are certain downstream firms who are critically supply dependent on commercial timber production since, for either technical or economic reasons, they cannot substitute imported wood for domestic wood and thus would go out of production if domestic forestry ceased. In an early cost-benefit study of forestry, the Treasury noted this dependence, arguing that "if, as seems to be the case, there is no alternative long-term supply of imported raw materials, then UK timber growing and processing becomes a single integrated industry" (HM Treasury, 1972). By ignoring the dependence and assuming that processors could substitute imported products for domestically produced output, one might considerably underestimate the economic importance of forestry.

Another aspect, again relating to imports, is the significant demand for wood products currently satisfied by imported products. Whilst the proportion of UK consumption met by domestic supplies has increased in recent years, it still remains low relative to some other product categories. Unless modified otherwise, an input-output model assumes constant import propensities. Thus, input-output analysis would suggest that any increased demand for wood products would be met by increased demand for timber from domestic and imported sources in the same relative proportions as observed in the base year of the study. If it is felt that increased domestic supplies will (or could) in future substitute for imports in some product lines, this needs to be explicitly accounted for through adjustments to the basic model. Both issues are taken up in the simulation stage of this study.

2.2.3 Self-employment and labour mobility

In most input-output tables, two types of factor incomes are distinguished: "Wages and Salaries" and "Profits and Other Value-added". In many cases (but not the Scottish input-output tables), self-employment income is treated as part of "Profits and Other Value-added" as opposed to wages and salaries. As a consequence, even in the closed version of the model, they play no role in generating induced effects in the economy, and are effectively treated as exogenous. In cases where a sector has very high levels of self-employment, such as forestry or agriculture, this is important, potentially leading to an underestimation of the benefits of investment and increased activity in that sector. In contrast, the high levels of spatial mobility of forestry workers may lead to an overestimation of the contribution of the sector. This is because it may inappropriately be assumed that all increases in income from forestry are spent within the region in which they were earned (whilst, in reality, some may be spent outside the study area). To correct for this, information on the residence of workers is collected and analysed as part of this study, and the level of induced effects is adjusted accordingly.

2.2.4 Technical change

Forestry has over the last few decades been characterised by extremely high levels of technical change and increases in labour productivity. In contrast, input-output models assume fixed technical coefficients, that is fixed relationships between inputs and between input levels and output. The assumption of fixed technical coefficients becomes increasingly less tenable over time, and Midmore (1993) shows that the accuracy of input-output forecasts declines rapidly as the period between the base year of the model and the forecast year increases. Many of the simulations considered in this study focus on time periods over which not only technology within the forestry industry is likely to change but also that of other industries in the economy. Thus, particularly when using input-output methods to analyse forestry with its long production cycle, the validity or otherwise of the underlying technical relationships in the model need to be born in mind.

2.3 The findings of previous input-output studies of forestry

There are a number of previous studies that were of particular relevance in assessing the particular methodological approach for this study.

McGregor and McNicoll (1991) investigated the impact of forestry on output levels in the UK economy using a modified Leontief input-output model based on the 1984 UK input-output tables. Picking up on the issue of critical supply dependence downstream from the sector, they estimate that the absence of forestry would lead to a fall in the value of output of £1954 million, a figure 2.3 times greater than if just the sector itself was removed.

From the point of view of understanding the role of forestry in Scotland, the results of the McGregor and McNicoll study are perhaps most interesting in terms of their findings relating to the spatial spread of activity between the four "regions" of the UK – England, Wales, Scotland and Northern Ireland. Of the total fall in UK output, 63% was estimated as occurring in England, 25% in Scotland, 8% in Wales and 4% in Northern Ireland. The dominance of England is explained by the fact that, whilst containing only a small proportion of forests, it has a proportionately much larger share of all other industries and thus absorbs the majority of secondary effects from forestry activity. The findings thus emphasise that when quantifying the full economic contribution of the sector, it is not just where forests are located but the location of related upstream and downstream industries that is also important. This suggested that a regional approach to the study in hand would be valuable.

The area-specific nature of input-output multipliers is illustrated by Flick, Trenchi and Bowers (1980). Using a 25-sector input-output model, they investigated the role of forestry in Alabama, their results reflecting the way in which the region had adjusted to accommodate the forestry specialisation. Forest industries were found to have substantially larger multipliers than other manufacturing industries and the average of all industries in the economy. This suggests that Alabama would have larger increases in business activity, household income and employment from expansions in the forest industries than comparable expansions in other manufacturing industries. Extrapolating this finding to other regions would be inappropriate: input-output analysis is "region-specific" with multipliers reflecting the particular type of inter-industry relationships that occur in the region under analysis. However, it does again suggest that the generation of multipliers at sub-national level for Scottish forestry may reveal important insights.

Using the 1989 version of Scottish input-output tables, Thomson and Psaltopoulos (1993) set out to investigate forestry's role in rural development. In this study, an input-output table for the whole of rural Scotland was constructed using a method developed by Jenson et al. (1979) known as Generating Regional Input-Output Tables or "GRIT". The authors then carried out conventional demand-driven input-output analysis to assess the output, income and employment multipliers of the sector. Their results suggested that the rural multiplier effects arising from both forest planting and forest harvesting sectors are relatively small due to the dependence of rural firms on goods and services and labour from non-rural Scotland and beyond. Backward linkages were found to derive mainly from induced effects (that is, through the spending of forestry employees). From the point of view of this study, their findings thus indicate that the calculation of multipliers that include induced effects[1] is important in order to get a better understanding of the contribution of the sector.

Other studies have used input-output techniques to investigate forestry-related issues not central to this particular study, such as the stability of forestry-dependent economies and the case for diversifying such economies to counter instability (Sullivan and Gilles, 1990; Berck et al., 1992). However, focussing on the specific issue of quantifying the linkage effects upstream and downstream from the sector, a review of previous studies does suggests considerable potential for using input-output techniques despite the methodological problems discussed above. Moreover, the review indicates three gaps in the existing literature. Firstly, surprisingly little attention has been paid to the extent to which forestry multiplier effects vary by woodland type. Secondly, despite stressing the regional specificity of multiplier effects, little is known about whether the benefits from forestry

1 The nature of these so-called Type II multipliers is discussed further in Chapter 5.

activity are locally retained or leaked from rural locations[2] Finally, most previous analyses have concentrated exclusively on the backward, demand-driven linkages associated with forestry as opposed to the forward (downstream) linkages of the sector. All three issues are areas which this study will address.

2.4 Decisions regarding the approach to the study

Given the above discussion, the following decisions were made in respect to the methodological approach for the study.

2.4.1 Disaggregation of the Forestry Sector by Forest Type

On the basis that different types of woodlands have different management and input requirements as well as different patterns of output distribution, it was decided that the forestry accounts in the Scottish input-output sector would be disaggregated to distinguish six generic forest types.

The following six types were chosen

- existing native woodlands
- new-planted native woodlands
- commercial conifer plantations
- farm woodlands
- crofter forestry
- community woodlands

The split between the planting/maintenance and harvesting stages of the production cycle used in the Scottish input-output tables was retained. Apart from the aim to distinguish woodlands with different input requirements and output flows, the choice of forest types was driven in part from a policy perspective. Each of the above types of woodland receives government support to a varying extent. Given forestry's links with other sectors in the economy, it was intended that analysis would give some indication of the full economic impact of this support.

2.4.2 Multiplier analysis

Having generated a balanced Scottish input-output table for 1995 distinguishing between the expenditures and revenues of the generic forest types, both backward (upstream) and forward (downstream) multipliers were estimated, using standard input-output methods. In particular the output, income and employment multipliers associated with a change in forestry activity levels were estimated for both the conventional demand-driven version of the input-output model and the lessor known supply-driven model. Both Type I multipliers (from the open version of the models) and Type II multipliers (from the closed version) were presented. 1995 was adopted as the base year for the analysis because this was the most recent year for which both Scottish input-output data and woodland coverage data were available.

2.4.3 Regional Analysis

Based on the expectation that the multiplier effects are regionally differentiated, it was decided that multiplier analysis would be carried out at the sub-national level. This was to be achieved by "GRITing" the aggregate Scottish input-output table into four regions and deriving four region-

2 Thomson and Psaltopolous (1993) investigated the role of the sector in the rural economy. However their analysis was based primarily on non-survey methods and was limited to measuring effects in the whole of rural Scotland – an area quite diverse in nature and economic structure.

specific forestry input-output models. The choice of regions, listed below, was based on a combination of factors including peripherality, population density and forest type.

Region 1: Southern Scotland
Region 2: Tayside & Southern Highlands
Region 3: Grampian
Region 4: Highlands and Argyll and Bute

Appendix 1 indicates the classification of each of these regions in terms of Local Authority Districts. Whilst still fairly aggregate, each of these regions has quite distinct characteristics in terms of the both the structure of the forestry sector and the general regional economy and it was hypothesised that the forestry multiplier effects would differ significantly.

2.4.4 Impact Analysis

Extensive impact analysis at the Scottish level was carried out. The scenarios to be investigated were agreed in consultation with the project sponsor - the Forestry Commission - and the steering group. Representatives from the Scottish Office Agriculture, Environment and Fisheries Department, the Timber Growers Association, and Highlands and Islands Enterprise were included in the steering group for the study.

Specifically, the model would be used to assess the following:

- the total suppression of the forestry sector, with and without critical supply dependence
- the effects of substituting Scottish timber for timber currently imported into Scotland from the rest of the world
- an increase in output from Scottish timber harvesting.
- changes in the proportions of different woodland types compared to the base year for the study, 1995.
- the impact of removing grant aid
- changes in labour productivity in the sector

2.4.5 Spatial Tracking of the Multiplier Effects from Forestry

Given the aim of the study to investigate the degree to which the multiplier effects are locally retained, a post-code based spatial tracking technique was used to analyse the precise location of upstream and downstream effects. The first-round effects (purchases and sales) were identified as part of the forestry survey by asking woodland mangers not only the type and value of their input purchases but also the name and address of their supplier. Likewise, the same managers were not only asked about the value of their sales but also the buyer's name and address. A sub-sample of these buyers and sellers were then contacted to ascertain the second round impacts of the sector. The results identify the extent to which different types of forestry have different levels of transactions within the locality and thus generate different magnitudes of local benefits. They also illustrate the extent to which the sector generates income and employment for rural as opposed to non-rural areas.

3. Context: The Scottish Forestry Sector

This chapter sets the context for the study by briefly describing the nature of the Scottish forestry industry, significant changes that have taken place over the last few decades, and the key issues associated with forestry's links with other sectors in the Scottish economy.

3.1 The nature of the forestry industry in Scotland

3.1.1 The structure of the industry

Forest expansion has been the most significant change in land use in Scotland this century. In 1905, only 4.5% of the land surface area was under forest (Mather, 1993). Today, after an extensive strategy of planting by both the private and public sectors, forests occupy 15% of the total land area (Forestry Commission, 1998).

As indicated in Table 3.1, of the 1.167 million hectares of land under forest in 1995[3], Forest Enterprise managed 44%, the private sector the remaining 56%. The vast proportion of existing Scottish forests are coniferous plantations. Of the 106 thousand hectares of broadleaved forests, 94% were in private ownership.

Table 3.1 Land area under forest, Scotland (thousand hectares)

	Conifer	Broadleaves	Other*	Total
1995				
Forestry Commission	482	6	26	514
Private Woodland	488	100	65	653
Total	970	106	91	1167
1998				
Forestry Commission	463	6	28	497
Private Woodland	526	115	65	705
Total	989	120	93	1202

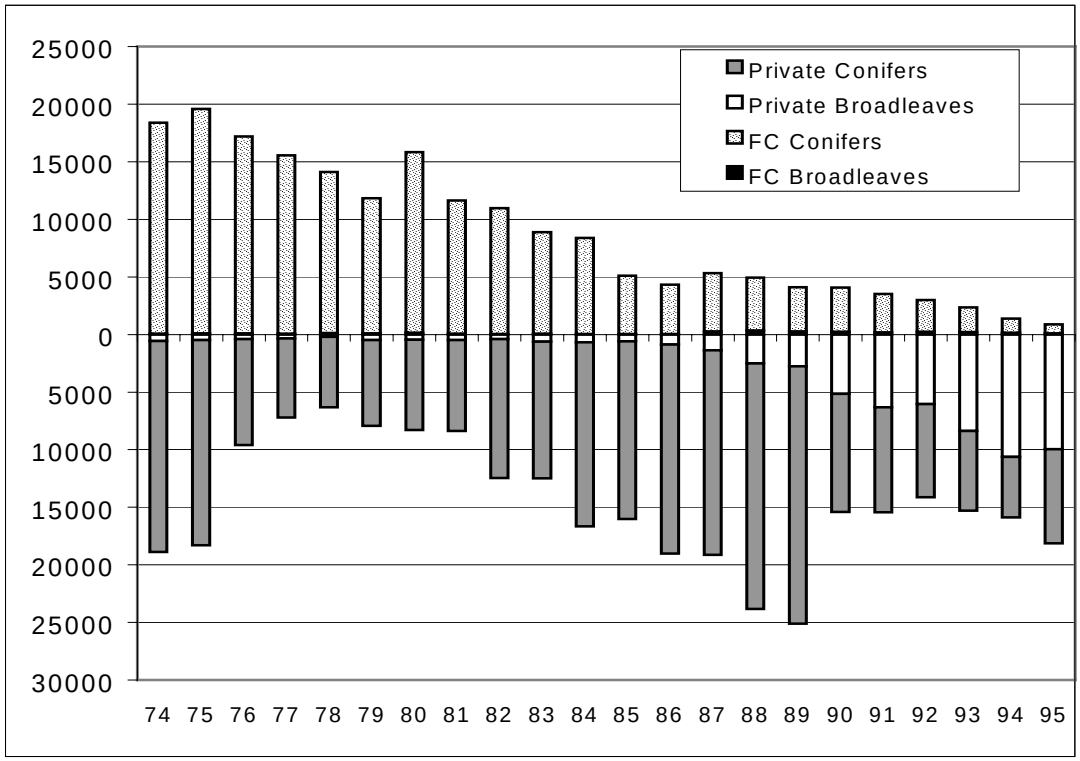
*Relates to woods not managed for timber but chiefly amenity and recreation
Source: The Forestry Industry Council for Great Britain.

Rates of afforestation over the last century have fluctuated in response to changing economic, social and political circumstances. Figure 3.1 indicates the changing patterns of state and private sector plantings from the mid 1970s.

As shown in Figure 3.1, a surge in private afforestation occurred from the early to the mid-1980s due to a combination of planting grants and, more significantly, tax concessions (Mather, 1991; Mather and Thomson, 1995; Crabtree and Macmillan, 1989). The combined financial benefits of these incentives amounted to around 70% of the cost of afforestation (Mather, 1993) and, as a result, over 50% of Scottish planting was carried out by private individuals with high marginal rates of income tax. The remaining 50% was carried out by traditional estate owners, farmers and corporate investors.

3 The discussion focuses on the sector in 1995 because this is the base year of the study.

Figure 3.1 ***New plantings by the Forestry Commission and private sector, 1974-1995 (vertical axis, hectares; horizontal axis, year ending March 31***



Source: The Forestry Industry Council for Great Britain, 1995

From the 1950s, Scotland has experienced the highest levels of afforestation in the UK. As shown in Table 3.2, as much as 99% of State plantings, and 80% of private sector plantings took place in Scotland in the late 1980s. The dominance of Scotland is partly attributable to the opposition to afforestation in National Parks in England and Wales, and partly to do with the fact that grant-aided planting approval was restricted to low cost, poor quality agricultural land (in effect, hill grazing land) of which Scotland has a relative abundance.

Table 3.2 ***Scotland's share of new planting in Britain, 1950 – 1990 (%)***

	Forestry Commission	Private Sector
1950	48	na
1960	58	na
1970	81	74
1980	90	83
1990	99	80

Source: Mather, 1993

Within Scotland, patterns of afforestation have changed over time. In the early stages of rapid afforestation, South West Scotland offered the most preferred sites in terms of both potential size of sites and quality of land. However, as increasing proportions of this area became forested, plantings

moved from South West Scotland gradually further north[4] onto progressively poorer land (Mather and Thomson, 1995), the implications of this shift being a change in the cost of planting and harvesting and, in some areas, a reduction in expected yields from plantations.

The importance of Scotland's share of woodlands is indicated in Table 3.3 which indicates the total area of woodland in Great Britain in 1998. The figures relate to both Forestry Commission and private woodlands.

Table 3.3 Total area of woodland, 1998

	High Forest					
	Conifers	Broadleaves	Coppice	Total Productive woodland	Other woodland	Total woodland
England	383	483	19	885	105	990
Wales	167	67	1	234	13	247
Scotland	989	120	0	1,109	93	1,202
Great Britain	1,539	670	20	2,229	211	2,440

Source: Statistics Unit, Forestry Commission, 1998.

3.1.2 Changing technology and increases in labour productivity

The forestry industry has been characterised in post war years by technical change and increased labour productivity. Despite continuing increases in timber output, the levels of employment in the industry have been in constant decline. For example between 1950 and 1980, annual roundwood removals from Forestry Commission land increased from 325 000 m3 to 2.3 million m3. At the same time, Forestry Commission employment fell from 11,110 to 8,129 (Wonders, 1990)[5].

As shown in Table 3.4, the most recent figures on employment levels suggest that the forestry and primary wood processing sectors together employ a total of 34,820 people, 10,660 in Scotland. These figures relate only to employment related to roundwood produced in Great Britain and thus, for example, exclude employment in downstream firms that are entirely reliant on imported timber for processing.

Table 3.4 Employment in forestry and primary wood processing, 1993-94

	England	Wales	Scotland	GB
Forestry Commission	2570	1270	2810	6650
Private Estate Owners	7525	1100	2125	10750
Forest Management Companies	735	125	1050	1910
Timber Harvesting Companies	2135	515	1645	4295
Wood Processing Industries	6445	1740	3030	11215
Total	**19410**	**4750**	**10660**	**34820**

Source: Forestry Commission, 1995

4 Mather and Thomson give a detailed account of the shift in new plantings and the role of consultation procedures with DAFS/SOAFD and the Forestry Commission on the afforestation patterns.

5 Whilst some of this reduction may be attributed to a decrease in Forestry Commission planting between 1950 and 1980, a large part is associated with new technology and increased labour productivity in the industry.

Forest management and timber harvesting companies support significant levels of employment within Scotland, with forest management noticeably more important than in other regions of the UK. Given the recent decline in afforestation but predicted increase in harvesting, employment is shifting towards the latter stages of the production chain with forest management companies restructuring and shedding workforce (Mather, 1993).

Table 3.5 again presents employment figures for Scotland, but in this case indicates more clearly the nature of the activities being carried out.

Table 3.5 Employment by activity, 1993-94

	Scotland	% of total Scottish forestry employment	GB
Forest nurseries	200	2	580
Establishment	720	7	2770
Maintenance	795	7	3725
Harvesting/extraction	3215	30	9290
Road construction	255	2	630
Other forest activity	360	3	1735
Forest Total	*5545*	-	*18730*
Haulage of timber	445	4	985
Processing	3290	31	12315
Other non-forest	1380	13	2790
Non forest total	*5115*	-	*16090*
Total	10660	100	34820

Source: Forestry Commission, Employment Survey, 1995

Existing literature suggests that the use of contractors as opposed to direct employees has increased in all sectors and activities of the forestry industry (Thomson and Psaltopoulos, 1994). Contracting is most significant in relation to harvesting and haulage. Whilst the labour-intensive establishment and early processing stages involve a higher proportion of direct employment, that is employees whose wages are paid by the owner of the enterprise, an increasing amount of forest planting is also now carried out by contractors (Forestry Commission, 1995).

Importantly, contractors tend to be more mobile and travel longer distances to work. For example, whilst 86% of direct employees travel less than 16 km to work, 75% of contractors travel more than 10 miles (Forestry Commission, 1996). This suggests that different stages in the forest production cycle generate quite different levels of local employment benefits, not just because of the relative labour intensities of each stage, but also because the likelihood of employees and contractors being locally based varies by activity.

3.1.3 The demand and supply of timber

The proportion of consumption met by domestic supplies has increased over the last decade but still remains low in many product lines. Since some 80-85% of imports are softwood-based and two-thirds are processed in the country of origin as opposed to being exported as roundwood, the growth in timber supplies over the next 25 years offers considerable potential for increasing self- sufficiency ratios. However, at present, sawnwood from domestic logs only satisfies certain types of demand and increases in its market potential may be limited by its quality.

Table 3.6 indicates the latest Forestry Commission forecasts of UK supply and demand. Total demand is expected to increase to 90 million m3 per year under the low-growth scenario of a 1%

increase in GDP per annum. In 1996, supply was forecast to peak at 16 million m3 in 2025, at which point the UK would be 20% self–sufficient.

Table 3.6 Forecast UK wood supply and demand 1989-2050 ('000 m^3 wood raw material equivalent)

		Forecast years					
	Actual 1989-91	2000	2010	2020	2030	2040	2050
Roundwood products	1 060	730	750	750	750	750	750
Paper products	40 410	39 350	41 810	44 480	47 430	50 660	54 200
Wood based panels	11 440	10 330	10 900	11 510	12 180	12 900	13 700
Sawnwood	24 100	21 990	22 230	22 410	22 610	22 800	23 000
Total (a)	77 010	72 400	75 690	79 150	82 970	87 110	91 650
Sawnwood residues (b)	1 190	1 520	2 440	2 930	2 920	2 120	1 970
NET TOTAL DEMAND (a-b)=(c)	75 820	70 880	73 250	76 220	80 050	84 990	89 680
ROUNDWOOD SUPPLY (d)	7 990	9 850	13 880	15 640	15 400	11 760	11 130
Recycled Supply (e)	9 800	12 590	16 720	17 790	18 970	20 260	21 680
SELF SUFFICIENCY (d)/(c)	10.5%	13.9%	18.9%	20.5%	19.2%	13.8%	12.4%
Self sufficiency in roundwood + recycled fibre ((d+e)/c)	23.5%	31.7%	41.8%	43.9%	42.9%	37.6%	36.6%

Source: Whiteman, A. (1996).

In terms of Scotland's capacity for processing raw timber, Table 3.7 indicates the number of sawmills in Scotland by size category.

Table 3.7 Number of Sawmills by size category, 1996

	Size category (000 m^3 total production)						
	<1	1-5	5-10	10-25	25-50	50+	Total
England	147	81	22	11	6	2	269
Wales	18	8	4	2	2	2	36
Scotland	**47**	**24**	**14**	**7**	**7**	**3**	**102**
GB Total	212	113	40	20	15	7	407

Source: Sawmill Survey, 1997, Forestry Commission.

The Scottish sawmill industry is currently dominated by a relatively few large sawmills with very high throughputs. Given the emphasis in forestry policy to the provision of rural employment opportunities, the location of these sawmills, or more particularly the residential location of their workforce, is important.

In a survey based in 1992, Thomson and Psaltopoulos (1994) found that the bulk of supplies to Scottish sawmills are of Scottish origin but are hauled over 30 miles to the mill. In terms of sales, a large proportion of output from sawmills flowed to English rather than Scottish destinations, again suggesting a significant leakage of benefits from an increase in forestry activity in Scotland. Finally in terms of the residence of workers in the sawmills, the survey results suggested that the split of residence between remote rural, rural settlements and urban areas depended on the size category of the mill. In particular, a far more significant proportion of workers in medium-sized sawmills lived in urban areas than workers in the smallest or largest sawmills. The authors suggest that this may be an indication of the spatial distribution of mills by size, with the newer, larger mills locating in more rural locations to achieve economies of scale, although inward investment incentives and lower transport costs also influence location decisions.

3.2 Changes in forestry policy

Relative to the experience in other countries, afforestation in the UK has been characterised by the continuity of government support (Mather, 1993). However, whilst government support for the forestry sector has been relatively constant, the objectives of forestry policy have changed dramatically. From emphasising the strategic requirement of standing timber reserves, the objectives of policy have shifted first towards the potential economic benefits of new commercial plantations and then broadened to incorporate the importance of the environmental and ecological benefits from forestry. Whilst references to multiple benefits have been stressed in official forestry policy documents for many decades, it is perhaps only within the last decade that the broader social considerations have been given equal status to commercial objectives. This section considers two specific changes in forestry policy that have had implications for the type, nature and location of current woodland planting in Scotland.

3.2.1 The ascendancy of conservation objectives

The potential conflicts between certain types of forestry and conservation interests have long been recognised[6]. However, concern about the adverse environmental affects of widespread coniferous afforestation did not make an impact on forestry policy until the late 1980s. Following intense media attention, the grants and tax concessions which had encouraged such plantations were removed, and in 1988 a new Woodland Grant scheme introduced.

The Woodland Grant scheme was geared much more closely towards changing the pattern of plantations and increasing the level of broadleaved woodlands. Watkins (1986) identifies three reasons for the increased policy commitment towards broadleaved woodlands: a changing attitude towards agriculture in general and a recognition of surplus agricultural production; increasing public concern with conserving landscapes; and growing recognition of the ecological importance of native woodlands. The shift in policy towards broadleaved woodlands thus represented an ascendancy of conservation and recreational benefits of forestry and a relative decline in the weight placed on traditional or commercial economic objectives of forestry policy.

3.2.2 The introduction of Farm Woodland Schemes

In line with the changing policy emphasis, the Farm Woodland Scheme introduced in the late 1980s and, more recently, the Farm Woodland Premium Scheme have been fundamental in reversing the spatial shift of afforestation and encouraging plantations on better-quality sites where it competes or at least complements agriculture.

Interactions between agriculture and forestry have, until very recently, been limited. In Scotland, Mather and Thomson (1995) found that between 1975 and 1990, the forest area increased by 40% at the cost, primarily, of land that was previously used for hill sheep farming. However, over the same period, total sheep numbers actually increased as a result of intensification on land remaining in agricultural production. Local-level analysis indicated that afforestation has little impact on agriculture if the extent of forests in the locality is low. However once forest cover extends to 30% or more of land area, the relationship between the two sectors becomes much more competitive, with further increases in forest area having a negative impact on agricultural returns (Mather and Thomson, 1995).

The lack of involvement of farmers in forestry up to the introduction of the new policy mechanisms can, in part, be attributed to the landlord-tenant system that dominated Scottish agriculture until the latter half of this century[7]. However, support for the farm sector in the form of the Common Agricultural Policy (CAP) has also been a primary factor militating against farmer involvement in

6 The first indication of a conflict between afforestation and the preservation of amenity came in the 1930s with an agreement of the Forestry Commission (following discussion with the Council for the Preservation of Rural England) not to acquire land for afforestation within a 300 mile square area of the Lake District

7 Under this tenure system, tenant farmers may be unable to benefit from establishing plantations on their holdings.

forestry. In particular, the CAP has influenced forestry through a) its impact on land prices and farm incomes, b) by contributing to the contraction of the agricultural labour market which has reduced the capacity of farmers to undertake non-farm activities such as woodland management, and c) through the workings of specific commodity regimes, for example livestock headage payments which can lead to overstocking and unwillingness of farmers to take land out of agriculture for woodland developments (Countryside Commission, 1998).

However, the recent introduction of the policies such as the Farm Woodland Premium Scheme aimed at encouraging farm woodlands has fundamentally changed the nature of agriculture-forestry interactions[8]. The rate and location of planting will in future depend much more directly on land prices, the level of agricultural support and the degree of flexibility in the release of agricultural land for planting (Crabtree and Macmillan, 1989). Whilst to date, participation in the scheme has been less than projected (Clarke and Johnson, 1993, Lloyd et al., 1995), it has provided a framework within which the combination of forestry and agricultural enterprises is a more attractive proposition to farmers (Mather, 1993).

3.3 Social aspects of forestry and the role of the sector in rural development

The idea that forestry provides important social benefits for rural areas stems back to the Acland report (1918) and is still used as a justification for forestry policy eighty years on. The sector, it is argued, provides employment in areas where alternative opportunities are scarce and thus helps to stem rural depopulation. However forestry's performance in this respect has been mixed and, as discussed above, the employment-generating potential of the sector is now considered only one of many broader social benefits provided by the industry (Selman, 1997).

In terms of post-war UK forestry policy, one of the most tangible commitments to an expanding forest sector and the social objectives of forestry policy came in the form of so-called "forestry villages" – villages which were actually built by the Forestry Commission to house workers and their families in specific locations. A number of different factors contributed to the eventual decline of these villages, including worker dissatisfaction, the geographical remoteness of the village sites and changing government policy (Wonders, 1990). Perhaps the most significant factor in their decline however was the dramatic increase in labour productivity and technical change in the forestry industry, which removed the need for high levels of fixed, permanent staff.

At a local level, Evans (1987) emphasises the impact on rural areas of increasing labour productivity in the sector. He describes how, within a 30 year period, while the forest area in Strathdon, North East Scotland increased by 93%, over the same period employment in forestry and traditional keepering fell by the same percentage. Whilst he attributes the decline in employment to technical change, Evans also stresses that, at the local level, interactions between forestry and other land uses are important in determining the net effect of the sector in rural development.

Whilst in the UK the social benefits of forestry may have been limited in duration, in other countries afforestation has been found to arrest and even reverse rural depopulation trends. In particular, Farnsworth (1983) argues that, in New Zealand, forestry has helped to create diverse local communities and has increased the percentage of young married couples and hence led to better support for local services. In the context of Alabama, Flick et al. (1980) also present evidence to suggest that forestry has much higher employment- generating potential than manufacturing or other

8 Other factors may also be contributing to this changing relationship between agriculture and forestry, including increasing pressures on the agriculture sector, the prospect of CAP reform and the possible impact of Scottish land reform.

land-based sectors. Thus it would appear that the role of forestry varies according to the characteristics of the economy in which it is located[9].

Apart from the level of employment associated with a sector, the stability of that employment is also important. In this respect, forestry with its long production cycle and uneven spread of labour is far from ideal (Thomson and Psaltopoulos, 1993; Sullivan and Gilles, 1990). However, Berck et al. (1992) use an extended input-output model to illustrate that, contrary to expectations, forestry-dependent regions may be no more unstable than regions specialised on another type of industry. Their analysis suggests that in certain circumstances, forestry dependence is preferable to the situation where a region diversifies. Given that diversification is often advocated as a key rural development strategy, their analysis raises important questions in relation to the appropriate economic structure of rural economies.

Nevertheless, whilst public forestry in the U.S. places much emphasis on "smoothing" the patterns of employment in forest-dependent regions through appropriate management of forest resources, experience has shown that ensuring production stability does not necessarily result in income and employment stability (Wear and Hyde, 1992). Moreover, policies that aim to increase community stability through commercial timber-based employment may do so at a cost to other forest uses such as recreation, tourism, access, and biodiversity. Importantly, these other outputs from forestry provide alternative income and employment opportunities for local economies (Broom et al., 1998). For example, forest-based recreation, tourism and access have associated benefits for local rural businesses supplying food, accommodation, souvenirs etc. Forestry clearly also contributes to the welfare of local and non-local residents alike through its provision of non-market environmental services (Crabtree et al., 1997; Crabtree, 1997). Thus policies aimed at optimising the supply of timber are not necessarily the best ways of ensuring the optimal levels of social benefits for communities as a whole.

Finally, the policy emphasis on commercial timber production has also had certain distributional consequences. In particular, as the industry has become more and more capital-intensive, more of the benefits from increased activity accrue to the providers of the capital who are often based outside the immediate local economy (Wear and Hyde,1992)[10]. Thus the shift in policy objectives and new policy instruments may bring about a change in the extent to which the sector generates benefits within the area in which it is located.

9 Both of these references are now somewhat dated. Given the significant changes in forest technology that have occurred over the last two decades, it could be argued that the role of forestry varies not only with the characteristics of the economy but also the period in which the analysis takes place.

10 Likewise, the tax relief given to high-rate taxpayers in the early 1980s in the UK also resulted in a flow of benefits from forestry to often non-resident high-income individuals.

4. Construction and Analysis of the Forestry Input-Output tables

This chapter describes the various steps involved in the construction of a balanced, disaggregated input-output table for Scotland, emphasising the role of the forestry sector. It begins by describing the way in which the sector is represented in the most recent 1995 input-output tables, produced by the Scottish Office Education and Industry Department. Whilst the data in these tables provided the basis of the disaggregation process, the figures relating specifically to forestry were adjusted for a number of reasons. Having described these adjustments, the chapter moves on to outline the survey methods used to collect data on the various different forest types and then presents some of the key findings from the survey. Section 4.4 describes the way in which the 1995 Inventory of Woodlands and Trees (Forestry Commission, 1998) was used to aggregate the survey findings up to industry level and the resulting tables balanced using standard input-output techniques. The chapter finishes with a brief description of the methods used to generate the four sub-national input-output tables for the analysis of the sector's role in the regional economy.

4.1 The forestry sector in the 1995 Scottish input-output tables

Unlike the UK Input Output Tables which contain a single aggregate forestry sector, the Scottish Input Output Tables distinguish between two sub-sectors – forest planting and maintenance, and forest harvesting. In this way the Scottish tables differentiate between the two most important employment-creating stages in the forest production cycle. Within the tables, the accounting balances are maintained by forest planting and maintenance "selling" its output to the change in the value of stocks column, whilst the forestry harvesting sector "buys" standing timber from the Sales by Final Demand[11] row of the tables.

Table 4.1 and Table 4.2 indicate the broad pattern of input expenditure and output sales of forestry recorded in the 1995 Scottish input-output tables. These figures represent the direct linkages of the sector within the Scottish economy and, as such, are key determinants of the magnitude of multiplier effects associated with the industry. The costs and returns from woodland thinning are, by convention, included in the forestry harvesting accounts of the tables as opposed to the planting and maintenance accounts.

The input expenditure data in Table 4.1 indicates the relatively low intermediate purchase requirements of both forestry activities but also the relatively high proportion of expenditure on labour. This explains the findings of previous multiplier studies that Type II forestry multipliers (incorporating the induced effects associated with household incomes) are significantly greater than the Type I multipliers of the sector which arise purely from inter-industry dependencies. What is surprising from Table 4.1 is the estimated zero level of intra-industry transactions. Since the list of activities classified under the SIC92 system as part of the forestry sector includes several activities providing goods and services to forestry itself (e.g. tree nurseries, stakes), one would expect to find a value representing intra-industry flows in the Scottish table similar to that of the agriculture sector[12].

The pattern of sales from the sector, shown in Table 4.2, shows the importance of sales from forestry to the timber and wood processing sector. However it also indicates a surprisingly high value of exports of roundwood from Scotland nearly all to the rest of the UK. Whilst some of the timber may then return to Scotland for further processing, the figures suggest a significant immediate leakage of benefits from increased harvesting activity in Scotland.

11 The Sales by final Demand account in the input-output tables is used as an accounting convention to accommodate for second hand transactions in the economy. Unlike any other account, its entries are such that the row and column sum equal zero.

12 Estimates of the direct flows between forestry and other industries were based solely on data supplied by the Forestry Commission This may be the reason why intra-industry transactions are estimated as zero in the Scottish input-output tables.

Having analysed the data in the Scottish tables in depth and considered the requirements of this study, it was decided that, rather than adopt a "top-down" approach to the disaggregation of the sector, forcing survey results to be consistent with the Scottish level data, estimates of direct flows between each forest type and the rest of the economy would be based on survey findings. In other words, the elements within the rows and columns of the final input-output table would be allowed to differ from those in the Scottish 1995 tables. However, to maintain consistency with the tables and in particular the relative importance of the sector in the economy, the gross value of output and inputs of the forestry harvesting accounts would be constrained to that in the Scottish table, £111m. Likewise, the gross value of output and inputs of the forestry planting and maintenance sectors would be made consistent to that in the Scottish table after having allowed for intra-industry transactions.

Table 4.1 Input expenditure of the sector, 1995 Scottish input-output tables (£m)

	Forest Planting/maintenance	Forest Harvesting
Agriculture	1.8	0
Forestry	-	-
Construction	3.0	11.7
Distribution and Motor Repair, etc	13.1	-
Other Land Transport	1.7	17.4
Other intermediate demand	12.4	7.3
Total intermediate demand	32.0	36.4
Imports	7.9	0.4
Sales by Final Demand	1.0	2.4*
Taxes	2.2	0.5
Subsidies	-10.6	-25.4
Income from Employment**	29.0	16.3
Other Value Added	24.3	80.4
Total Primary inputs	53.8	74.6
TOTAL INPUTS	85.8	111.1

*Estimated purchases from stocks of standing timber
** Includes income from self-employment
Source: Scottish input-output tables,1995

Table 4.2 Pattern of sales from forestry, 1995 (£m)

	Forest Planting/maintenance	Forest Harvesting
Timber & Wood	0	31.8
Furniture	0	0.9
Construction	0.1	4.1
Other intermediate sales	0.1	1.8
Total Intermediate Demand	0.2	38.6
Consumer Expenditure	-	11.9
Government Expend	0	0.1
Stocks	85.4	-
Exports	0	60.5
Total Final Demand	85.4	72.5
TOTAL DOMESTIC OUTPUT	85.6	111.1

Source: Scottish input-output tables,1995

4.2 Survey of the Scottish forestry sector

To carry out the proposed disaggregation of the sector, information was required on the source and level of inputs, source and level of labour, level and pattern of sales to different types of outlets and their destination, all by forest type and region. Thus a face-to-face survey of private woodland owners and contractors and harvesters was carried out with the data collected also feeding into the spatial tracking stage of the analysis.

Given the nature and length of the forestry production cycle, it was felt that, rather than just collecting "normal" input-output information, i.e. costs and receipts for a single year, the survey should try and collect income and expenditure data for the whole production cycle of a woodland. This would then be used, in conjunction with national inventory of woodlands data to aggregate results up to the Scottish level for 1995. The requirement of full-cycle data from the survey was also driven by the fact that three of the six forest types chosen for the study (farm woodlands, crofter forestry and new native woodlands) have only recently undergone rapid expansion and thus have yet to reach maturity. Whilst asking woodland managers their anticipated costs and revenues associated with the whole production cycle of a woodland is clearly far from ideal, it does provide information on which harvesting multipliers and downstream effects of these new forest types could be estimated. Further, it is a relatively simple matter to provide some sensitivity analysis on the estimates by altering key variables such as the proportion of area harvested and the value of output.

The first step in conducting the survey was that of obtaining a suitable sampling frame. One of the most comprehensive sources of contact information for forest managers is the database used for the administration of the Woodland Grant Scheme. The structure of this database is quite complex and not originally designed for survey use. However it was possible to aggregate various data tables in such a way as to identify certain characteristics of approved plantings including the woodland type, size and location.

Whilst the survey sample was based on the characteristics of a particular woodland, the sampling method was such that it focussed on the selection of forest managers rather than the forests themselves. Data from the WGS shows that many managers, agents in particular, are responsible for a number of clients and plans, and so are likely to be important sources of information. In this way, some interviewees were able to provide data based on woodlands in addition to that drawn in the sample, thus extending the data available for analysis and improving the reliability of estimates relating to the "new" forest types. In addition to the private woodland sample, further interviews with Forest Enterprise staff were conducted in various conservancies around Scotland. An example copy of the questionnaire is given in Appendix 2.

A total of 81 face-to face interviews were carried out with the sample selected to cover all four regions of Scotland, and the appropriate coverage of woodland types and sizes in each region. With 8 questionnaires not completed in a form that could be utilised in the analysis, analysis was based on the returns of 73 interviews covering 78 woodlands. Table 4.3 indicates the spread of woodland types and regional location covered by the survey.

Table 4.3 Usable survey returns by region and forest type

	Woodland type						
Region	A	B	C	D	E	F	TOTAL
Southern Scotland			4	13		3	20
Tayside	2	6	3	4			15
Grampian	1	5	3	6			15
Highlands	7	3	7	5	4	2	28
TOTAL	10	14	17	28	4	5	78

A: Existing Native woodlands
B: New-planted Native Woodlands
C: Commercial Conifer Plantations
D: Farm Woodlands
E: Crofter Forestry
F: Community Woodlands

Taking into account the area covered by interviews with Forest Enterprise managers, the total area of woodland covered by the sample was 350,633 ha, or 28% of the total forested area of Scotland in the base year of the study, 1995.

In addition to information on the costs and revenues associated with different stages of the woodland production cycle, the forestry questionnaire also ascertained the source (destination) of inputs (outputs). In the case of woodlands yet to mature, the intended (or usual) destination of output was recorded. Using post-code based GIS analysis, this was used to provide information on the spatial spread of the direct flows between forestry and the wider economy. Further, a sub-sample of input suppliers and output purchasers was generated and targeted for a follow-up survey asking them the source and destination of their own inputs and outputs. The sample frame and findings from this exercise are reported in Chapter 7.

4.3 Results from the forestry survey

The survey provided a wealth of information on the costs and revenues associated with different forest types. Of particular relevance to the study in hand is the extent to which different forest types have different input expenditure patterns and output flows, and whether these in turn vary between regions.

It became clear early on in the analysis that the category of woodland classified as community woodlands for the study was far from homogenous. Whilst all were community-owned, some were being managed for commercial purposes, others for recreation and environmental reasons. The actual types of woodlands falling into this category also varied, some being large coniferous plantations purchased from Forest Enterprise, others small native woodlands close to population centres. Given this diversity, it was considered futile to try and generate "average" input and output figures for this category and instead the five completed survey returns were reallocated to another woodland type as appropriate. Likewise the sample size for crofter woodlands was considered too small to generate reliable estimates and these questionnaires were included with the farm woodland type[13].

Given these adjustments, Table 4.4 presents basic data relating to the remaining four different forest types as generated from the survey returns.

13 In fact, the survey returns relating to crofter woodlands were very similar those from farm woodlands. Thus the original intention of having a separate category for the purposes of the input-output study may not have been merited in any case.

Table 4.4 ***Average base data by woodland type***

	TYPE A	TYPE B	TYPE C	TYPE D
Sample size	*10*	*14*	*19*	*35*
Total area of woodland (ha)	760.52	136.74	616.20	43.30
Unplanted area (ha)	418.53	41.16	85.77	4.73
Planted area (ha)	341.99	95.58	530.43	38.57
Planted for commercial reason? 1=yes, 2=no	2.00	1.86	1.00	1.69
Average length of rotation (years)	-	67.00	48.12	50.63
Anticipated profit from woodland (%IRR))	0.00	0.54	3.71	3.00

As anticipated, the two "new" woodland types, farm woodlands (Type D) and new native woodlands (Type B) were found to be, on average, considerably smaller than either commercial coniferous plantations or existing native woodlands. More surprising was the proportion of woodlands that were not being managed for commercial timber reasons and the consequently low level of anticipated profit which the timber element of the enterprise was expected to yield. Instead many interviewees cited environmental or recreational reasons for the establishment and maintenance of the woodlands, supported by the availability of grant income.

Returns to scale for certain of the input costs were very evident from the survey returns, as was the relatively large variability in some of the costs due to site-specific factors. Table 4.5 compares the average costs per hectare associated with establishing and maintaining the woodlands, and supports the hypothesis that per hectare expenditures differ significantly between the types. The table shows both the average direct costs of owners and managers who carried out the work themselves and the average costs of those who chose to employ contractors. In some cases, comparison of the two alternatives is confused by the fact that only contract labour was "purchased" by the forest owner/manager whilst in other cases the contract cost included both labour and materials. For the purpose of the study, all contract costs had to be analysed and, if appropriate, split to separate out costs of materials from costs of labour. In difficult cases, this was aided through discussions with experts in the industry.

The standard deviations presented in the table indicate the degree of variability in costs per hectare found from the survey. The average figures presented in the table should be interpreted in the light of this variability.

Table 4.5 Average costs per hectare associated with planting and maintenance by woodland type (£)

	AVERAGE COSTS (£/Ha)			
	TYPE A	TYPE B	TYPE C	TYPE D
Sample size	*10*	*14*	*19*	*35*
DIRECT LABOUR COSTS PER HECTARE				
Establishment	21.23	49.67	47.56	119.33
Maintenance	6.21	14.96	16.74	45.80
DIRECT PURCHASES				
Chemical Weedkiller & Pesticides	0.30	0.00	10.26	10.42
Fencing Materials	126.19	121.91	40.39	107.26
Fertiliser	0.97	4.90	2.88	2.65
Hiring Equipment	0.00	6.41	0.00	1.17
Insurance	2.55	1.66	0.65	98.65
Legal Costs	0	0	0.36	0.76
Machinery Repairs	0	0	6.19	65.09
Plants/Ha	12.39	145.04	167.44	278.51
Misc	0.91	0.12	20.76	4.36
Stakes and tubes/Ha	0.54	19.11	18.05	254.69
Trees for beating up	0.25	4.00	45.59	154.86
CONTRACTING COSTS				
Beating Up	31.87	92.26	366.95	70.18
Chemical Weeding/Spraying	1.58	5.78	73.88	63.74
Drains	0.85	3.61	12.48	0.48
Fencing	36.52	72.57	16.28	452.61
Fertilising	0.00	0.35	6.01	6.72
Maintenance	2.81	0.23	51.73	14.80
Management	0.00	5.67	4.25	19.46
Mounding and other ground preparation	7.58	295.36	128.89	31.38
New Planting	11.45	226.70	42.83	182.75
Misc Contract	10.14	36.06	302.79	53.69
Total input costs per hectare	246.88	1041.71	1322.66	1874.24
Standard Deviation	*308.9*	*1347.2*	*1724.1*	*1501.0*
Grant income per hectare	224.67	512.16	220.64	1505.35

In terms of the harvesting, costs and expected returns were also shown to vary significantly by forest type and scale. Table 4.6 indicates the average per hectare returns either received or anticipated from various different types of output. "Other" output includes, amongst other things, returns from stalking, venison sales and recreation.

Table 4.6 Average value of output per hectare by woodland type over one rotation (£/Ha)

	TYPE A	TYPE B	TYPE C	TYPE D
Sample size	*10*	*14*	*19*	*35*
Fencing posts	21.16	0	0.06	0
Christmas trees	0	0	0.11	0
Firewood	60.94	0.93	0	29.47
Thinnings	48.66	48.66	24.40	72.93
Timber	0	381.07	1551.66	982.54
Other income	0.74	0	86.82	55.90
Total	131.5	430.66	1663.05	1140.84

4.4 Aggregation to industry level and balancing the table

Having generated costs and returns on a per hectare basis for each woodland type, the next step in constructing the input-output table involved reclassifying these flows onto an input-output basis and aggregating the survey results up to the industry level.

The reclassification of products and services into input-output accounts was straightforward. Rather than maintaining the full 123-sector breakdown of the Scottish input-output tables, the accounts were aggregated to 34 sectors to focus attention on forestry and forestry-related flows in the economy. The final classification scheme is given in Appendix 3.

The process of aggregating the survey results to industry level was more time consuming. The basic source of information used was the 1995 National Inventory of Woodlands (Forestry Commission, 1998). This provided information on a number of variables including the age, ownership, type, species and size of woodlands throughout Scotland for the base year of the study. However, the woodland types differentiated in the inventory differed from those adopted for the purpose of this study. Therefore a "bridging" classification needed to be drawn up to link the two studies. These rules were based on the various (known) attributes of the study woodland types, such as the fact that new and existing native woodlands contain certain species types and not others, that new native woodlands are not older than 10 years, etc.[14] The type most easily identified from inventory data was commercial coniferous woodlands which dominates Scottish forestry in terms of land cover.

Table 4.7 presents the total areas of each woodland type estimated from detailed analysis of the inventory data.

Table 4.7 Estimated coverage of each forest type from inventory data (ha)

	Southern Scotland	Tayside	Grampian	Highlands	TOTAL
A	48864	49487	58076	143310	299737
B	1413	1218	1257	3227	7115
C	255637	80158	70166	329969	735930
D	-	-	-	-	37909
(D based on WGS	*9137*	*7129*	*3781*	*15312*	*35359)*
Other	-	-	-	-	171571
Total Scottish woodland cover 1995	-	-	-	-	1252262

The estimate of coverage of farm woodlands came within 7% of the area of approved farm woodland plantings from the WGS database giving some credibility to the bridging process[15].

Information collected as part of the forestry survey had identified the stages in the woodland production cycle when various activities would be carried out. Therefore, once the area and age structure of each of the study's forest types had been derived from inventory data, the process of generating input-output flows for 1995 was simply a matter of linking the two sources of information and forming (unbalanced) estimates of the expenditures and revenues of each forest account.

The final process in generating the input-output table was to balance the table to ensure that the necessary accounting identities were maintained. This was achieved through the standard input-output method known as "RAS" (Bacharach, 1970). This involves adjusting the cells of the initial unbalanced table on an iterative basis so that their row and column totals meet the required

14 A residual "other" woodland cover type was identified as part of the bridging process. This included for the most part small woodlands (under 5 hectares), and non-native woodlands over 80 years old.

15 The WGS estimate was adopted for use in the aggregation process and the residual attributed to the "other" woodlands category.

constraints[16]. The adjustment is carried out in such a way as to ensure that the difference between the entries in the initial and final, balanced table is minimised.

Appendix 4 presents the final balanced 1995 Scottish input-output table emphasising forestry. Since two of the forest types were not harvested in the base year of the table, the harvesting accounts of these types have null entries. Thus, in order to investigate the potential linkages between these types and the wider Scottish economy, two additional balanced tables were generated, "Equilibrium 1" and "Equilibrium 2". These attempt to reflect the situation when woodland types B and D reach maturity with the differences between Equilibrium 1 and 2 relating to assumptions regarding the proportion of planted woodland area that is eventually harvested for commercial reasons.

Equilibrium 1 input-output table is based purely on the survey findings. Anticipated average costs of harvesting per hectare and expected average output values per hectare of woodland were taken from survey results and, in conjunction with forest inventory data, used to generate rows and columns in the input-output tables reflecting the harvesting stages of native woodlands and farm woodlands. Critically, in this table, the total value of output from these new sectors was based only on the proportion of woodlands that survey respondents anticipated as being harvested for commercial purposes.

In contrast, on the grounds that some survey respondents may have underestimated the potential value of their woodland once it reaches maturity, another table was generated, in this case assuming that the total area planted of new native and farm woodlands would, at maturity, be harvested. The latter table, labelled Equilibrium 2, is likely to overstate the potential activity level of the sector at maturity just as the 1995 base table understates it. Nevertheless, generating and comparing multipliers from all three versions of the table gives some indication of the spread and range of potential linkages associated with the differing forest types. Thus multipliers from these two additional input-output tables were derived and compared to those from the basic 1995 table. The results are discussed in the following chapter (section 5.3) and in Appendix 5.

4.5 Generation of regional forestry tables

In order to investigate possible regional differences in the multiplier effects associated with forestry, four regional input-output tables were generated, relating to Southern Scotland, Tayside, Grampian and Highlands respectively.

The process of generating regional tables involved two steps. Firstly, the Scottish level input-output table was disaggregated into 4 regional tables using a Generating Regional Input-output Tables (GRIT) method (Jenson et al. 1979). A number of alternative GRIT methods exist. In this case the method used involved the derivation of cross-industry location quotients (CILQ) from employment statistics at the 114-sector level. These quotients indicate the ratio of the proportion of national employment in selling industry i in a region to the proportion in purchasing industry j[17]. Having calculated a CILQ for each of the inter-industry transactions taking place in the economy, these were then used to adjust the coefficients from the Scottish table to reflect the structure of the economy at the regional level.

Having generated region-specific inter-industry flows, the forestry sector in each regional table were then adjusted to reflect the particular nature of forestry in each region. Unfortunately, the sample size

16 For the sector accounts the constraint is that the total value of gross output (row total) equals the total value of gross inputs (column total) where the latter includes profits and additions to capital accounts.

17 For example, focussing on sales from agriculture to forestry and assuming that 10% of total Scottish employment in agriculture is based in region 1, whilst 20% of Scottish forestry employment is in the region, then the CILQ for this particular transaction is calculated as

$$CILQ_{agric,\ forestry} = 0.1/0.2 = 0.5$$

On the grounds that this indicates that local agricultural production is insufficient to satisfy regional forestry demand, the coefficient in the national input-output table will be reduced and the level of estimated imports of agricultural goods into the region increased accordingly.

of the forestry survey was such that it was not possible to differentiate between forest types at the regional level. Instead, forestry in each region is represented by two aggregate sectors as in the Scottish input-output tables – all forestry planting and maintenance and all forestry harvesting. However, rows and columns relating to these sectors for each region were estimated on the basis of survey estimates and the relative proportion of different forest types in each region (see Table 4.7).

5. Scottish and Regional Multiplier Analysis

5.1 Introduction

This chapter presents the multipliers from the forestry input-output tables described in the previous Chapter. Having generated balanced, disaggregated input-output tables, the process of deriving multipliers is straightforward. Technical details of the methods used and the underlying assumptions of both the demand and supply-driven versions of the model are given in a number of texts including Miller and Blair, 1985, and Bulmer-Thomas, 1982. However, before analysing the multipliers, a brief non-technical description of both versions of the input-output model, and other multiplier-related concepts is provided.

5.1.1 The Demand-driven input-output model

The demand-driven input-output model is that most commonly used to assess the interdependencies that exist between sectors of an economy. Based on the assumption of fixed input coefficients, the model solves for the level of gross output in an economy consistent with a given (exogenous) level of final demand. The model is called "demand-driven" because it is the demand for inputs directly and indirectly that creates multiplier or knock-on effects in the economy. Multipliers from this version of the model thus measure the so-called backward linkage effects in the economy.

5.1.2 The Supply-driven input-output model

In addition to the backward linkage effects, some writers have argued that the forward linkage effects in an economy are of equal interest, particularly in relation to changes in the forestry sector (Jones, 1976, Schallau and Maki, 1983, Shallau and Maki, 1986). In this case, the argument is that the level of output from a particular sector influences the level of output of the sectors which use its product as an input. For example, in the case of forestry, it might be argued that an increase in raw timber supplies would bring about an increase in timber processing downstream through forward linkage effects. Several alternative ways of trying to quantify forward linkages have been suggested[18]; however, that most commonly used is based on the so-called supply-driven version of the input-output model.

The supply-driven input-output model solves for the level of gross output in the economy consistent with a given level of primary inputs. It is based on the assumption of fixed output proportions[19]. The multipliers from this version of the model can be used to generate measures analogous to those used on multipliers from a demand-driven model, but in this case the measures reflect the forward as opposed to backward linkage effects of a sector.

5.1.3 The "open" input-output model and Type I multipliers

The basic form of an input-output model is often referred to as an open input-output model. It focuses purely on inter-sectoral linkages in an economy, that is the fact that no sector in an economy operates in isolation but is linked, through the demand for material inputs and supply of output, to other sectors in that economy. The multipliers from an open input-output model indicate the total effect in the economy of a unit increase in final demand for one particular sector's output taking into account not only the direct effects of the increased demand but also the indirect effects as the initial impact spreads through the economic system. Payments to primary inputs such as labour and capital are effectively treated as leakages in this version of the open input-output model.

18 See Bulmer-Thomas (1985) for a discussion of their relative merits.

19 For example, it is assumed that if the output of sector i increases by, say, 10%, then sales to each of the sectors and final demand categories that buy output from sector i also increase by 10%: the pattern of output distribution remains constant.

Type I multipliers, derived from open input-output models, express the effects arising from a unit change in final demand in the system as a ratio of the total multiplier effects to the direct effects arising from the impact. For example, a Type I employment multiplier is calculated as

$$\text{Type I employment multiplier} = \frac{\text{Total employment effect (including direct plus indirect)}}{\text{Direct employment effect}}$$

5.1.4 The "closed" input-output model and Type II multipliers

In input-output terminology, model "closure" involves treating an additional row and column of the input-output table as endogenously determined, or determined by the level of sectoral economic activity as opposed to external factors. Typically, the additional row relates to income from employment and the column to private household consumption. By endogenising household income and expenditure, the modeller allows for so-called induced effects in the economy, effects which come about as a result of additional income from employment being spent on domestic goods and services. The cost of allowing closure of the model in this way is that the assumption of fixed expenditure coefficients extends beyond inter-industry transactions to household consumption patterns. Explicitly, it is assumed in closed models that households spend any additional income from the increased economic activity in exactly the same manner as observed in the input-output table - double their income and they will double the amount they spend on food, double the amount they spend on leisure goods, double the amount saved etc[20]. Despite the lack of credibility of this assumption, the recognition that there are multiplier effects arising from household spending is sufficient to make the presentation of multipliers from closed versions of input-output models fairly standard.

Type II multipliers are based on the results from a closed model, thus incorporating induced as well as direct and indirect effects. Like Type I multipliers, they are expressed as ratios of the total multiplier effect on the economy to the direct effect of a unit change in a particular sector. For example, a Type II employment multiplier would be calculated as

$$\text{Type II employment multiplier} = \frac{\text{Total employment effect (direct plus indirect plus induced)}}{\text{Direct employment effect}}$$

Specific examples and their interpretation will be given as part of the discussion which follows.

5.2 Multipliers from the 1995 input-output model

Table 5.1 presents the output multipliers, employment and income effects for forestry and forestry-related sectors based on the 1995 version of the input-output table. The multipliers are all demand-driven and thus reflect the backward linkages of the sectors. The rank positions shown in the table indicate the relative performance of each sector out of a total of 40 sectors with position 1 indicating the highest multiplier value of all sectors, position 40 the lowest. The unit output multipliers and zero income and employment effects associated with sectors B2 and D2 (harvesting of new native woodlands and harvesting of farm woodlands) are explained by the fact that in the 1995 version of the table, these sectors had not yet reached maturity and thus their potential for stimulating effects within the wider economy is zero. For comparative purposes, the multipliers relating to "all" Scottish forestry are also presented[21].

20 In technical terms, it implies that the income elasticity of demand for all goods and services is unitary.

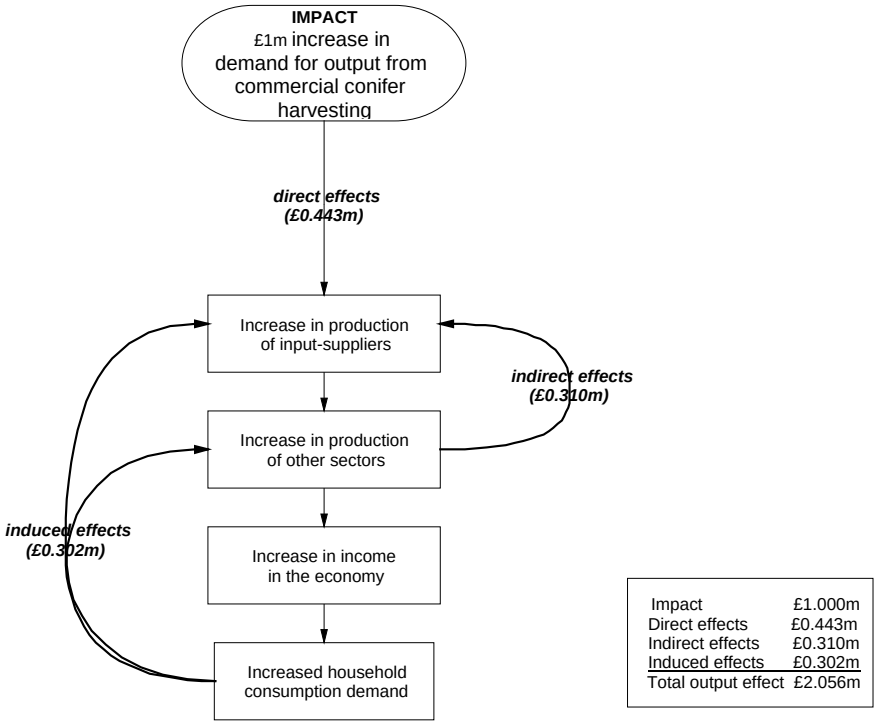
21 The latter are derived from the survey-based 1995 input-output table as opposed to the published Scottish input-output tables.

Table 5.1 ***Output multipliers, employment and income effects for forestry and forestry-related sectors, 1995 input-output model***

	Open model				Closed model			
	Type I Output multiplier	*Rank*	Employ. Effect (FTEs)	Income effect (£m)	Type II Output multiplier	*Rank*	Employ. effect (FTEs)	Income effect (£m)
Woodland types								
Existing native planting/maint.	1.392	*28*	12.303	0.230	1.585	*35*	15.078	0.282
Existing native harvesting	1.392	*27*	36.462	0.346	1.683	*30*	40.639	0.424
New native planting & maint.	1.728	*8*	19.014	0.367	2.037	*10*	23.445	0.450
New native harvesting	1	*=39*	0	0	1	*=39*	0	0
Commercial con. plant/ maint.	1.581	*15*	36.268	0.717	2.183	*4*	44.918	0.878
Commercial conif. harvesting	1.754	*6*	29.186	0.359	2.056	*8*	33.521	0.440
Farm planting and maint.	1.504	*19*	12.527	0.243	1.708	*28*	15.454	0.297
Farm harvesting	1	*=39*	0	0	1	*=39*	0	0
All Scottish forestry								
Planting/maintenance	*1.541*	-	*23.497*	*0.461*	*1.928*	-	*29.061*	*0.564*
Harvesting	*1.714*	-	*29.986*	*0.358*	*2.015*	-	*34.304*	*0.438*
Downstream Sectors								
Timber and wood products	1.733	*7*	26.010	0.367	2.041	*9*	30.439	0.449
Paper and pulp	1.520	*17*	12.124	0.261	1.739	*24*	15.269	0.319
Paper products	1.463	*22*	14.336	0.332	1.742	*23*	18.344	0.407
Furniture	1.378	*32*	23.116	0.405	1.719	*27*	28.004	0.496

Figure 5.1 illustrates the various components of the multipliers focussing on the Type II output multiplier effect of commercial conifer harvesting.

Figure 5.1 ***Generation of Type II output multiplier effects: commercial conifer harvesting***



The different types of forestry are shown to generate very different levels of multiplier effects in the economy. Focusing first on the harvesting sectors, commercial coniferous harvesting is shown to generate the highest multiplier effects once the induced as well as direct and indirect linkage effects are taken into consideration. Specifically a £1m increase in demand (the impact or injection into the system) leads to the sector demanding £443,000 worth of additional inputs from industries which support harvesting activity. This is known as the "direct effect" of the increase in final demand. The direct effect then leads to a series of indirect effects as the input suppliers demand additional inputs from their own suppliers, and so on. The total value of indirect effects in the case of commercial conifer harvesting is estimated to be £310,000. However, the additional expenditure on wages and salaries needed to support the increase in economic activity will lead to increased household incomes and subsequently increased household consumption demand. The total value of these induced effects on the economy is estimated at £302,000 resulting in a total Type II output multiplier of 2.056. The £1m increase in demand is also estimated to generate a total increase in employment of 33FTEs jobs[22] and a total increase in income of £444,000. In comparison, the economy-wide multiplier effects associated with an increase in native woodland harvesting are lower. In particular, the total effect of a £1m increase in demand for output from harvesting existing native woodlands is estimated at £1.683m, the employment effect associated with the increased demand is 40 additional FTE jobs and the increase in income in the economy £424,000. The differences can be traced back to the differing pattern of input demands of both harvesting sectors. Although it is more labour intensive per unit output (see employment effect)[23], harvesting of existing native woodlands involves fewer purchases of inputs from other Scottish production sectors than coniferous harvesting, thus resulting in fewer indirect output and income effects being generated within the economy.

In terms of forest planting and maintenance, again coniferous plantations generate higher multiplier effects than the other forest types once induced effects are accommodated in the analysis. However the economy-wide effects of an increase in new native woodlands also appear significant with a £1m increase in demand for output generating a total output effects of £2.037m, 23 additional FTE jobs and an increase in income of £450,000.

Table 5.2 again presents the income and employment effects associated with the forestry sectors in the 1995 model but in this case presents them as Type I and Type II multiplier effects.

Table 5.2 ***Type I and Type II income and employment multipliers of forestry and forestry-related sectors, 1995 input-output model***

	Employment multipliers				Income multipliers			
	Type I	*Rank*	Type II	*Rank*	Type I	*Rank*	Type II	*Rank*
Existing native planting/maint.	1.703	20	2.088	20	1.586	24	1.941	24
Existing native harvesting	1.183	38	1.319	40	1.477	28	1.809	28
New native planting & maint.	2.075	14	2.559	14	1.995	12	2.442	12
New native harvesting	-	-	-	-	-	-	-	-
Commercial planting & maint.	1.279	36	1.584	33	1.257	39	1.539	39
Commercial harvesting	1.620	25	1.860	26	2.623	7	3.211	7
Farm planting and maint.	2.261	8	2.789	11	2.180	8	2.669	8
Farm harvesting	-	-	-	-	-	-	-	-
Timber and wood products	1.774	18	2.076	22	2.025	10	2.479	10
Paper and pulp	2.141	12	2.696	13	1.977	13	2.420	13
Paper products	1.793	17	2.295	15	1.600	23	1.959	23
Furniture	1.305	34	1.581	34	1.324	34	1.621	34

22 Employment effects are based on the full-time equivalent full time equivalent no of employees.

23 The survey suggested that *per unit output harvested*, the direct employment requirements in the case of native woodlands were higher than those involved in conifer harvesting. This is reflected in the higher total employment effects associated with this sector.

The Type 1 and II multipliers express the total effect in the economy relative to the direct effects in the sector itself. This presentation of the results alters the relative performance of sectors. In particular, focussing on commercial coniferous forestry, the Type I employment multiplier indicates that, for every 100 jobs created directly in planting and maintaining coniferous plantations, a further 28 would be created indirectly through backward linkage effects. In contrast, for every 100 jobs created directly in planting and maintaining farm woodlands, a further 126 would be created indirectly in the economy. From a policy perspective both the absolute income and employment-generating potential of a sector (shown by the employment effects measures included in Table 5.1) and its ability to generate jobs indirectly (as indicated through the Type I and II multipliers shown in Table 5.2) may be of importance.

Up to this point, the discussion has focussed on multipliers from the demand-driven version of the 1995 input-output model. Table 5.3 considers instead the forward linkage effects of forestry from the supply-driven version of the model.

Table 5.3 ***Supply-driven multiplier effects of forestry and forestry related sectors, 1995 version of model***

	Open model			Closed model		
	Supply-driven output multiplier	*Rank*	Employ. effect (FTE)	Supply-driven Output multiplier	*Rank*	Employ. effect (FTE)
Forestry sectors:						
Existing native planting/maint.	1.171	*33*	9.313	1.181	*36*	9.493
Existing native harvesting	2.099	*4*	47.171	2.327	*10*	51.397
New native planting & maint.	1.200	*31*	11.711	1.214	*35*	11.970
New native harvesting	1.000	*=39*	0	1.000	*=39*	0
Commercial planting & maint.	1.116	*35*	29.575	1.117	*37*	29.601
Commercial harvesting	1.834	*8*	30.412	1.947	*20*	32.510
Farm planting and maint.	1.116	*36*	6.751	1.117	*38*	6.777
Farm harvesting	1.000	*=39*	0	1.000	*=39*	0
Downstream sectors:						
Timber and wood products	1.912	*6*	28.457	2.089	*16*	31.755
Paper and pulp	1.280	*28*	9.387	1.311	*32*	9.973
Paper products	1.571	*19*	16.684	1.738	*25*	19.792
Furniture	1.541	*21*	27.706	1.742	*24*	31.442

As described in section 5.1.2, forward linkage effects are driven by the assumption that a change in the level of output from a sector influences the level of output of the sectors that use the product as an input in their own production process. This contrasts strongly with the assumption of fixed input requirements that gives rise to backward linkage effects in the economy. Thus the forward linkage effects for the forestry sector are not equivalent to the backward linkage effects of the downstream processing sectors: the two effects are derived from two different models and two quite different representations of the way in which the economy operates.

In the case of the forward linkage effects, it is the pattern of output distribution which determines the relative magnitude of multiplier effects. Sectors that sell a large portion of their output to other sectors will generally have high forward linkage effects, while those that sell predominantly to final demand will have lower forward linkage effects. In the case of the forest harvesting sectors, the fact that 30% of output in 1995 was estimated as being exported from Scotland would lead one to anticipate fairly low forward multipliers. However both existing native woodland harvesting and coniferous harvesting have fairly high forward linkage effects. For example, a £1m injection into the

native woodlands harvesting sector is estimated to generate a total £2.33m output in the economy through supply-driven effects, that is, £1.33m over and above the initial injection. Commercial conifer harvesting has lower forward linkage multiplier effects with a £1m injection estimated to increase total Scottish gross output by £1.947m and employment by 32.5FTEs.

The difference between the forest types can be traced back to the higher proportion of exports per unit output from conifer harvesting than native woodland harvesting. These exports represent a direct leakage from the supply-driven model and thus do not generate any (indirect) forward linkage benefits for other sectors. Of course, in absolute terms the far greater size and value of output coming from commercial coniferous harvesting in Scotland means that it is currently associated with far more jobs downstream than native harvesting[24].

What is perhaps more surprising from Table 5.3 is the relatively low forward linkage effects of the planting and maintenance sectors. Since these are further upstream in the forestry industry, one would expect them to generate high forward linkage effects. The reason for their poor performance was traced to the way in which their output is treated within input-output accounting procedures. From Chapter 4, it can be re-called that the "output" of the planting and maintenance sectors is recorded in the input-output tables as an increase in stocks. Since stocks are exogenous to the model, this flow is treated in the supply-driven model as a direct leakage from the economy. Thus it can be argued that the forward linkage multipliers of these sectors are not adequately represented by the multipliers presented in Table 5.2 and, more importantly, by conventional input-output measures. In order to make sure that forest planting and maintenance activity is linked within the model with activity downstream in the forest production cycle, an alternative treatment of stocks of standing timber would be required.

5.3 Multipliers from the "Equilibrium 1" input-output model

The forestry industry in the 1995 input-output table is clearly not a sector at maturity or, expressed in another way, in equilibrium. Two of the forest types distinguished in the table – new native woodlands and farm woodlands - had not, in 1995, reached the age at which harvesting would take place. Thus, in order to get a fuller picture of the potential role of the sector in the Scottish economy, two additional input-output tables were generated. Both attempt to reflect the situation when the new categories of forest reach maturity but under differing assumptions as to the proportion of these woodlands that will be harvested for commercial purposes. Specifically, in the case of the Equilibrium 1 model, 14% of the new native woodland area and 32 % of the farm woodland area is assumed to be harvested at maturity for commercial reasons, whilst in the Equilibrium 2 model it is assumed that 100% of both woodland areas is eventually harvested.

Table 5.4 presents the output, employment and income effects generated from the Equilibrium 1 version of the input-output table, also presenting, for comparative purposes, the multipliers from the 1995 version of the model.

24 The multipliers from the supply-driven model, just like those from the demand driven model, focus attention on the marginal effects of an increase in a sector's activity and do not as such convey information on the relative importance of different sectors in absolute terms.

Table 5.4 ***Demand driven output multipliers, employment and income effects for forestry and forestry-related sectors, Equilibrium 1 input-output model***

	Open model				Closed model			
	Type I Output multiplier	*1995 multiplier*	Employ. Effect (FTE)	Income effect (£m)	Type II Output multiplier	*1995 multiplier*	Employ. effect (FTE)	Income effect (£m)
Existing native planting/maint.	1.394	*1.392*	12.359	0.230	1.587	*1.585*	15.140	0.282
Existing native harvesting	1.392	*1.392*	36.461	0.346	1.683	*1.683*	40.637	0.424
New native planting & maint.	1.730	*1.728*	19.042	0.368	2.039	*2.037*	23.479	0.450
New native harvesting	1.549	*1.000*	33.717	0.353	1.846	*1.000*	37.982	0.433
Commercial con. plant/ maint.	1.581	*1.581*	36.275	0.717	2.184	*2.183*	44.929	0.878
Commercial conif. Harvesting	1.754	*1.754*	29.185	0.359	2.055	*2.056*	33.519	0.440
Farm planting and maint.	1.506	*1.504*	12.558	0.243	1.710	*1.708*	15.490	0.297
Farm harvesting	1.406	*1.000*	35.951	0.345	1.695	*1.000*	40.110	0.422
Timber and wood products	1.746	*1.733*	26.450	0.367	2.054	*2.041*	30.876	0.449
Paper and pulp	1.520	*1.520*	12.131	0.261	1.739	*1.739*	15.277	0.319
Paper products	1.463	*1.463*	14.340	0.332	1.742	*1.742*	18.349	0.407
Furniture	1.379	*1.378*	23.134	0.405	1.719	*1.719*	28.023	0.496

As might have been anticipated, the equilibrium multipliers are slightly larger than those from the 1995 model. The multipliers relating to the timber and wood products sector are those most affected since they are now assumed to purchase output from two additional domestic sectors and thus generate larger indirect and induced effects within Scotland. In particular, focussing on the closed version of the model, a £1m increase in demand for output from the timber and wood products sector is shown to generate a total increase in gross output in Scotland of £2.05m, 31 extra FTE jobs and a £450 thousand increase in Scottish income.

Perhaps more interesting is how the two additional forest harvesting sectors compare with commercial coniferous harvesting and existing native woodland harvesting. Whilst coniferous harvesting still has the highest knock-on effects, in terms of output and income, based on information collected from the survey, new native harvesting appears to offer considerable benefits to the wider economy in terms of increased activity levels. It also generates larger output and income multiplier effects than existing native woodland harvesting. This can be traced back to differences that the survey found in terms of species type, woodland size and respondents estimates of the average harvesting costs per unit output of the two woodland types.

Table 5.5 turns attention to the forward linkage effects of the sector, presenting multipliers from the supply-driven version of the Equilibrium 1 input-output model.

Table 5.5 ***Supply-driven multiplier effects of forestry and forestry related sectors, Equilibrium 1 version of model***

	Open version of model		Closed version of model	
	Supply-driven Output multiplier	Employment effects (FTEs)	Supply-driven output multiplier	Employment effects (FTEs)
Existing native planting/maint.	1.171	9.314	1.181	9.494
Existing native harvesting	2.091	47.052	2.319	51.291
New native planting & maint.	1.200	11.712	1.214	11.972
New native harvesting	2.091	42.711	2.319	46.949
Commercial planting & maint.	1.116	29.576	1.117	29.602
Commercial harvesting	1.826	30.298	1.939	32.389
Farm planting and maint.	1.116	6.752	1.117	6.778
Farm harvesting	1.826	42.445	1.939	44.536
Timber and wood products	1.910	28.439	2.088	31.740
Paper and pulp	1.280	9.391	1.312	9.977
Paper products	1.571	16.690	1.738	19.801
Furniture	1.541	27.710	1.742	31.449

The forward linkage effects of the two new harvesting sectors are shown to be significant. For example, a unit increase in new native woodland harvesting generates a total forward linkage multiplier of 2.319 and an employment effect of 47 FTE jobs. Unlike the situation with the backward linkage multipliers, the forward linkage multipliers relating to new native woodland harvesting and existing native woodland harvesting are identical. This arises from the assumption that despite having different input requirements, the pattern of distribution of output from these two sectors is identical.

For comparison, Appendix 5 presents multipliers from the alternative Equilibrium 2 input-output table which correspond to the scenario where, at maturity, all farm woodlands and planted native woodland area is eventually harvested.

5.4 Regional Forestry multipliers

As discussed in Chapter 3, previous analysis has indicated that the multiplier effects associated with forestry are region-specific, varying significantly in accordance with the structure of the regional economy and, in particular, the location of upstream and downstream forestry industries. For this reason, regional multiplier analysis was carried out using the four input-output tables representing Southern Scotland, Tayside, Grampian and the Highlands.

The sample size of the forestry survey was such that it was not possible to differentiate between forest types at the regional level. Instead, forestry in each regional model is represented by only two accounts – "all" forest planting and maintenance, and "all" forest harvesting – with the row and column entries in these accounts estimated on the basis of survey findings and the relative proportions of different forest types in each region. Despite the fact that only two forest types were differentiated in the regional tables, analysis of the multipliers reveals some interesting findings. Table 5.6 presents the demand-driven output multipliers for each of the four regions. The fact that each region had differing proportions of each forest type ensured that the row and column entries of the forestry accounts differed in each of the regional input-output tables[25].

25 As with the Scottish-level multipliers, the multipliers relating to the downstream firms are based on the observed dependence on domestic and imported sourced timber in the base year of the models, 1995. Thus, even when, for example,

Table 5.6 Comparison of demand-driven forestry multipliers by region

	Output multipliers							
	South Scotland		Tayside		Grampian		Highlands	
	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
Forestry planting and maintenance	1.567	1.943	1.556	1.918	1.563	1.923	1.562	1.918
Forestry Harvesting	1.601	1.863	1.619	1.876	1.731	2.015	1.692	1.962
Timber and Wood Products	1.623	1.900	1.405	1.623	1.674	1.947	1.675	1.934
Pulp, Paper and Board	1.485	1.688	1.265	1.415	1.191	1.326	1.459	1.647
Paper and Board Products	1.389	1.644	1.243	1.452	1.403	1.648	1.435	1.684
Furniture	1.336	1.653	1.221	1.504	1.346	1.653	1.365	1.672

Each of the four regional economies is of a different size, with Southern Scotland producing the largest value of output and employing the highest proportion of the Scottish workforce. In general, the smaller the economy under analysis, the greater the leakages from the area and thus the smaller the multiplier effects arising from a change in economic activity. Thus one might expect *a priori* that Southern Scotland, being the largest economy, would have the largest multipliers for all sectors, the Highlands, the lowest. However, from Table 5.6, in the case of forestry-related sectors, the relative magnitude of multiplier effects appears to be more closely related to the structure of each particular economy and, in particular, the extent to which the forestry sector is more or less "contained" within the region. In particular, forestry harvesting in the Grampian and Highlands regions generate relatively high output multiplier effects since the mix of woodland types in these regions have relatively high input requirements at harvesting plus a large proportion of these requirements can be locally sourced[26]. Likewise, increased activity in the timber and wood products sector generates high backward linkage effects in the regions where raw timber is produced in abundance but lower knock-on effects in Tayside.

In terms of the demand-driven model, if a region has a low incidence of an industry supplying an input to forestry, it is assumed that the necessary inputs are imported from outside the region with the import representing a leakage from the model. In many cases, leakages from a region will benefit neighbouring regions in Scotland whilst others will accrue to further afield. In terms of the current model, the destination of leakages is irrelevant: once a leakage occurs, it generates no more multiplier effects within the region and is thus "lost" from the economy[27].

Table 5.7 again compares the multiplier effects associated with forestry in the four different regions of Scotland, in this case presenting the employment and income effects as well as Type II multipliers associated with the sector.

there is no use of domestic timber by say pulp and paper firms in a region, that sector will still generate multiplier effects in the wider regional economy due to its use of other inputs in its production process.

26 In practice, poorer access and growing terrain may also result in higher harvesting costs in Grampian and the Highlands.

27 In situations where it is likely that inter-regional feedback effects may occur (e.g. a leakage from region 1 to region 2 generating its own multiplier effects within region 2 which then leak back into region 1) an inter-regional input-output modelling framework is required (Miller and Blair, 1985).

Table 5.7 ***Income and employment effects and multipliers from the demand driven closed regional input-output models***

	Type II output multipliers	Employ. effect per £1m increase in demand (FTEs)	Type II employment multipliers	Income effect per £1m increase in demand (£m)	Type II income multipliers
Southern Scotland:					
Forestry planting/maint.	1.943	36.211	1.615	0.567	1.752
Forestry harvesting	1.863	36.299	1.533	0.394	2.668
Tayside:					
Forestry planting/maint.	1.918	33.180	1.671	0.561	1.732
Forestry harvesting	1.877	38.813	1.500	0.399	2.701
Grampian:					
Forestry planting/maint.	1.923	31.965	1.698	0.561	1.733
Forestry harvesting	2.015	28.685	2.091	0.442	2.990
Highlands:					
Forestry planting/maint.	1.918	22.043	2.213	0.560	1.732
Forestry harvesting	1.962	27.646	2.046	0.424	2.874

The employment effects associated with increased forestry activity in the Highlands region seem low in comparison with those in other areas, particularly Southern Scotland. The reasons for this was traced back to the lower employment per unit output from the forestry sector in the Highland region as compared to the other regions. In part this may in turn reflect a higher proportion of self-employment in forestry in the Highlands[28]. In contrast the income effects associated with the sector in the Highlands appear far more consistent with the estimates of gross output effects.

In terms of new planting, Southern Scotland appears to offer the greatest potential economic benefits with a £1m increase in demand for output from planting and maintenance sector generating a total increase of £567,000 income in the region or, from the Type II income multiplier, £752,000 for every £1m increase in income in planting and maintenance itself.

Table 5.8 turns attention to the forward linkage effects associated with forestry in each region. Based on the supply-driven version of the regional models, the table illustrates the potential effects associated with increased supplies of output to sectors downstream in the forestry production chain.

Table 5.8 ***Supply driven output and employment effects from regional closed regional models***

	Southern Scotland		Tayside		Grampian		Highlands	
	Output effect (£m)	Empl. effect (FTEs)	Output effect (£m)	Empl. Effect (FTEs)	Output effect (£m)	Empl. Effect (FTEs)	Output effect (£m)	Empl. Effect (FTEs)
Forestry planting and maintenance	1.121	25.047	1.159	22.936	1.139	21.385	1.132	11.383
Forestry Harvesting	1.525	31.998	1.466	33.113	1.541	22.033	1.476	20.776
Timber and Wood Products	2.044	31.324	1.636	24.777	1.965	30.001	1.743	26.512
Pulp, Paper and Board	1.298	9.785	1.195	8.072	1.100	6.730	1.233	9.021
Paper and Board Products	1.674	19.050	1.349	13.571	1.697	19.268	2.301	31.385
Furniture	1.646	29.870	1.426	26.020	1.760	31.902	1.815	33.451

28 NOMIS, the employment database on which the employment coefficients and GRIT procedures were based excludes self-employees and thus the employment effects and employment multipliers only partially reflect the number of potential jobs created from increased economic activity. This means that in cases where self-employment levels are high, the employment effects at the regional level may underestimate the full impact of increased activity. This is particularly a problem in the case of the Highlands and Islands where self-employment is approximately 15% as compared to 7% in Scotland as a whole. Within the Highlands and Islands area it runs as high as 22% in Skye and Lochalsh (HIE).

The supply-driven multipliers relating to forestry are relatively low across all regions. In the case of the planting and maintenance sector, the reasons for this were discussed in section 5. 2, above. One interesting finding is that the forward linkage effects of the timber and wood products sector appear higher than the forest harvesting forward linkage effects in all regions. This suggests that there is a greater percentage of raw timber exported from a region than the percentage of first-stage processed timber.

The results from the regional analysis provide some indication of the relative importance of forestry in each of the regions and the potential benefits from increased investment. However, it should be borne in mind that they are based on tables generated using non-survey techniques and involve some fairly strong assumptions regarding the proportion of regional demand that is met by regional supply. The spatial tracking analysis of flows upstream and downstream from the sector will further supplement understanding of the extent to which the benefits from forestry activity are locally retained.

6. Impact Simulations: Methods and results

This chapter describes the way in which the balanced input-output tables described in Chapter 4 were used to investigate the impacts on the Scottish economy of various alternative forestry-related scenarios. In each case, before presenting the results of the simulation, the modelling approach used for each scenario is briefly described

6.1 The total suppression of the Forestry sector in Scotland

One method of gauging the importance of forestry sector to the Scottish economy is to compare the actual values of gross output and levels of employment in the economy with hypothetical equivalents estimated on the assumption of the complete absence of the sector. This is achieved by suppressing the rows and columns of the input-output table that relate to forestry, re-estimating the multipliers, and comparing the outcomes with those from the original version of the model.

This approach to measuring the importance of a sector in an economy has become fairly commonplace in the input-output literature since it circumvents some of the problems of more conventional backward and forward linkage analysis (Harrigan and McGilvray, 1988; McGregor, Swales and Yin, 1998). However, the fact that it imposes a particularly dramatic change on the input-output system constrains the credibility of the results. In particular, the technique implicitly assumes that the remaining structure of the economy and inter-industry linkages are not affected by the removal of the sector in question. In the hypothetical model, the sectors that previously bought inputs from forestry (user industries) are assumed to simply import the inputs instead whilst the sectors that used to sell inputs to forestry (supply industries) reduce their gross output by exactly the reduction in input sales. Nevertheless, the simulation provides a readily interpreted estimate of the contribution of forestry, capturing both the backward and forward linkage effects of the sector.

Table 6.1 summarises the output and employment effects of the complete suppression of all types of forestry in the case of the 1995 version of the model and the "Equilibrium 1" version of the model, the latter reflecting the situation when the new native woodlands and farm woodland types are assumed to have reached maturity.

Table 6.1 The impact of the removal of the forestry sector on the Scottish economy

		Open version		Closed version	
		Total Gross Output (£m)	Employment (FTEs)	Total Gross Output (£m)	Employment (FTEs)
1995 model	Base year level	114501.6	1712150	114501.6	1712150
	New level	114137.6	1706378	114059.1	1705244
	Difference	-364.0	-5771	-442.5	-6906
	of which Forestry	*-208.1*	*-3720*	*-208.1*	*-3720*
Equil. 1model	Base year level	114523.4	1712807	114523.4	1712807
	New level	114146.5	1706478	114066.5	1705330
	Difference	-377.0	-6329	-456.9	-7477
	of which Forestry	*-229.9*	*-4377*	*-229.9*	*-4377*

The results suggest that the removal of the forestry sector from the 1995 Scottish economy would result in a £364m reduction in total value of industrial output if the direct and indirect linkages of the sector are taken into account, or a £442.5m reduction if the induced effects associated with the sector are included in the analysis. The equivalent figures from the Equilibrium 1 version of the model are £377m and £456.9m respectively. The fact that the Equilibrium 1 model estimates exceed those from

the 1995 model is not surprising given that the forestry sector produces a higher value of output once the two "new" woodland types, new native woodlands and farm woodlands have reached maturity. What is more interesting is the extent to which the total effects on output and employment exceed the direct effects of the removal of the sector: the latter are shown in italics in the table. In particular, considering the closed version of the Equilibrium 1 model, only 50% of the total fall in gross output levels is due to the removal of forestry itself: the remaining 50% comes about as a result of reduced "knock-on" benefits from the sector.

One of the characteristics of forestry industry noted in Chapter 2 was the absence of an international market for certain types of timber and consequently the critical supply dependence of certain downstream processing sectors. In particular, certain timber-using sectors are totally dependent on output from domestic forestry since, for either economic, technical or locational reasons, they are unable to use imported timber within their production processes. In this situation, the above technique of suppressing only the rows and columns of the input-output tables relating to forestry would underestimate the total impact of the removal of the sector since these "dependent" sectors could also not exist in the absence of domestic production. Thus, following the example of McGregor and McNicoll (1992), the simulation was repeated, in this case imposing certain levels of critical supply dependence on the downstream users of Scottish timber.

In particular, a 21.6% dependency ratio was assumed for the timber and wood products industry, and a 2% dependency for paper and pulp industry. These percentages are identical to those adopted in the McGregor and McNicoll study. The dependency ratios, derived following analysis of data and discussions with industry experts, represent the percentage of activity in each downstream sector assumed to be reliant on domestic forestry as a source of timber, or, in other words, for financial, regulatory or technical reasons, unable to import timber for processing.

The results of the suppression of forestry taking account of critical downstream supply dependence are given in Table 6.2 .

Table 6.2 ***The impact of the suppression of the forestry sector on the Scottish economy allowing for critical supply dependence***

		Open version		Closed version	
		Total Gross Output (£m)	Employment (FTEs)	Total Gross Output (£m)	Employment (FTEs)
1995 model	Base year level	114501.6	1712150	114501.6	1712150
	New level	113844.7	1702248	113690.0	1700020
	Difference	-656.9	-9901	-811.5	-12130
	of which Forestry	-279.3	-4635	-279.3	-4635
Equil, 1model	Base year level	114523.4	1712807	114523.4	1712807
	New level	113857.9	1702413	113704.3	1700207
	Difference	-665.6	-10393	-819.1	-12599
	of which Forestry	-301.1	-5293	-301.1	-5293

Table 6.2 illustrates that allowing for critical supply dependence in the sectors downstream from forestry significantly increases the impact of the removal of the sector. For example, in the case of the closed version of the Equilibrium 1 model, the total value of gross output produced in the Scottish economy falls by £819m and employment by 12,599 FTEs as opposed to drops of only £456.9m and 7,477FTEs when only forestry itself is suppressed. Even the most conservative version of the model, based on 1995 forestry activity levels and excluding induced multiplier effects, predicts a reduction in total gross output levels of £657m once import substitution is ruled out for a proportion of the sectors downstream from forestry. The magnitude of these results clearly depends on the level of dependency

ratios assumed in the analysis: larger dependency ratios would make the impact of the removal of forestry still greater whilst smaller dependency ratios would bring the impact more in line with the results presented in Table 6.1. However the analysis presented gives a clear indication of the importance of allowing for supply dependence in cases, such as the forestry industry, where it is believed to exist.

6.2 The effects of a doubling Scottish timber harvesting

As a consequence of a surge in afforestation during the 1980s, the domestic supply of timber is forecast to increase dramatically over the next two decades with UK supply levels forecast to peak in 2025 (Whiteman, 1996). With Scotland having by far the highest share of UK coniferous afforestation during the 1970s and 1980s, the value of timber ready for harvesting from Scottish plantations is set to double within the next 15 to 20 years. This simulation considers the economy-wide effects of an increase in timber output assuming the value of timber harvested from commercial conifer plantations doubles from the 1995 base year level.

As described in Chapter 5, the conventional demand-driven input-output model takes the final demand for output as exogenous (being determined by forces outside the model such as consumer tastes, exchange rates and government policy) and solves for the effects of changes in final demand on sectoral gross output levels. In simple terms, the multipliers and solutions to input-output model represent the gross output levels consistent with a given level of final demand. However, in certain situations, for example a strike or a planned increase in production, it is more appropriate from a modelling perspective to consider the gross output as opposed to the final demand of a sector as exogenous. In such a situation a so-called mixed exogenous/endogenous model needs to be employed.

The scenario of a doubling of timber harvesting clearly requires the use of a mixed exogenous/endogenous input-output model since it is the output as opposed to demand for timber which is being taken as given. Further, since not only the backward linkage effects of the increase in output but also the forward linkage effects are of interest, both a demand and supply-driven version of the mixed variable model were developed. The derivation of the demand-driven mixed variable model is described in detail in Miller and Blair, 1985 whilst Roberts, 1994 presents the derivation of a mixed variable supply-driven model[29]. The results from both models were checked for consistency by generating new input-output tables for the economy, ensuring that accounts balanced and that the gross output of coniferous harvesting was as specified.

Table 6.3 presents the aggregate results of the simulations, Table 6.4 indicating which sectors were most affected by the increase.

Table 6.3 ***Aggregate effects of a doubling of timber harvested from commercial conifer plantations (based on a modified version of the 1995 forestry model)***

		Open version	Closed version
Backward (demand-driven)effects	Change in gross output levels (£m)	173.2	203.0
	Change in employment (FTEs)	2882	3310
Forward (supply-driven) effects	Change in gross output levels (£m)	181.1	192.2
	Change in employment (FTEs)	3003	3210

29 Roberts (1994) carried out an analogous investigation into the economy-wide effects of milk quotas using two mixed exogenous variable input-output models. In that case, it was the gross output from dairy farmers that needed to be exogenously specified so as to ensure that the analysis was consistent with the way in which the policy instrument worked.

Table 6.4 ***Change in gross output levels from base-year values following a doubling of timber harvested from commercial conifer plantations (£m)***

IO sectors		Backward (demand-driven)effects		Forward (supply-driven) effects	
		Open version	Closed Version	Open version	Closed Version
1,4	Agriculture and fishing	0.177	0.597	0.331	0.594
C2	Commercial coniferous plantations (EXOGENOUS)	98.795	98.795	98.795	98.795
A1-D2	Other forest sectors	0.008	0.010	0.196	0.207
5	Mining and extraction	0.421	0.667	0.492	0.720
6,7	Food and drink processing	0.386	1.865	0.805	1.243
9	Timber and Wood Products	0.559	0.638	47.618	47.665
10	Pulp, Paper and Board	0.042	0.061	0.538	0.590
11	Paper and Board Products	0.126	0.201	0.091	0.137
8,12-16	Other manufacturing	3.803	6.007	2.469	3.771
18	Machinery and vehicles	1.236	1.427	0.209	0.504
19	Furniture	0.061	0.089	0.477	0.494
20	Electricity, gas and water	1.610	3.143	0.270	0.510
21	Construction	19.425	20.975	19.145	19.979
22,23,24	Wholesale & distribution	3.140	8.306	1.763	2.995
25	Hotels, Catering, Pubs, etc	0.082	1.876	0.526	0.818
26,27,28	Transport and communications	22.949	25.485	0.568	1.649
29,30	Banking and insurance	7.055	8.700	0.583	1.135
31	Real estate	1.135	6.585	2.000	2.233
32,33,34,35	Services	12.186	17.570	4.235	8.197
	TOTAL	173.2	203.0	181.1	192.2

The additional timber output, valued at £98.8m, is shown to result in a total increase in the value of gross output in Scotland of £203m from backward linkage effects, plus £192m from forward linkage effects once direct, indirect and induced effects are taken into consideration. The respective estimates of the employment generated from the increased timber harvesting are 3,310 FTE jobs from backward linkages and 3,210 jobs through forward linkage effects in the economy. 1,780 of these additional jobs are in the coniferous harvesting sector itself the remaining 1,530 (backward) and 1,430 (forward) jobs are created in other sectors of the economy, including woodland input suppliers, wood processing sectors and other Scottish sectors less directly associated with the forestry industry. Both sets of results are based on the standard input-output assumptions of fixed relative prices and that all output harvested is sold.

The sectoral breakdown of the impact shown in Table 6.4 indicates that, excluding the increase in the value of timber itself, the vast proportion of benefits through demand-driven effects accrue to the construction and transport sectors whilst the main beneficiary from supply-driven effects is the timber and wood products sector as would have been anticipated. It is interesting to note that in the open versions of the model (which measure the direct and indirect effects of the shock), the forward linkage effect exceeds the backward linkage effect. In contrast, in the closed versions of the model (which measure the direct, indirect and induced effects of the shock) the reverse holds true. Closer investigation indicated that this was largely due to the higher labour requirements involved in harvesting and thus the high level of direct income effects from increased harvesting activity.

6.3 The effects of substituting Scottish timber for timber imported into Scotland

As described in Chapter 3, the proportion of timber consumption met by domestic supplies has increased over the last decade but remains low in many product lines. Since two-thirds of the timber that is currently imported is processed in the country of origin, the potential for replacing currently imported timber for Scottish timber would appear considerable even if tempered by concern in relation to the quality of domestic supplies.

The previous simulation focusing on the effects from increased timber harvesting implicitly assumed that the timber and wood products sector continued to purchase raw timber from domestic and foreign sources in the same proportions as observed in the base year of the model. In contrast, this simulation considers the potential magnitude of economy-wide benefits if the timber and wood products sector were to substitute domestic production for imported timber. Two alternative scenarios were considered: firstly that the timber and wood products sector replace 100% of their imports with domestic production, secondly that they replace only 50% of imports with Scottish timber[30].

In terms of modelling, simulating the effects of import substitution is relatively straightforward. The column coefficients of the timber and wood products sector were adjusted to reflect an increased propensity to use domestic timber, with the coefficient relating to imports from the rest of the world reduced accordingly. The output of the timber and wood products sector is not changed but domestic harvesting increases to meet the additional demand. The relative proportions of sales to the timber sector from each forest type were kept constant with those observed in the 1995 input-output model. The results of the simulation are reported in Table 6.5.

Table 6.5 ***The impact of substituting domestic for imported timber on the Scottish economy (1995 input-output model)***

		Open version		Closed version	
		Total Gross Output (£m)	Employment (FTEs)	Total Gross Output (£m)	Employment (FTEs)
100% substitution	Base year level	114501.6	1712150	114501.6	1712150
	New level	114647.8	1714957	114671.0	1715290
	Difference	146.2	2807	169.4	3140
50% substitution	Base year level	114501.6	1712150	114501.6	1712150
	New level	114564.3	1713474	114572.7	1713595
	Difference	62.7	1325	71.1	1446

Considering the closed version of the model, 100% substitution of timber imported from the rest of the world with timber harvested in Scotland is estimated to give rise to a £169.4m increase in the value of output in the Scottish economy and boost Scottish employment levels by 3140FTEs. In order to maintain the output of the timber and wood products sector, domestic supplies in this case increase by £97m. This accounts for 57% of the total increase in gross output value, the rest coming about as a result of the change in pattern of input use by the timber and wood sector. Even in the case of 50% import substitution, the benefits are fairly substantial indicating that there are significant gains to be had from import replacement downstream from forestry.

30 Neither scenario is considered realistic but together they provide some indication of the magnitude of potential gains from import replacement.

6.4 The combined effect of increased timber harvesting and downstream import replacement

In the light of the results from the two previous simulations, it is interesting to investigate the combined impact of both the projected increase in forest harvesting activity and a change in sourcing patterns by the Scottish timber and wood products sector. In order to carry out this simulation, the mixed endogenous/exogenous model was again used (so as to allow the gross output of forest harvesting to be specified) but in this case the coefficients relating to the timber and wood products sector were altered to reflect 100% replacement of imports from the rest of the world with domestic timber supplies. Thus the simulation was set up in such a way as to reveal the maximum potential effects on the Scottish economy of increased timber supplies.

Table 6.6 presents results from the analysis.

Table 6.6 ***Combined effects of doubling of timber harvesting and 100% import substitution (based on a modified version of the 1995 forestry model)***

		Open version	Closed version
Backward (demand-driven)effects	Change in gross output levels (£m)	174.6	205.0
	Change in employment (FTEs)	2906.9	3343.3
Forward (supply-driven) effects	Change in gross output levels (£m)	229.9	243.9
	Change in employment (FTEs)	3730.7	3991.9

The results show clearly that allowing for import substitution substantially increases the level of forward linkage effects in the economy without significantly effecting the backward (demand-driven) multiplier effects. In particular, the £98m increase in value of harvesting when combined with increased use of domestic timber downstream increases the total forward linkage effect on gross output to £244m (as opposed to £192m from Table 6.3) and increases the forward linkage employment effect to 3,992FTEs (as compared to an increase of 3210FTES from Table 6.3).

The Jaakko Poyry report (1998) also quantified the potential impact on the economy of increased timber harvesting and processing. In this case, the authors suggested a UK-wide estimate of between 15,000 and 20,000 additional jobs created in the years ahead. Even allowing for a disproportionately large proportion of indirect effects outwith Scotland, the predominance of conifer plantations located in Scotland suggests that a substantial proportion of these jobs would be based in Scotland. Taking this into account, the results presented appear less optimistic about the level of jobs that would be created. Nevertheless, they do suggests a substantial boost to the Scottish economy could come about as a result of additional forestry-related activity in the next two decades.

6.5 The effects of removing grant-aid to Scottish forestry

The vast majority of new planting of woodlands in Scotland currently receives grant support through the Woodland Grants Scheme and, in the case of farm woodlands, the Farm Woodlands Premium Scheme. Thus it could be argued that the removal of grant aid would significantly reduce the area of woodlands planted and, through links between forestry and the wider economy, have negative repercussions for other sectors in the economy. This simulation estimates the magnitude of effects following the removal of grant-aid under the assumption that the area of planting and associated establishment would reduce by 90%.

A 90% reduction in the area of woodlands planted in the base year of the study, 1995, is equivalent to 11.3m hectares (Forestry Commission, 1998). The first step in carrying out this simulation involved converting this area into a reduction in gross output value from each of the four types of planting and maintenance sectors in the model. In terms of each woodland type, the reduction in value of activity depended on the relative costs of planting and establishing each type of woodland and the area planted

in the base year. Information provided from the Forestry Commission formed the basis for estimating the value of gross output changes. These were then fed into the mixed endogenous/exogenous version of the 1995 input-output model with the results presented in Table 6.7.

Table 6.7 ***The effects of reduced planting following the removal of grant-aid (based on a modified version of the closed 1995 forestry model)***

		Forest planting and` maintenance	Other sectors	Total
Backward effects	Change in GO levels (£m)	103.86	79.00	182.86
	Change in employment (FTEs)	1450.6	1075.3	2525.9
Forward effects	Change in GO levels (£m)	104.01	1.36	108.69
	Change in employment (FTEs)	1393.0	21.6	1467.5

The table separates the effects on the planting and maintenance sector itself to those felt in other sectors of the Scottish economy. It suggests that, in terms of demand-driven effects., the economy-wide impacts of grant removal are significant. In particular, from the demand driven model, the value of gross output in the Scottish economy is estimated to fall by a total £182.8m, and employment by 2525.9 FTEs, 1450 in planting and maintenance itself, the remaining 1075 in other sectors of the economy. The supply-driven effects of grant removal are far lower as might be anticipated given that there are no close links wit other sectors downstream from forest planting and maintenance. Apart form those lost in the sector itself, only 21.6 other jobs are lost in the economy through forward linkage effects.

6.6 The impact of a doubling of labour productivity in the forestry sector

The final simulation to be reported relates to the impact on the economy of an increase in labour productivity in forestry. As discussed in Chapter 3, there have been dramatic increases in labour productivity in the forestry industry over the last few decades which have reduced the number of people employed in the industry. Despite this, the labour intensity of forest harvesting in particular remains relatively high. Indeed, the multiplier analysis in Chapter 5 indicated that a large proportion of links between forestry and the wider Scottish economy can be attributed to induced effects associated with the labour intensity of the sector. Thus the purpose of this simulation is to investigate the extent to which the links between forestry and the Scottish economy would be weakened by further increases in labour productivity and consequent reduction in the forest labour force.

The doubling of labour productivity was modelled by adjusting the levels of transactions in the primary inputs portion of the input-output table. In particular, expenditure on wages and salaries per unit output from each of the forest types was halved with a compensating adjustment made to the "Gross trading profit and other value added" entries of the table to maintain the necessary accounting balances[31].

Table 6.8 indicates how the adjustment in labour productivity affects the knock-on effects from forestry on the Scottish economy by comparing the multipliers from the base Equilibrium 1 version of the model with the new adjusted model.

31 Since the input-output table has been constructed on a value basis (as is normal), the same changes to the base model could be taken to represent the impact of a halving of labour costs as opposed to a doubling of labour productivity.

Table 6.8 ***The impact on forestry-related multipliers following a doubling of labour productivity in the sector, Equilibrium 1 model***

	Open model					
	Output effect (£m)	Change	Employ. Effect (FTEs)	Change	Income effect (£m)	Change
Existing native planting/maint.	1.394	0	8.413	-3.947	0.152	-0.078
Existing native harvesting	1.392	0	21.048	-15.413	0.229	-0.117
New native planting & maint.	1.730	0	13.485	-5.557	0.256	-0.111
New native harvesting	1.549	0	20.475	-13.242	0.253	-0.101
Commercial planting & maint.	1.581	0	21.733	-14.542	0.425	-0.292
Commercial harvesting	1.754	0	20.168	-9.017	0.291	-0.069
Farm planting and maint.	1.506	0	8.330	-4.227	0.158	-0.085
Farm harvesting	1.406	0	20.864	-15.087	0.230	-0.115
Timber and wood products	1.746	0	25.306	-1.145	0.358	-0.009
Paper and pulp	1.520	0	12.121	-0.009	0.261	-0.000
Paper products	1.463	0	14.337	-0.002	0.332	-0.000
Furniture	1.379	0	23.098	-0.036	0.405	-0.000
	Closed model					
	Output effect (£m)	Change	Employ. Effect (FTEs)	Change	Income effect (£m)	Change
Existing native planting/maint.	1.481	-0.107	9.662	-5.478	0.176	-0.106
Existing native harvesting	1.523	-0.160	22.925	-17.712	0.264	-0.160
New native planting & maint.	1.869	-0.170	15.479	-8.000	0.293	-0.157
New native harvesting	1.682	-0.163	22.392	-15.590	0.288	-0.144
Commercial planting & maint.	1.852	-0.332	25.622	-19.307	0.497	-0.381
Commercial harvesting	1.889	-0.166	22.116	-11.403	0.327	-0.113
Farm planting and maint.	1.597	-0.112	9.649	-5.842	0.183	-0.115
Farm harvesting	1.536	-0.159	22.733	-17.377	0.265	-0.157
Timber and wood products	1.884	-0.170	27.295	-3.581	0.395	-0.054
Paper and pulp	1.618	-0.121	13.535	-1.741	0.287	-0.032
Paper products	1.589	-0.154	16.139	-2.210	0.366	-0.041
Furniture	1.532	-0.187	25.295	-2.728	0.446	-0.050

As anticipated, the results illustrate that the most significant impact of a change in labour productivity is a reduction in the induced effects associated with forestry activity. This follows from the fact that, all other variables remaining constant, the increase in productivity results in a fall in payments to employees. This in turn results in a fall in the extent to which the reduced population of employees generate consumption-led effects on output which in turn affects the impact on employment and income in the economy. The output multiplier effects from the open version of the model do not change following the productivity adjustment since they contain only the direct and indirect effects associated with the sector. In contrast, the output multiplier effects from the closed version of the model (incorporating the induced effects associated with forestry) change dramatically. The results thus imply that, if historic trends of increases in labour productivity continue, the results from all the previous simulations may significantly overestimate the potential gains to the Scottish economy of changes in forestry-related activity.

7. The Spatial Tracking of income and employment flows from Scottish Forestry

The multiplier analysis discussed in Chapters 5 and 6 give an indication of the links between Scottish Forestry and the wider Scottish economy. However the analysis does not reveal whether the income and employment multiplier effects associated with the sector are retained within the locality of the forest or woodland giving rise to the effects, or, alternatively leaked to other areas. Likewise, the analysis does not reveal whether the benefits from increased forestry activity would accrue to rural or urban areas. This chapter presents the findings of an attempt to "track" the flow of income and employment effects associated with forestry through the Scottish economy. It focuses on the first and second round effects of forestry activity which together account for the lions share of the total multiplier effects (Bulmer-Thomas, 1982).

7.1 Methodology

The approach used to track forestry-related income and employment flows was based on that used by Harrison in her study of the distribution of farm inputs and outputs (Harrison, 1993). As part of the main survey of woodland owners and managers, information was collected, not only on the level and type of inputs purchased and outputs sold from a particular woodland, but also the names and addresses of the firms that the owner/manger deals with. The address and postcode associated with each firm was subsequently used, in association with an Ordinance Survey database to identify the precise location of the firms. Using both this information, and knowledge of the location of access points of each woodland in the survey, road distances between the woodland and source (destination) of inputs (outputs) were calculated[32]. In addition, a sub-sample of 20 upstream and downstream firms identified from the main forestry survey were interviewed to verify the general findings of tracking exercise and to provide supplementary information for the analysis.

Allowing for incomplete survey returns, information on a total of 431 transactions were available relating to the activities carried out on 57 individual woodlands across Scotland. In addition to calculating road distances, GIS methods were used to assess whether the source and destination of each transaction was based in a rural or non-rural area and whether flows were contained within a region or took place across regions. The Randall definition of rural area (Scottish Office, 1992) was used as the basis for classifying areas of Scotland as either rural or urban with Appendix 6 illustrating the coverage of both types of area. The classification of regions follows that used throughout the study and detailed in Appendix 1.

7.2 The local retention of forestry-related economic activity

7.2.1 Input flows

Table 7.1 presents, by input type, the average distance between access points of a woodland and the source of inputs for that woodland. In some cases, for example in the case of plants, this is the distance between the woodland and the point of production of the input. In other cases, for example chemical purchases, the source of the input is not the point of production of that input but a wholesaler/ retailer such as an agricultural merchant[33].

32 The network analysis extension of ArcView was used to calculate road distances between the point of access to each woodland and the source/destination of forestry-related transactions. In contrast, Harrison's analysis of farm-related flows relied on the calculation of straight-line distances between the midpoints of two postcode areas and was thus significantly less accurate than the approach taken in this study.

33 Analysis revealed that even within input types, there was considerable variability in the path of the input to the actual woodland depending on the nature of the input itself and the size and location of the woodland. For example, interviews with wholesalers and retailers upstream from forestry revealed that in many cases they tended to source most of their supplies from other wholesalers as opposed to direct from manufacturers of the inputs.

Table 7.1 Average distance between woodland and source of input by input type

	Average distance (km)	Average value per transaction (£)	No. of transactions
Fencing materials	87.07	10564.65	20
Stakes	100.84	940.60	15
Misc.	105.75	8819.18	22
Chemicals	119.49	1158.14	23
Plants	146.82	9616.44	57
Insurance	180.15	189.64	6
Tubes	477.85	1448.60	15
All Inputs	157.89	6437.12	158

The table suggests that of all the different types of inputs, fencing materials are typically sourced from firms closed to a woodland. This is important since the table also suggests that fencing accounts, on average, for the largest single input expenditure for a woodland thus suggesting that the most important injection of income upstream from the sector is retained nearest to the woodland itself. Plants, the second most significant input expenditure shown in the table are bought from further afield with an average 147km between the source of plants (for both new planting and beating up) and the woodland in which they are used. Tubes travel by far the furthest distance to their destination – an average of 478km. As becomes clearer below, the survey found that a large proportion of all tube expenditure came from sources outside Scotland. Thus, in respect to the woodlands covered by the survey, tube expenditure represents a leakage of forest-related expenditure from Scotland[34].

Both the survey results and the multiplier analysis presented in Chapters 4 and 5 confirmed the hypothesis that there is a large variability in the pattern and level of inputs used by different woodland types. Thus Table 7.2 again concentrates on the distances between input sources and woodlands but in this case differentiates the flows by woodland type[35].

34 Closer investigation indicated that the sources of tubes were actually manufacturers as opposed to retailers indicating that there was limited possibility of any tube-related activity "leaking back" into the Scottish economy through the use of Scottish labour or Scottish production inputs etc.

35 Due to the limited sample size, the two types of native woodlands in the study (existing and new planted) have been combined for purposes of this analysis.

Table 7.2 Distance between woodlands and source of inputs by woodland type

	Distance from woodland to source of inputs (km)					
Forest Type	0-19	20-49	50-99	100-199	200+	Total
	% of transactions					
New/existing native woodlands	0	11.54	19.23	38.46	30.77	100.00
Commercial conifer plantations	8.33	16.67	12.50	33.33	29.17	100.00
Farm woodlands	18.56	19.59	18.56	26.80	16.49	100.00
All types	13.61	17.69	17.69	29.93	21.09	100.00
	% of total value of input costs					
New/existing native woodlands	0	0.71	12.16	33.41	53.72	100.00
Commercial conifer plantations	16.72	25.70	26.83	9.94	20.81	100.00
Farm woodlands	10.91	10.99	11.09	27.61	39.39	100.00
All types	13.21	18.86	20.94	17.38	29.61	100.00
	Average value of flows over each distance (£)					
New/existing native woodlands	-	283.33	2926.94	4022.35	8083.55	-
Commercial conifer plantations	52514.50	40356.25	56186.14	7805.00	18677.14	-
Farm woodlands	1628.00	1553.36	1654.29	2851.65	6609.89	-
All types	6716.65	7376.49	8191.16	4018.33	9715.05	-

The results suggest that of all the woodland types, farm woodland owners/managers are more likely to source their inputs from local suppliers than native or commercial conifer woodland owners/managers. In particular, over half (57%) of all farm woodland related input expenditures were sourced from suppliers living within 100 km of the woodland, almost 20% being based within 20 km of the woodland. In contrast, only 31% of native woodland input transactions, 37% of commercial conifer input transactions took place with firms based less than 100 km from the woodland. However, the significance of these differences changes when the average value of transactions over each distance is taken into account. In particular, whilst farm woodlands have a larger percentage of their transactions with local businesses, these same transactions account for a lower proportion of total value than the transactions that take place over longer distances. In contrast commercial conifer plantations have a lower proportion of transactions within 100 km, but these same transactions account for a far higher proportion of total input expenditure than in the case of farm woodlands. Given the larger absolute expenditure associated with conifer plantations, this finding has important implications for the amount of economic value that is locally retained through upstream links with the sector. The results in Table 7.2 suggest that flows of expenditure from large woodlands do generate significant income and employment effects within the area surrounding the plantation. This contrasts strongly with available evidence on farm-related transactions which suggests that larger farms are less integrated in the area in which they are based than smaller farms (Harrison, 1993, Harrison et al., 1998).

One surprising result from Table 7.2 is that native woodland input expenditure appears to be that which travels furthest of all woodland types. In particular, in contrast to farm woodlands and conifer plantations, both the number and average value of input transactions for native woodlands increase over each distance to an average of £8,083 flowing to firms more than 200km from the woodland. However, the relatively low sample size on which these results are based should be borne in mind.

7.2.2 Output flows

Turning attention to flows downstream from forestry, Table 7.3 presents analysis of the average distances between woodlands and the first stage buyers of timber. The results relate to sales from thinnings as well as timber from woodlands at clearfell.

Table 7.3 Distance between woodlands and timber purchasers

	Distance from woodland to first-stage processor (km)				
Forest Type	0-49	50-99	100-199	200+	Total
			% of transactions		
New/existing native woodlands	12.50	62.50	25.00	0.00	100.00
Commercial conifer plantations	11.76	44.12	14.71	29.41	100.00
Farm woodlands	52.63	5.26	42.11	0.00	100.00
All types	24.59	34.43	24.59	16.39	100.00
			% of total value of output		
New/existing native woodlands	7.45	43.31	49.24	0.00	100.00
Commercial conifer plantations	20.47	58.17	13.33	8.03	100.00
Farm woodlands	37.08	5.54	57.37	0.00	100.00
All types	21.59	54.22	16.79	7.39	100.00
			Average value of output flows (£)		
New/existing native woodlands	2700.00	3140.00	8925.00	-	-
Commercial conifer plantations	252470.00	191342.13	131560.00	39643.20	-
Farm woodlands	14526.44	21715.20	28094.00	-	-
All types	77189.63	138454.63	60026.80	39643.20	-

The most striking finding from Table 7.3, especially in the light of the previous section, is the much smaller distances over which unprocessed timber is transported as compared to forest inputs. This can be attributed to nature of the products involved and associated transportation costs. The results suggest that 75% of the value of timber from all woodlands in Scotland is processed within 100 km of the source of the timber. Of all woodland types, timber from commercial conifer plantations is likely to travel furthest with 29% of transactions taking place over 200km. Again, looking purely at the number of transactions, it would appear that farm woodlands are more closely integrated within local areas than either native or coniferous woodlands. Over 50% of all sales from farm woodlands are to processors within 50km of the woodland. However, the average value of sales from farm woodlands is shown to increase with distance with 57% of total value of output sold accruing to destinations between 100 and 200 km from the source of timber. In contrast, for conifer plantations, the woodland type with by far the highest absolute value of timber output, a much higher proportion of total sales value (78%) is sold to processors within 100 km of the plantation.

From the sub-sample of firms downstream from forestry, some idea of the second round income and employment effects associated with forestry could be ascertained. In particular, as discussed in Chapter 3, timber processing is a labour intensive stage of the forestry production chain employing 31% of total Scottish forestry employment (Forestry Commission, 1995). As shown in Table 7.4, the survey of downstream firms found an average of 128 employees per business as compared to an average of 41 employees in upstream firms. Of these employees, 100% lived within 32 km of the company[36]. Taken together with results from Table 7.3, a large proportion of the value downstream multiplier effects from forestry would appear to be contained within a relatively small geographical area. In contrast, although employees are likely to live close to the supply firm, the distance over which input transactions take place suggests that the upstream multiplier effects are less well contained. To some extent this was reflected in the perceptions of the two different types of firms on their dependence on Scottish Forestry. When asked the proportion of turnover they believed was attributable to Scottish forestry demand/supply, the downstream firms interviewed suggested an average of 87.5% dependence. In contrast , upstream firms tended to have a more diverse activity base and suggested that on average only 39% of their turnover was dependent on Scottish Forestry.

36 This finding is consistent with the more detailed analysis of Thomson and Psaltopoulos, 1993.

Table 7.4 Employment in firms upstream and downstream from forestry

	Upstream	Downstream
Average no. of employees	41.3	127.8
Residence of employees (%)		
Within 16 km of company's. address	71.2	50
Between 16 and 32 km	20.8	50
Over 32 km	8	0

7.2.3 Contractors

As discussed in Chapter 4, the main forestry survey found widespread use of contractors at every stage of a woodlands production cycle. In many cases, where the management of a woodland was passed over to a company, subcontractors were used to carry out specific tasks. There has been some suggestion in the literature that the use of contractors has decreased the extent to which the multiplier effects associated with forestry are locally retained since contractors and contract employment are more likely to travel long distances to their place of employment.

Table 7.5 presents results from an analysis of the average distance between a woodland and the location of the contractors and/or subcontractors company base. When interpreting the figures relating to the average value of contracting costs, it should be borne in mind that in some cases these relate purely to labour costs, in others the costs of inputs associated with the contract task are included.

Table 7.5 Distance from woodland to contractors

	Distance from woodland to contractors (km)				
Forest Type	0-19	20-99	100-199	200+	Total
	% of transactions				
New/existing native woodlands	9.76	60.98	14.63	14.63	100.00
Commercial conifer plantations	66.67	12.50	16.67	4.17	100.00
Farm woodlands	28.24	44.71	21.18	5.88	100.00
All types	29.33	44.00	18.67	8.00	100.00
	% of total value of contracting				
New/existing native woodlands	8.64	86.12	1.59	3.65	100.00
Commercial conifer plantations	75.88	11.68	11.57	0.86	100.00
Farm woodlands	40.97	47.45	9.60	1.98	100.00
All types	45.27	44.28	8.46	1.98	100.00
	Average value of contracting costs (£)				
New/existing native woodlands	5938.99	9469.36	729.17	1673.00	-
Commercial conifer plantations	19241.88	15795.00	11739.50	3500.00	-
Farm woodlands	9321.88	6818.35	2913.19	2158.00	-
All types	12621.62	8230.55	3706.09	2027.33	-

The vast proportion of both contractors and sub-contractors used by all woodland types appear to be based within 100km of the woodland itself. Particularly conifer plantations appear to inject a large amount of income into the local economy through the use of contractors based less than 20km from the plantation. However, whether such income is locally retained depends, in part, on whether the

contracting companies use local labour[37]. Table 7.6 addresses this question by presenting results from the main forestry survey relating to the residence of employees. In the table employees are differentiated according to whether they were directly employed by a woodland owner or employed by a contracting business.

Table 7.6 Residence of employees in relation to woodland

	Distance from woodland (%)			
	Within 16 km	Between 16 and 32 km	Over 32 km	Total
Contract employees	44.26	22.07	33.67	100
Direct employees	77.83	7.00	15.17	100

Whilst the results confirm that contract labour is likely to come from further afield, a surprisingly large proportion of contract employees (66%) live within 32km of the woodland in which they carry out work. Closer analysis revealed that, as might have been anticipated, management companies are more likely to sub-contract work to companies/individuals located close to the source of that work than companies further afield.

7.3 The rural-urban spread of forestry-related transactions

Whilst the contribution of the forestry sector to rural development has been used as a justification for state support for the sector, very little analysis has been carried out on the extent to which the benefits from forestry activity are retained within rural areas. This section aims to add to existing knowledge of the role of the sector in rural Scotland by explicitly tracing the extent to which the flows to and from forestry accrue to rural as opposed to non rural areas. The definition of rural areas of Scotland is based on that proposed by Randall (Scottish Office, 1992) and shown in Appendix 6. Table 7.7 also indicates the proportion of flows which leak from Scotland to the rest of the UK.

Table 7.7 indicates the percentage of input, output and contract transactions that take place with firms based in either rural or urban areas of Scotland. It also indicates the importance of these flows in value terms.

Table 7.7 Destination Of Input, Output And Contract Flows From Scottish Woodlands

	% of total number of transactions				% of total value of transactions			
	Rural Scotland	Urban Scotland	Rest of UK	Total	Rural Scotland	Urban Scotland	Rest of UK	Total
Chemicals	82.61	17.39	0.00	100	90.62	9.38	0.00	100
Fencing mat.	85.00	15.00	0.00	100	96.66	3.34	0.00	100
Insurance	16.67	83.33	0.00	100	31.77	68.23	0.00	100
Plants	68.42	29.82	1.75	100	36.77	60.49	2.74	100
Stakes	73.33	13.33	13.33	100	49.33	37.85	12.82	100
Tubes	6.67	0.00	93.33	100	3.45	0.00	96.55	100
Misc.	77.27	18.18	4.55	100	92.32	2.53	5.15	100
All inputs	66.46	22.15	11.39	100	60.68	34.63	4.70	100
Output	73.77	16.39	9.84	100	60.46	22.35	17.19	100
Contractors	88.74	9.93	1.32	100	98.40	1.42	0.19	100

Firms and businesses based in rural Scotland are shown to receive 66% of all direct input transactions, 74% of all output transactions and 88% of all contract-related flows. In terms of the flows of money associated with these transactions, the percentages are 61%, 60% and 98% respectively. Flows related to the use of contractors in the sector are those most likely to be retained within rural Scotland both in

37 In the case where the contractors also supplies material inputs, is also depends on the source of those inputs

terms of number of transactions taking place and their value. In terms of input and output flows, whilst the majority of the flows associated with forestry accrue to rural areas, a relatively high percentage of value "leaks" from the rural economy to urban areas of Scotland. For example, 35% of the value of input purchases and 22% of the value of output flows to urban Scotland.

Turning attention to individual input types, Table 7.7 suggests that certain inputs appear far more likely to be sourced from rural areas than urban areas. For example, over 90% of chemicals, fencing materials and miscellaneous inputs are bought in rural areas whilst over 60% of the value of plants and insurance is bought from companies based in urban Scotland. The result relating to plant expenditure is perhaps most significant since it represents a significant proportion of total input expenditure associated with woodland establishment. However, as noted in Section 7.2 above, the data on input expenditures relates purely to point of the purchase of inputs and not necessarily the point of production of those inputs. Thus no conclusions can be drawn on whether subsequent knock-on effects of forestry demand are retained within rural areas. 96% of all expenditure on Tubes flowed to companies based in the rest of the UK.

7.4 Regional analysis of forestry input and output flows

The regional multiplier analysis presented in Chapter 5 suggested that the forestry sector had differing employment and income generating potential depending on the region in which it was based. This was attributed to differences in the particular economic structure and the relative importance of the different woodland types in each region. However, the multiplier analysis presented was based on some simple assumptions regarding the proportion of inputs and outputs that were regionally supplied to or purchased from woodlands[38]. No allowance was made in the multiplier analysis of the possibility that woodland owners and managers in a region would choose to source their inputs or supply their output to firms outside the region despite having a more local companies to deal with.

This section thus supplements the analysis presented in Chapter 5 by explicitly analysing the source and destination of forest-related flows according to the region in which a woodland is based. Table 7.8 concentrates on the average distance between a woodland and a transaction, including those flowing to businesses in England and Wales, whilst Table 7.9 identifies the proportion of transactions that are retained within a region. Unfortunately, sample size restricted the extent to which representative results for the Tayside and Grampian region could be generated.

38 The description of the GRIT technique given in Chapter 4 indicate the nature of these assumptions.

Table 7.8 ***Comparison of the distances involved in forestry-related transactions according to regional location of a woodland***

	Southern Scotland		**Tayside**		**Grampian**		**Highlands**	
	Average distance (km)	No. of Trans	Average distance (km)	No. of Trans	Average distance (km)	No. of Trans	Average distance (km)	No. of Trans
Chemicals	53.66	10	-	-	-	-	184.14	10
Fencing materials	59.92	9	-	-	-	-	103.69	7
Insurance	-	-	-	-	-	-	193.62	5
Misc	70.10	12	-	-	-	-	102.87	9
Plants	154.19	21	123.22	9	90.36	10	183.43	17
Stakes	92.98	8	-	-	-	-	-	-
Tubes	378.53	7	-	-	-	-	-	-
All inputs	126.75	68	182.00	19	214.32	19	169.18	52
Output	64.67	21	54.96	9	179.91	11	131.43	20
Contractors	53.17	44	90.79	22	53.74	20	98.54	65

Comparing the two regions for which the fullest results are available, Table 7.8 indicates that forest related flows in the Highland region take place, on average, over significantly longer distances than the same type of flows in the Southern region of Scotland. In particular, the average distance between a woodland and source of input for that woodland is 169km in the Highlands, and 127km in Southern Scotland. The difference between distances relating to output flows is even greater with the average distance travelled by unprocessed Highland timber to its destination 131km, more than twice that travelled by timber from Southern Scotland woodlands. To a large extent, one might argue that these findings are explained simply by the differing geographical characteristics of the two regions. However, Table 7.9 indicates, with the exception of contractors, that as well as taking place over longer distances, transactions relating to woodlands in the Highlands are more likely to be "cross-border" or with firms or companies based in other regions of Scotland.

Table 7.9 ***Percentage of forestry-related transactions retained within a region***

		Percentage			
	Total no, of transactions	Within region	Rest of Scotland	Rest of UK	Total
Inputs					
Southern	68	44.1	41.2	14.7	100
Tayside	19	5.3	84.2	10.5	100
Grampian	19	10.5	78.9	10.5	100
Highlands	52	25.0	67.3	7.7	100
Output					
Southern	21	76.2	14.3	9.5	100
Tayside	9	66.7	22.2	11.1	100
Grampian	11	0.0	100.0	0.0	100
Highlands	20	50.0	35.0	15.0	100
Contractors					
Southern	44	63.6	36.4	0.0	100
Tayside	22	72.7	22.7	4.5	100
Grampian	20	80.0	20.0	0.0	100
Highlands	65	70.8	27.7	1.5	100

Input transactions in particular appear to take place across regional boundaries. In the case of the retention of backward linkage multiplier effects, this suggests that the multipliers presented in Chapter 5 may over-estimate the potential regional income and employment effects associated with additional forestry activity.

Whilst the results presented in this chapter are far from conclusive they do provide new insights into the spatial pattern of forestry-related flows. They complement the information provided from the multiplier analysis of the sector, thus providing a fuller understanding of the role of the sector in the Scottish economy.

8. Conclusions to the study

Like all sectors, forestry does not operate in isolation but, through its use of labour and materials and through its sale of timber output, has links with other sectors in the economy. These links form part of a complex web of inter-industry dependencies, which mean that any change in forestry activity has repercussions that extend well beyond those directly involved in the sector.

The multiplier analyses and various simulations presented in this report provide a comprehensive picture of the nature and extent of income and employment effects associated with Scottish forestry. Perhaps the clearest indication of the significance of the sector came from simulating the effects of totally removing the sector. This resulted in an estimated £442m reduction in the value of gross output in the Scottish economy, only 47% of which could be attributed to the removal of the forestry industry itself. The remaining £243m related to a fall in the value of output from other sectors of the economy.

As discussed in Chapter 3, forestry has undergone rapid structural and technological change within the last few decades. With a large area of conifer plantations about to reach maturity, the changes are set to continue. In terms of forestry policy, environmental and social objectives have been given increased weight, and this has caused a shift in the pattern of new planting towards native and broad-leaved woodlands. The survey of woodland managers and owners indicated that these woodlands are associated with very different levels and patterns of input expenditures and output flows from commercial conifer plantations, and consequently give rise to different multiplier effects for the wider economy. Thus the decision to differentiate between generic forest types in the study proved worthwhile.

Of the different types of woodlands, conifer plantations were found to generate the highest multiplier effects per unit additional demand, however the benefits associated with the establishment and maintenance of new native woodlands were also shown to be significant. Farm woodlands on the other hand were found to be associated with lower employment and income effects but (from the Type I and II multipliers), the highest indirect and induced effects per unit of direct employment and income were associated with farm planting, maintenance and harvesting.

Regional analysis confirmed that the multiplier effects associated with forestry differ between regions depending on the type of woodlands in the region, the structure of the regional economy and the extent to which the sector is more or less "contained" within the region. In terms of new planting, Southern Scotland was found to offer the greatest potential for generating regional economic benefits. In contrast, marginal increases in demand for output form the timber harvesting was found to generate the largest economic benefits in the Grampian and Highlands regions.

One of the main innovations introduced in this study was the attempt to spatially track forestry related income and employment flows through the Scottish economy. The results suggested that the nature of transactions upstream and downstream from the sector is such that the downstream multiplier effects are more likely to be retained within the locality of a woodland than upstream effects. Moreover, whilst rural areas of Scotland appear to retain the majority of benefits associated with additional forestry activity, a relatively high percentage, particularly of upstream flows, appear to leak to urban areas. The findings from the spatial analysis complement those from the multiplier analysis of the sector to provide a fuller understanding of the role of the sector in the rural and wider economy. In terms of further analysis, it would be useful to be able to compare the spatial distribution of forestry-related flows with those from the other main land-use sector, agriculture, to see which of them stimulates the greatest level of local economic activity.

Although, given the aims of the study, input-output analysis was an obvious methodological approach to adopt, certain characteristics of the forestry industry were difficult to reconcile with the underlying technical assumptions of the input-output model. In particular, the survey identified wide variability in the expenditures on inputs even within woodland types depending on the scale of woodlands and site specific factors. Likewise harvesting costs and the value of output from woodlands appeared to

vary significantly. In contrast, within the input-output model, it is assumed that the transactions relating to any sector are adequately represented by a single set of (average) coefficients. Moreover these coefficients are subsequently assumed constant and invariant to the level of activity in that sector. In the case of forestry, given the variability in costs, economies of scale and rapid technological change, this assumption is, perhaps, less tenable than in other sectors.

The other major methodological problem relates to the long production cycle of the sector. Differentiating between the planting and maintenance stage and the harvesting stage of the production cycle goes some way towards relaxing the problem but does not remove it. More research into the way in which the basic form of the model could be adapted to deal with forestry would be useful.

Covering 16% of the land area of Scotland, the forestry industry clearly plays an important part in ensuring the sustainability of rural areas in Scotland where rural sustainability is taken to incorporate not only economic but also social and environmental objectives. Echoing this, the recent Scottish forestry strategy document (Forestry Commission 1999) suggests three themes for the future development of forestry: forestry for the people; forestry for the economy; and forestry for the environment. This study has only considered one of these themes, the role of forestry in the economy. However, it provides the necessary foundations for a more comprehensive study of the full value of the sector in the future.

9. References

Aldwell, P. H.B. and Whyte, J. (1984) Impacts of forest sector growth in Bruce Country, Otago: a case study. *New Zealand Journal of Forestry*, 29, 269-295.

Bacharach, M. (1970) *Biproportional Matrices and Input-Output Change*. Cambridge University Press.

Benson, J.F. and Willis, K.G. (1992) Valuing Informal Recreation on the Forestry Commission Estate, *Forestry Commission Bulletin 104*, H.M.S.O.

Berck, P., Burton, D., Goldman, G. and Geoghegan, J. (1992) Instability in Forestry and Forestry Communities. Chapter 14 in Nemetz, P.N. (Ed.) *Emerging Issues in Forest Policy*, UBC Press, Vancouver.

Broom, G., Crabtree, B., Hill, G. and Roberts, D. (1998) *The Socio-economic Impact of Natura 2000 Site Designation.* A Report for the Scottish Office Agricultural and Environment Department, Edinburgh.

Bulmer-Thomas, V. (1982) Input-output Analysis in Developing Countries: Sources, Methods and Applications. John Wiley & Sons, Chichester.

Clark G.M. and Johnson, J.A. (1993) Farm Woodlands in the Central Belt of Scotland: A Socio-economic critique, *Scottish Forestry*, 47 (2), 15-24.

Countryside Commission (1998) *Agenda 2000: Forestry*. A working paper by the countryside agencies of Great Britain.

Crabtree, J.R. and Macmillan, D.C. (1989). UK Fiscal Changes and New Forestry Planting, *Journal of Agricultural Economics*, 40, 314-322.

Crabtree, J.R. (1997) Policy Instruments for Environmental Policy: Carbon Retention in Farm Woodlands. Chapter 14 in Adger, N., Pettenella, D. and Whitby, M. (Eds) *Climate-change, Mitigation and European Land-use Policies*. CAB International.

Crabtree, J.R., Bayfield, N.G., Wood, A.M., Macmillan, D.C. and Chalmers, N.A. (1997) Evaluating the benefits from Farm Woodland Planting, *Scottish Forestry* 51(2), 84-92.

Elrod, R.H., Shesai, S.M. and Schaffer, W.A. (1972). *Interindustry study of forestry sectors for Georgia economy*, Georgia Forest Research Council Report No. 31, Macon, Georgia, USA.

Evans, A. (1987). The growth of Forestry and its Effects upon Rural Communities in North-East Scotland: The Case of Strathdon. *Scottish Forestry*, 42, 310-313.

Farnsworth, M.C. (1983) The Social Impact of forest development in Northland. *New Zealand Journal of Forestry* 28, 246-254.

Flick, W.A., Trenchi, P. and Bowers, J.R. (1980). Regional analysis of forest industries: input-output methods, *Forest Science*, 26, 548-560.

Forestry Commission (1990). *Forest Employment Survey, 1993-1994*, Edinburgh: Forestry Commission.

Forestry Commission (1997) *Sawmill Survey, 1996,* HQ Statistics, Edinburgh

Forestry Commission (1999) Facts and Figures 1997-98. Statistics Unit Forestry Commission, Edinburgh.

Forestry Commission (1999) Forests for Scotland: Consultation towards a Scottish forestry document. Forestry Commission, Edinburgh.

Forestry Industry Council of Great Britain (199?) *The Forestry Industry Year-Book*, Forestry Industry Council of Great Britain, London.

Harrison, L.E. (1993). The impact of the Agricultural Industry on the rural economy - tracking the Spatial distribution of the farm inputs and outputs, *Journal of Rural Studies*, 9, 8121-88.

Harrison-Mayfield, L., Dwyer, J. and Brookes, G. (1998) The socio-economic effects of the Countryside Stewardship Scheme, *Journal of Agricultural Economics*, 49(2), 157-170.

Hutchinson, W.G., Davis, J. and Chilton, S. (1995) Theoretical and Spatial Limits to the Value of Rural Environmental Benefits: Evidence from the Forestry Sector, *Journal of Rural Studies*, 11 (4), 397-404.

Jenson, R.C., Mandeville, T.D. and Karunaratne, N.D. (1979). *Regional Economic Planning*, Croom Helm, London.

Jones, L. P. (1976) The measurement of Hirshmanian Linkages. *Quarterly Journal of Economics*, 90:323-333

Johnson, J. and Price, C. (1987). Afforestation, Employment and Depopulation in the Snowdonia National Park, *Journal of Rural Studies*, 7, 195-205.

Lloyd, T., Watkins, C. and Williams, D. (1995). Turning farmers into foresters via market liberalisation. *Journal of Agricultural Economics*, 46(3), 361-370.

Lynch, R. (1979). "An assessment of the RAS Method for Updating input-output Tables", in Sohn, I. (ed.) Readings in Input-output analysis. Oxford: Oxford University Press.

Mather, A.S. (ed) (1993). Pressures on British Forest Policy: Prologue to the Post-Industrial Forest?, *Area*, 23, 245-253.

Mather, A.S. (1991) The Changing Role of Planning in Rural Land Use: The example of Afforestation in Scotland, *Journal of Rural Studies*, 7 (3), 299-309.

Mather, A.S. (1993) Afforestation in Britain. Chapter 2 in Mather, A.S. (Ed*) Afforestation: Policies, Planning and Progress*, Belhaven Press, London.

Mather, A.S. and Murray, N. (1988). The dynamics of rural land-use change: the case of private sector afforestation in Scotland, *Land Use Policy*, 5, 103-120.

Mather, A.S. and Thomson, K.J. (1995) The Effects of Afforestation on Agriculture in Scotland, *Journal of Rural Studies*, 11 (2), 187-202.

Maxwell, J.S. (1930) A Decade of State Forestry and its Lessons. *Scottish Forestry Journal*, 44, 4.

McGregor, P.G. and McNicoll, I.H. (1989). *The Impact of Forestry on Output and Employment in the UK and its member Countries*. A Report to the Scottish Forestry Trust, Edinburgh.

McGregor, P.G. and McNicoll, I.H. (1991). "The impact of forestry on output in the U.K. and its member countries", *Regional Studies*, 26, 69-79.

McGregor, P., Swales, K. and Yin, Y. (1998) An Input-Output table and model for the Orkney Islands, 1995. Fraser of Allander Institute, University of Strathclyde.

Macmillan, D.C. and Chalmers, N. (1992) An Investment Model for Commercial Afforestation in Scotland, *Forestry*, 65 (2), 171-188.

Macmillan, D.C. (1993). Commercial forests in Scotland – an economic appraisal of replanting. *Journal of Agricultural Economics*, 44(1), 51-66.

Midmore, P. (1993). Input-Output Forecasting of Regional Agricultural Policy Impacts, *Journal of Agricultural Economics*, 44, 284-300.

Miller, R.E. and Blair, P.D. (1985) *Input-Output Analysis: Foundations and Exte*nsions. Prentice-Hall, London.

Psaltopoulos, D. and Thomson, K.J. (1993). Input-output evaluation of rural development: a forestry-centred application, *Journal of Rural Studies*, 9, 351-358.

Rayment, M. (1995*) Nature Conservation, Employment and Local Economies : A Literature Review.* Policy Research Department, Royal Society for the Protection of Birds, Bedfordshire December 1995.

Rayment , M (1997) *Working with Nature in Britain: Case studies of Nature Conservation, Employment and Local Economies*. Royal Society for the Protection of Birds, Bedfordshire January 1997

Roberts, D. (1994). "A modified Leontief model for analysing the impact of milk quotas on the wider economy", *Journal of Agricultural Economics*, 45 (1), 90-101.

Scottish Office (1992) "Scottish Rural Life: A Socio Economic Profile of Rural Scotland"

Scottish Office Industry Department (1998) Scottish Input Output Tables for 1995, Economics and Statistics Unit, SOID, HMSO: Edinburgh.

Selman, P. (1997) The role of forestry in meeting planning objectives, *Land Use Policy*, 14 (1) 55-73.

Schallau, C.H. and Maki , W.R. (1983) Interindustry model for analysing the regional impacts of forest resource and related supply constraints. *Forest Science*, 25 (4): 607-661

Schallau, C.H. and Maki , W.R. (1986) Input-output models and forest resource supply constraints revisited. *Forest Science*, 32 (2): 401-404

Slee, B., Clark, G. and Snowdon, P. (1996) *The Scope for Community Participation in Forest Management*. Summary Report for the Scottish Office and Forestry Commission. Published by the Forestry Commission: Edinburgh.

Sullivan, J. and Gilless, J.K. (1990). "Hybrid econometric/input-output modelling of the cumulative economic effect impact of national forest levels". *Forest Science*, 36, 863-877.

The Scotsman, (1998) "Money twinkling in trees could make farms reconsider*", The Scotsman*, Monday 21st September.

Thomson, K.J. and Psaltopoulos, D. (1993). "Input-output Evaluation of Rural Development: a forestry-centred Application", *Journal of Rural Studies*, (4), 351-358.

Thomson, K.J. and Psaltopoulos, D. (1993). *The Rural Employment League: agriculture versus forestry"*, Discussion paper presented at the Agricultural Economics Society conference, 31 March - 2 April, 1993, Oxford.

Thomson, K.J. and Psaltopoulos, D. (1994) "The Regional Economic Impact of Afforestation Strategies". Paper presented at the Annual Agricultural Economics Society Conference, Exeter, April 1994.

Thomson, K.J. and Psaltopoulos, D. (1996) Methodological Issues in Forestry Input-output modelling. Chapter 4 in Midmore, P. and Harrison-Mayfield, L. (eds*) Rural Economic Modelling: An Input-output Approach*, CAB International.

Watkins, C. (1986). Recent changes in Government Policy towards Broadleaved Woodland. *Area*, 18, 117-122.

Wear, D.H. and Hyde, W.F. (1992) Distributive Issues in Forest Policy. Chapter 13 in Nemetz, P.N. (Ed.) *Emerging Issues in Forest Policy*, UBC Press, Vancouver.

Whiteman, A. (1996). *Revised Forecasts of the Supply and Demand for Wood in the United Kingdom*, Technical Paper 19, Edinburgh: Forestry Commission.

Wonders, W.C. (1990). Forestry Villages in the Scottish Highlands, *Scottish Geographical Magazine*, 106, 156-166.

Appendices

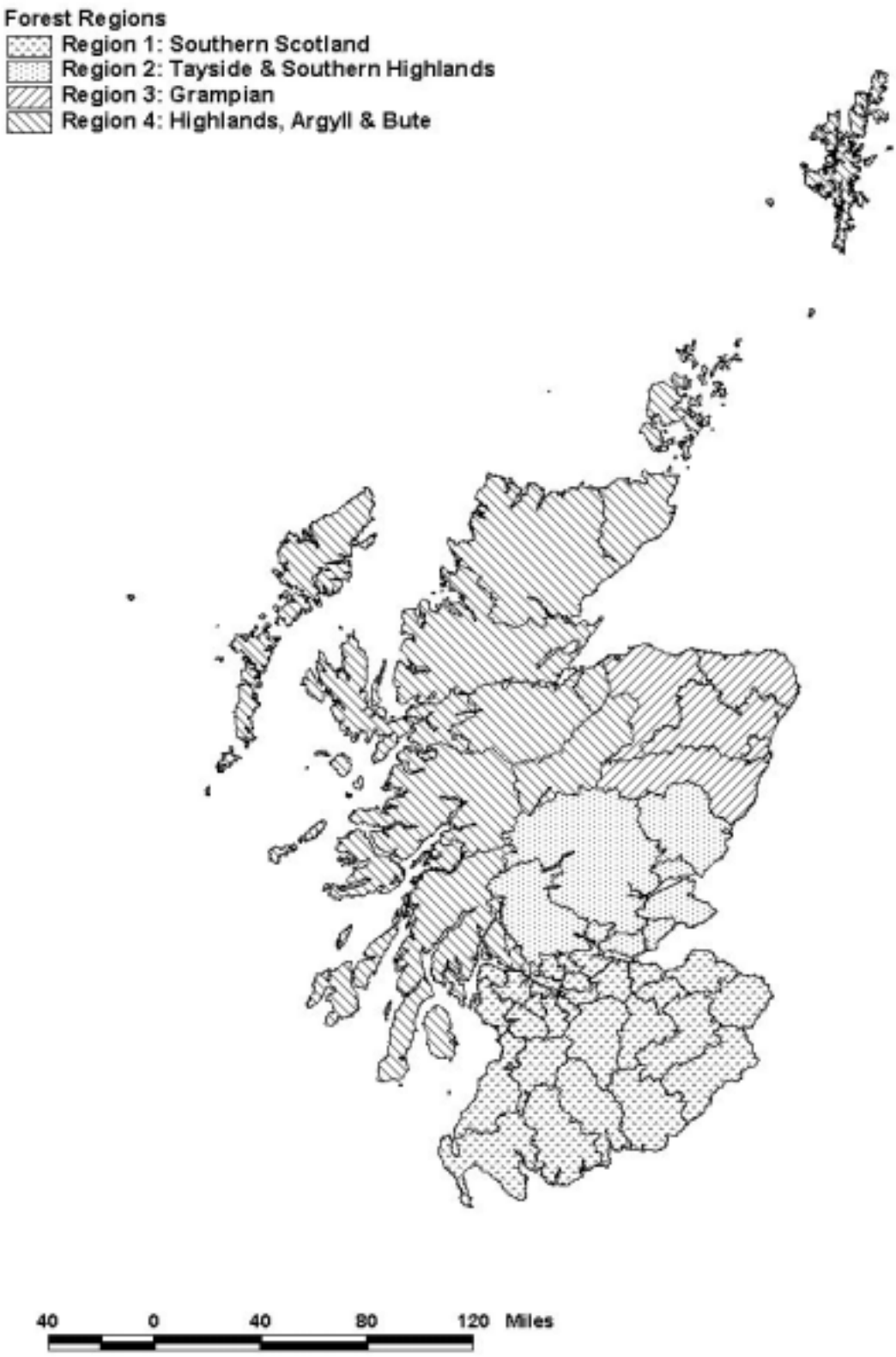
Appendix 1 List and map of local authorities grouped by forest regions

REGION 1: SOUTHERN SCOTLAND
Annandale & Eskdale
Bearsden and Milngavie
Berwickshire
City of Glasgow
Clydebank
Cumbernauld and Kilsyth
Cumnock and Doone Valley
Cunninghame
East Kilbride
East Lothian
Eastwood
Edinburgh
Ettrick and Lauderdale
Falkirk
Hamilton
Inverclyde
Kilmarnock and Loudon
Kyle and Carrick
Lanark (Clydesdale)
Mid Lothian
Monklands
Motherwell
Nithsdale
Renfrew
Roxburgh
Stewartry
Strathkelvin
Tweeddale
West Lothian
Wigtown

REGION 2: TAYSIDE AND SOUTHERN HIGHLANDS
Angus
Clackmannan
Dundee
Dunfermline
Kirkcaldy
North East Fife
Perth and Kinross
Stirling

REGION 3: GRAMPIAN
Aberdeen
Banff and Buchan
Gordon
Kincardine and Deeside
Moray

REGION 4: HIGHLANDS
Argyll and Bute
Badenoch and Strathspey
Caithness
Dumbarton
Inverness
Lochaber
Nairn
Orkney
Ross and Cromarty
Shetland
Skye and Lochalsh
Sutherland
Western Isles


Forest Regions
Region 1: Southern Scotland
Region 2: Tayside & Southern Highlands
Region 3: Grampian
Region 4: Highlands, Argyll & Bute
40
0
40
80
120 Miles

Appendix 2 Questionnaire used in the survey of private woodland owners and managers

CONFIDENTIAL

SURVEY NUMBER	
Name of Interviewer	
Date of Interview	

MACAULAY LAND USE RESEARCH INSTITUTE

PRIVATE FORESTRY QUESTIONNAIRE

A. COMPANY INFORMATION

1.	Name of owner/agent/company	
2.	Address	
3.	Post Code	
4.	Telephone Number	
5.	Selected forest type	
6.	(Map Reference of access point)	
7.	(WGS Application Name and Number)	
8.	Additional forest types to cover (please tick)	

Existing Native Woodland		(page 2)
New Native Woodland		(page 10)
Conifer woodlands		(page 20)
Farm Woodlands		(page 29)

9.	Name of interviewee	
10.	Job description of interviewee	

B BASE DATA

11. Total area of woodland (ha) (a) _____

Comment: Please ensure the data below corresponds to the area referred to in question 8 above.

12. Unplanted area (ha) (b) _____

13. Stocked area (a-b) _____

% conifers and species type	_____	_____
% broadleaves and species type	_____	_____
% Total	100	

14. Initial Stocking rate (plants/ha)

Conifers	_____
Broadleaves	_____

15. Do you expect to sell timber from the woodland on a commercial basis? Yes/No/Don't Know

Delete as appropriate

If yes

16. Planned length of rotation (years) _____

17. Age of woodland in 1995
(Number of years since the grant-aided planting operations began) _____

18. What determined the selection of planting site?

C CONTRACTOR COSTS

19. Please estimate the expenditure associated with the farm woodland. Please identify local address of contractor/management company rather than national headquarters

Operation	Year(s)	Cost (£)	Name of Contractor/Management Co	Address	Postcode
1. Preparing grant application					
2. Mounding					
3. Other ground preparation					
4. Drains					
5. Pre-plant spraying					
6. Spraying for weevils (pest control)					
7. Fertilising at planting					
8. Fencing					
9. New planting					
10. Restocking					
11. Post-plant spraying					
12. Beating up yr 1 Yr 2 Yr 3					
5. Chemical weeding yr 1 Yr 2					
6. Vermin control (per year)					
7. Maintenance (per year)					
8. Management (per year)					
9. Thinning 1 2 3 4					
10. Harvesting					
11. Other (specify)					

D PURCHASES

20. I would now like to ask you about purchases you have made in relation to the woodland - this will be used to identify the knock-on income and employment effects of forestry. Do not include purchases by contractors (for which costs would have been included in section C). Source of purchases refers to where payment is made rather than the origin of the goods. For example, if you buy Fertilisers in Inverurie, the source is Inverurie even though the fertilisers may have been made in the Netherlands

			Source			
Products purchased	Year	Cost (£)	Scottish supplier code %	Rest of UK	Rest of World	Total
Materials:						
1. Fencing materials						100
2. Plants conifers						100
Broadleaves						100
3. Stakes						100
4. Tubes						100
5. Chemical Weedkiller						100
6. Fertiliser						100
7. Trees for beating up Yr 1						100
Yr 2						100
Yr 3						100
8. Other (specify)						100
Services:						
1. Insurance (per year)						100
2. Legal costs of acquisition						100
3. Environmental Impact Assessment						100
4. Fire Protection						100
5. Hiring/leasing capital equipment						100
6. Vermin control						100
7. Haulage companies						100
8. Machinery repairs and maintenance						100
9. Other (specify)						100

21. For all Scottish suppliers, please provide name, address and postcode of source:

Name	Address	Postcode
1.		
2.		
3.		
4.		
5.		
6.		

22. Are there other costs assoicated with providing recreational facilities? Yes/No

If yes, please specify _____

E EMPLOYMENT

23. How many people were employed per year in the establishment of the woodland (eg years 0-3) (including working proprietors but excluding all contractors).

	Persons	Total Days
Full time (greater than or equal to 30 hrs per week)		
Part time (less than 30 hrs per week)		
Seasonal/Casual workers		

24. Where do the employees live?

	%	Within region?
Within 10 miles of woodland		
Within 20 miles of woodland		
Within 50 miles of woodland		
More than 50 miles from woodland		

25. How many people do you expect to be involved on average in maintaining the woodland per year (eg years 3 to harvest) (including working proprietors but excluding all contractors).

	Persons	Total Days
Full time (greater than or equal to 30 hrs per week)		
Part time (less than 30 hrs per week)		
Seasonal/Casual workers		

26. Where do the employees live?

	%	Within region?
Within 10 miles of woodland		
Within 20 miles of woodland		
Within 50 miles of woodland		
More than 50 miles from woodland		

27. Assuming technology does not change, how many people would you expect to employ at clearfell (including working proprietors but excluding all contractors).

	Persons	Total Days
Full time (greater than or equal to 30 hrs per week)		
Part time (less than 30 hrs per week)		
Seasonal/Casual workers		

28. Where do the employees live?

	%	Within region?
Within 10 miles of woodland		
Within 20 miles of woodland		
Within 50 miles of woodland		
More than 50 miles from woodland		

29. What was the average wage and salary of employees (including working proprietors but excluding contractors)? (Complete whichever category is easiest)

	Per yr	Per mnth	Per week	Per day
Full time workers				
Part time workers				
Seasonal/Casual workers				

30. Does this include employers' contribution to National Insurance and occupational pension schemes? Please tick

	Yes	No
National Insurance		
Occupational Pension		

F CAPITAL EXPENDITURE

31. Please indicate any capital expenditure made in connection with the woodland (see interviewer notes)

Capital Item	Year	Cost (£)	% from Scottish suppliers
1. Land			
2. New machinery			
3. New vehicles			
4. Other capital equipment (specify)			
5. Second hand capital equipment			

32. Is it used soley in connection with this woodland? Yes/No

If no,

33. Roughly what proportion of the machine's use can be attributed to this particular woodland? _____

G OUTPUT

34. Please complete the following table detailing the expected type and value of output and its likely destination.

			Destination (%)					
Products Sold	Year	Value of Sales (£)	Agent	Scottish Sawmill	Other Scottish Buyers	Rest of UK	Rest of World	Total
								100
								100
								100
								100
								100
TOTAL								**100**

35. For all Scottish destinations, please provide name, address and postcode of purchases

Name	Address	Postcode
1.		
2.		
3.		
4.		

36. Grant income from woodland.

	Year(s)	Value per year
Initial grant		
Installment 1		
Installment 2		
Annual payment		
Other (please specify)		

37. Other income from woodland.

	Year(s)	Value per year
Stalking income		
Other (please specify)		

H PROFIT

38. Roughly what % of turnover do you hope to make as profit for the woodland over the full rotation.

_____

Additional Comments

Thank you very much for taking part in the survey. Your input has been very valuable.

Appendix 3 Classification of industries in the forestry input-output tables

Sector	Industry/Product Group	Scottish IO Code	SIC 1992 Code
1.	Agriculture	1	01
2.	Forestry planting and maintenance	2.1	02(part)
3.	Forestry Harvesting	2.2	02(part)
4.	Fishing	3.1, 3.2	05.01, 05.02
5.	Mining and extraction	4, 5, 6, 7	10, 11, 12, 13, 14
6.	Food processing	8, 9, 10, 11, 12, 13, 14, 15, 16, 17	15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.81-15.89
7.	Alcoholic and soft drinks	18.1, 18.2, 19	15.91 - 15.97, 15.98
8.	Textiles, clothing and footwear	21, 22, 23, 24, 25, 26, 27, 28, 29 30	17.1, 17.2, 17.3, 17.4, 17.51, 17.52, 17.6, 18, 19.1, 19.2, 19.3
9.	Timber and Wood Products	31	20
10.	Pulp, Paper and Board	32	21.1
11.	Paper and Board Products	33	21.2
12.	Printing and Publishing	34	22
13.	Oil Process, Nuclear Fuel	35	23
14.	Chemicals and chemical products	36, 37, 38, 43, 44, 45	24.11, 24.13, 24.14, 24.4, 24.5, 24.6
15.	Fertilisers	39	24.15
16.	Other manufacturing	40, 42, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 68, 69, 70, 71, 72, 73, 74, 75, 76, 82, 83, 84	24.16, 24.17, 24.3, 24.7, 25.1, 25.2, 26.1, 26.2, 26.4, 26.5, 26.6, 27.1, 27.4, 27.5, 28.1, 28.2 - , 28.7, 28.7, 29.7, 30, 31.1 - 31.6, 31.4, 32.1, 32.2, 32,3, 33, 36.2 - 36.6, 37
18.	Machinery and vehicles	62, 63, 64, 65, 66, 67, 77, 78, 79, 80	29.1, 29.2, 39.3, 29.4, 29.5, 29.6, 34, 35.1 - 35.5, 35.3,
19.	Furniture	81	36.1
20	Electricity, Gas and water	85, 86, 87	40.1, 40.2, 40.3, 41
21	Construction	88	45
22	Distribution and Motor Repair, etc	89	50
23	Wholesale Distribution	90	51
24	Retail Distribution	91	52
25	Hotels, Catering, Pubs, etc	92	55
26	Land transport	93, 94	60.1, 60.2, 60.3
27	Other transport	95, 96, 97	61, 62, 63
28	Communications	98, 99	64.1, 64.2
29	Banking and finance	100, 100	65.11, 65.12, 65.2
30	Insurance	101, 102, 102	66, 67.1, 67.2
31	Real estate	103, 104, 105	70.1, 70.2, 70.3
32	Renting of Machinery	106	71
33	Legal Activities	109	74.11
34	Other business services	107, 108, 110, 111, 112, 113, 114	72, 73, 74.1-74.14, 74.2 – 74.8
35	Other services	115, 116, 117, 118, 119, 120, 121, 122, 123	75, 80, 85.1, 85.3, 85.3, 90, 91, 92, 93, 95

Appendix 4 Balanced 1995 input output table emphasising forestry

		1	Type A.1	Type A.2	Type B.1	Type B.2	Type C.1	Type C.2	Type D.1	Type D.2	4	5	6	7	8	9	10	11	12	13
1	Agriculture	317.890	0.007	0.000	0.008	0	0.076	0.000	0.074	0	0.498	4.276	544.730	105.453	3.492	0.386	3.049	0.400	1.288	0.199
Type A.1	Existing Native Planting/Maintenance	0.000	0.007	0.000	0.021	0	0.094	0.000	0.380	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type A.2	Existing Native Harvesting	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	6.979	0.000	0.000	0.000	0.000
Type B.1	New Native Planting/Maintenance	0.000	0.005	0.000	0.014	0	0.062	0.000	0.252	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type B.2	New Native Harvesting	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type C.1	Commercial conifers planting/maintenance	0.000	0.062	0.000	0.176	0	0.784	0.000	3.176	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type C.2	Commercial Forestry harvesting	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.230	0.000	0.000	42.600	0.000	0.000	0.000	0.000
Type D.1	Farm woodlands Planting/Maintenance	0.000	0.063	0.000	0.176	0	0.787	0.000	3.187	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type D.2	Farm woodlands Harvesting	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Fishing	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	25.651	0.000	91.953	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Mining and extraction	0.297	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	77.684	2.084	4.752	1.390	0.768	20.023	1.591	0.099	289.951
6	food processing	108.399	0.000	0.000	0.000	0	0.000	0.000	0.000	0	42.757	0.397	172.212	30.490	2.590	0.385	1.826	0.200	0.494	0.697
7	Alcoholic and soft drinks	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	2.358	0.000	9.738	86.753	0.000	0.000	0.100	0.000	0.000	0.098
8	Textiles, clothes and footwear	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	6.241	0.396	0.496	0.198	108.163	1.631	4.145	1.193	1.084	0.000
9	Timber and Wood Products	0.000	0.509	0.000	0.098	0	0.116	0.000	1.318	0	1.507	2.910	1.610	1.104	0.403	64.226	6.152	0.605	0.799	0.101
10	Pulp, Paper and Board	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.099	2.077	0.000	1.781	0.765	43.039	30.333	54.619	0.000
11	Paper and Board Products	9.582	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.198	0.198	7.330	11.069	1.487	0.287	9.995	12.312	5.117	0.000
12	Printing and Publishing	2.799	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.800	6.214	10.300	1.705	1.066	0.511	0.804	14.038	1.703
13	Oil Process, Nuclear Fuel	39.818	0.000	0.000	0.000	0	0.000	0.000	0.000	0	23.076	15.592	15.534	13.312	1.993	2.793	2.842	1.298	2.176	72.374
14	Chemicals and chemical products	2.080	0.006	0.000	0.005	0	1.945	0.000	0.797	0	0.694	3.764	7.449	16.845	2.186	3.170	11.540	2.787	2.368	5.858
15	Fertilisers	17.963	0.007	0.000	0.006	0	0.027	0.000	0.046	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	Other manufacturing	38.560	0.501	0.124	0.108	0	0.156	0.805	2.280	0	8.277	18.792	60.468	130.599	20.430	18.034	10.858	5.636	11.758	8.777
18	Machinery and vehicles	0.099	0.004	0.125	0.000	0	0.078	0.811	0.531	0	24.608	18.230	10.132	11.001	1.690	3.555	4.050	1.693	2.566	2.681
19	Furniture	0.000	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.100	0.000	0.100	1.651	0.205	0.302	0.199	0.100
20	Electricity, Gas and water	32.091	0.001	0.125	0.001	0	0.008	0.816	0.008	0	0.799	21.730	34.180	31.509	17.699	5.607	34.938	6.912	5.361	10.791
21	Construction	13.514	0.057	0.972	0.058	0	5.664	15.439	0.087	0	0.000	53.647	2.731	3.668	0.841	0.711	0.857	0.632	0.939	6.827
22	Distribution and Motor Repair, etc	91.926	0.048	0.000	0.058	0	0.554	0.000	0.538	0	0.200	22.861	3.703	4.094	2.804	2.517	2.142	1.304	0.795	0.500
23	Wholesale Distribution	46.329	0.001	0.000	0.001	0	0.013	0.000	0.012	0	15.603	37.849	100.328	81.117	38.569	12.785	21.533	13.549	11.438	32.634
24	Retail Distribution	71.081	0.003	0.000	0.004	0	0.034	0.000	0.033	0	24.401	56.017	149.269	123.456	57.996	21.305	33.162	20.271	18.795	47.343
25	Hotels, Catering, Pubs, etc	7.818	0.000	0.000	0.000	0	0.000	0.000	0.000	0	2.643	9.579	10.976	9.191	5.785	1.612	1.698	1.474	0.681	0.294
26	Land transport	27.296	0.006	0.201	0.008	0	0.072	14.394	0.070	0	13.421	21.001	24.866	18.406	10.333	6.304	7.562	6.633	6.075	0.802
27	Other transport	0.000	0.001	0.125	0.001	0	0.013	0.815	0.012	0	33.329	103.025	9.790	11.761	4.298	1.450	1.120	1.402	2.878	0.699
28	Communications	17.125	0.003	0.125	0.004	0	0.038	0.815	0.037	0	0.000	2.290	6.290	7.471	5.594	3.091	1.323	2.302	11.307	0.399
29	Banking and finance	40.078	0.005	0.237	0.006	0	0.059	3.763	0.057	0	10.386	47.664	75.181	88.076	36.610	12.669	17.934	13.929	27.310	47.778
30	Insurance	2.482	0.018	0.125	0.820	0	0.208	0.813	1.544	0	7.857	19.067	11.749	7.649	6.575	4.238	4.364	2.695	4.945	2.986
31	Real estate	0.000	0.027	0.000	0.027	0	2.670	0.000	0.041	0	6.629	56.805	10.202	4.052	6.838	3.833	1.413	3.574	16.923	0.396
32	Renting of Machinery	0.000	0.004	0.125	0.034	0	0.000	0.814	0.026	0	0.000	88.895	14.456	25.066	5.985	3.954	3.658	4.897	10.893	0.797
33	Legal Activities	0.000	0.000	0.314	0.000	0	0.002	2.041	0.005	0	0.000	1.996	4.102	6.588	1.501	0.677	0.408	0.802	1.292	0.300
34	Other business services	39.339	0.028	0.382	0.028	0	2.741	2.489	0.042	0	36.257	270.656	172.538	223.775	98.775	48.388	38.756	41.377	39.893	11.385
35	Other services	287.507	0.004	0.000	0.005	0	0.049	0.000	0.048	0	11.113	5.178	29.668	41.546	13.464	5.227	3.672	5.098	96.307	2.331
	Imports from Rest of UK	341.525	0.029	0.023	0.023	0	0.337	0.150	0.257	0	32.615	503.617	669.291	278.750	224.152	22.838	159.121	104.730	84.926	505.322
	Imports from Rest of World	39.567	0.004	0.023	0.003	0	0.043	0.149	0.033	0	12.180	154.012	292.637	70.000	216.393	97.356	119.487	81.147	32.564	14.489
	Sales by Final Demand	0.025	0.000	0.005	0.000	0	0.001	0.035	0.001	0	0.000	0.053	0.002	0.004	0.020	0.015	0.367	0.049	0.002	0.047
	Taxes	45.431	0.009	0.057	0.007	0	0.105	0.374	0.080	0	5.701	37.750	46.760	885.705	38.069	15.788	25.819	17.765	19.793	1031.19
	Subsidies	-419.67	-1.635	-3.024	-0.6567	0	-1.085	-19.686	-12.282	0	0.000	-4.661	-7.580	-6.941	0.000	0.000	0.000	0.000	-0.103	-4.464
	Income from Employment	309.138	0.787	2.860	0.675	0	25.050	13.535	4.903	0	140.319	579.919	581.033	243.316	512.066	111.169	113.762	126.646	329.440	56.698
	Other Value Added	870.021	4.856	9.282	1.950	0	3.223	60.424	36.475	0	66.481	357.113	244.973	476.166	316.426	83.568	151.471	93.760	224.440	258.911
	TOTAL INPUTS	2400.10	5.427	12.205	3.668	0	43.925	98.795	44.067	0	555.800	2589.20	3419.50	3056.30	1768.20	613.400	862.900	610.100	1043.50	2411.00

		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
1	Agriculture	0.299	0.000	10.304	1.195	0.200	0.597	18.195	2.186	15.623	49.615	81.140	1.996	3.884	2.385	4.962	5.562	4.163	0.100	0.099	
Type A.1	Existing Native Planting/Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type A.2	Existing Native Harvesting	0.000	0.000	0.035	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type B.1	New Native Planting/Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type B.2	New Native Harvesting	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type C.1	Commercial conifers planting/maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type C.2	Commercial Forestry harvesting	0.000	0.000	0.276	0.000	0.178	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type D.1	Farm woodlands Planting/Maintenance	0.000	0.000	0.000	0.000	0.000	0.000	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Type D.2	Farm woodlands Harvesting	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
4	Fishing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.531	0.000	1.282	0.000	0.000	0.000	0.000	0.000	0.000	
5	Mining and extraction	9.220	0.000	55.644	3.467	0.299	238.808	87.180	0.000	10.991	2.276	0.594	0.695	0.099	0.000	0.000	0.000	0.000	0.000	0.000	
6	food processing	0.099	0.000	4.394	0.099	0.100	1.391	7.108	2.083	87.121	284.382	179.280	5.081	5.170	2.679	3.963	2.281	0.198	0.000	0.991	
7	Alcoholic and soft drinks	0.000	0.000	0.000	0.000	0.000	0.000	30.143	0.196	5.693	19.028	46.691	1.575	4.323	2.059	2.056	0.882	0.196	0.000	0.490	
8	Textiles, clothes and footwear	1.288	0.000	7.761	1.980	2.089	0.000	7.770	9.884	11.184	34.120	11.176	2.680	0.297	0.000	2.073	1.482	1.084	0.100	1.876	
9	Timber and Wood Products	0.000	0.000	16.451	1.205	3.733	0.100	199.331	0.802	2.711	6.320	3.511	0.604	0.100	0.702	0.300	0.501	1.000	0.000	0.401	
10	Pulp, Paper and Board	0.494	0.000	5.258	0.099	0.099	0.000	0.000	0.000	0.000	4.536	0.000	0.000	0.000	0.000	0.000	0.000	0.590	0.000	0.000	
11	Paper and Board Products	0.000	0.000	8.149	0.198	0.000	2.965	3.831	5.528	8.007	15.013	4.248	3.371	1.088	0.099	5.028	7.104	5.022	0.000	0.789	
12	Printing and Publishing	0.300	0.000	18.703	1.501	0.201	8.901	9.940	9.988	44.410	27.684	6.897	9.830	0.601	1.898	43.190	33.545	10.760	9.555	13.871	
13	Oil Process, Nuclear Fuel	21.392	0.502	69.030	10.737	0.899	153.615	17.182	37.212	30.208	25.617	6.554	40.459	31.228	2.977	10.702	7.340	3.860	50.859	2.974	
14	Chemicals and chemical products	7.542	0.100	26.106	0.892	0.100	2.081	21.767	3.167	7.533	14.162	2.179	2.386	0.298	0.000	0.395	0.495	0.296	0.000	0.000	
15	Fertilisers	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
16	Other manufacturing	1.774	0.000	791.814	50.325	4.551	56.599	413.610	12.288	95.487	130.132	37.282	49.755	8.473	33.819	7.363	6.682	6.275	0.891	1.473	
18	Machinery and vehicles	0.397	0.000	40.462	47.306	0.498	5.254	103.143	15.047	18.042	8.915	0.991	7.953	14.584	5.445	2.570	2.573	7.702	0.299	0.593	
19	Furniture	0.000	0.000	1.712	0.000	1.007	0.100	12.941	0.700	1.402	6.406	3.203	0.703	0.000	0.500	0.599	0.600	1.397	0.101	0.999	
20	Electricity, Gas and water	33.654	1.008	195.820	32.428	1.403	768.708	24.382	45.814	34.508	138.820	32.191	20.504	11.279	10.558	7.062	4.978	3.378	10.731	5.075	
21	Construction	1.890	0.000	6.640	3.147	0.000	42.457	1427.95	40.830	89.741	119.315	67.572	3.575	5.876	3.874	31.260	30.138	760.312	40.586	19.560	
22	Distribution and Motor Repair, etc	2.800	0.101	20.786	7.395	0.201	11.186	3.871	2.992	69.021	15.570	9.582	91.355	29.091	12.469	13.945	12.463	16.117	0.402	0.299	
23	Wholesale Distribution	35.218	1.010	537.428	73.274	4.318	44.762	139.713	22.751	72.643	95.249	56.615	17.636	22.501	20.756	24.911	41.690	34.934	21.200	3.689	
24	Retail Distribution	51.619	1.515	798.496	107.547	6.527	78.422	228.156	35.418	111.397	151.639	88.055	27.753	33.097	31.429	37.362	60.831	51.946	30.640	5.881	
25	Hotels, Catering, Pubs, etc	4.700	0.099	49.849	9.393	0.491	1.663	0.000	0.781	1.174	9.772	0.684	1.765	4.405	1.563	5.657	3.417	0.195	1.868	0.878	
26	Land transport	8.215	0.303	76.148	12.212	1.006	0.100	33.510	38.369	64.038	106.278	5.699	404.589	30.944	14.789	27.739	26.067	10.664	19.821	4.592	
27	Other transport	5.790	0.000	37.684	10.373	0.401	4.586	12.483	45.496	72.576	8.467	3.287	223.049	929.106	27.678	75.358	60.999	28.002	17.643	7.858	
28	Communications	3.492	0.000	23.039	12.261	0.401	4.982	3.862	21.890	20.725	34.547	7.965	26.180	34.105	62.691	166.932	135.261	27.392	17.433	26.543	
29	Banking and finance	33.865	0.504	332.700	79.152	4.111	68.937	144.756	37.262	78.419	136.875	57.526	56.331	71.794	37.165	79.098	72.598	104.246	23.576	26.677	
30	Insurance	3.880	0.100	36.162	18.689	0.899	13.115	61.913	14.289	10.632	21.843	11.121	31.290	34.707	6.847	117.124	166.229	156.871	15.387	15.664	
31	Real estate	1.584	0.100	35.476	14.240	3.974	7.018	142.531	10.463	26.985	35.457	0.099	27.260	65.886	46.594	91.574	101.426	56.316	27.432	7.396	
32	Renting of Machinery	4.682	0.101	38.708	21.499	1.700	4.377	120.522	4.471	0.000	0.000	0.000	31.429	9.061	0.994	0.000	1.589	0.099	4.802	15.882	
33	Legal Activities	1.799	0.000	8.732	3.496	0.100	1.997	7.540	14.855	10.084	34.815	10.475	14.117	15.088	5.683	43.010	39.562	32.319	6.726	5.478	
34	Other business services	73.147	0.923	455.345	205.248	7.546	45.351	276.881	131.415	59.255	156.332	25.652	231.488	288.801	160.000	402.202	357.708	304.401	25.098	35.228	
35	Other services	14.505	0.107	80.685	26.447	1.169	28.760	91.736	7.603	3.489	2.219	3.804	78.153	36.511	31.786	45.975	25.753	15.693	0.213	0.738	
	Imports from Rest of UK	153.491	4.054	2337.76	975.830	30.228	524.415	1298.21	225.166	731.281	576.723	276.714	114.419	329.720	209.663	287.444	693.706	156.084	301.730	21.606	
	Imports from Rest of World	367.012	13.106	4670.18	314.114	33.079	13.464	313.012	12.350	282.162	21.227	98.272	63.515	53.105	96.121	25.761	55.751	69.144	6.118	0.000	
	Sales by Final Demand	0.006	0.000	1.435	0.088	0.004	0.014	0.235	0.037	0.053	0.084	0.039	0.121	0.107	0.029	0.021	0.014	0.614	0.194	0.000	
	Taxes	36.519	1.414	883.604	101.866	4.519	278.368	194.727	85.515	741.230	480.745	128.509	81.269	74.804	48.698	56.400	87.172	29.958	35.769	32.101	
	Subsidies	-5.188	0.000	0.000	0.000	0.000	0.000	-21.934	0.000	-1.762	0.000	0.000	-235.17	-7.260	-0.103	0.000	-2.172	-14.347	0.000	0.000	
	Income from Employment	278.628	2.527	2338.14	963.317	58.586	536.510	2174.62	526.114	1177.17	2320.60	987.090	964.647	1121.21	799.662	695.698	570.587	277.172	289.562	337.785	
	Other Value Added	261.485	1.625	2443.57	533.082	16.864	740.598	571.068	363.035	304.759	1707.71	901.271	359.036	237.734	342.691	624.766	199.589	3616.64	298.866	206.214	
	TOTAL INPUTS		1415.60	29.200	16464.5	3644.10	191.500	3690.20	8182.30	1786.00	4298.10	6802.50	3160.50	2761.40	3503.10	2024.20	2942.50	2814.40	5780.70	1257.70	8

		33	34	35	Expend				Expend	RUK	ROW	OUTPUT
1	Agriculture	0.099	3.123	17.122	96.568	5.909	5.670	191.556	3.005	578.422	311.080	2399.780
Type A.1	Existing Native Planting/Maintenance	0.000	0.100	0.000	0.000	0.000	0.000	4.720	0.000	0.000	0.000	5.427
Type A.2	Existing Native Harvesting	0.000	0.000	0.000	1.002	0.002	0.000	0.000	0.000	3.097	1.053	12.205
Type B.1	New Native Planting/Maintenance	0.000	0.098	0.000	0.000	0.000	0.000	3.135	0.000	0.000	0.000	3.668
Type B.2	New Native Harvesting	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Type C.1	Commercial conifers planting/maintenance	0.000	0.103	0.000	0.000	0.000	0.000	39.467	0.000	0.000	0.000	43.925
Type C.2	Commercial Forestry harvesting	0.000	0.000	0.000	2.269	0.018	0.000	0.000	0.000	44.106	8.994	98.795
Type D.1	Farm woodlands Planting/Maintenance	0.000	0.103	0.000	0.000	0.000	0.000	39.595	0.000	0.000	0.000	44.067
Type D.2	Farm woodlands Harvesting	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	fishing	0.000	0.000	0.000	2.599	0.000	0.000	-0.099	3.387	145.510	280.192	555.700
5	Mining and extraction	0.000	1.504	13.372	1.908	2.262	0.000	-2.775	0.412	953.760	806.318	2587.900
6	food processing	0.991	64.563	91.725	362.049	27.864	0.093	-4.077	3.310	1495.759	422.884	3415.300
7	Alcoholic and soft drinks	0.490	26.035	99.376	579.628	7.533	0.000	-6.485	27.393	213.184	1892.643	3055.500
8	Textiles, clothes and footwear	1.876	24.047	72.676	69.455	15.644	0.000	-3.765	19.685	811.940	531.226	1763.500
9	Timber and Wood Products	0.401	10.773	21.291	14.761	5.870	4.314	21.004	2.300	213.293	1.952	615.555
10	Pulp, Paper and Board	0.000	7.893	0.000	0.000	0.000	0.000	-0.889	0.000	357.160	353.569	862.600
11	Paper and Board Products	0.789	59.542	24.722	20.650	1.626	0.000	-1.286	1.544	177.383	196.747	609.700
12	Printing and Publishing	13.871	147.52	63.437	57.104	72.559	0.000	7.510	2.187	324.934	75.126	1043.400
13	Oil Process, Nuclear Fuel	2.974	40.439	165.51	555.727	0.908	0.000	11.738	0.931	918.282	0.000	2410.700
14	Chemicals and chemical products	0.000	22.074	158.54	11.659	70.542	0.093	-2.183	8.256	312.433	681.051	1415.228
15	Fertilisers	0.000	0.303	3.297	0.203	0.000	0.000	0.000	0.000	2.405	4.803	29.196
16	Other manufacturing	1.473	92.478	259.68	420.659	76.628	229.414	-9.066	56.377	2701.422	10563.839	16456.734
18	Machinery and vehicles	0.593	51.080	30.048	91.578	8.151	194.357	-13.695	1.135	1353.030	1557.624	3641.481
19	Furniture	0.999	14.907	16.134	10.361	11.532	8.140	0.802	3.234	62.029	28.292	190.700
20	Electricity, Gas and water	5.075	59.771	326.95	856.127	113.265	0.000	553.515	7.477	154.644	28.679	3689.913
21	Construction	19.560	120.140	210.69	251.747	483.808	3771.607	-13.014	6.113	635.708	0.000	8278.511
22	Distribution and Motor Repair, etc	0.299	31.953	0.600	916.670	10.495	0.000	361.266	10.401	0.000	0.102	1787.410
23	Wholesale Distribution	3.689	95.489	129.14	1045.589	107.360	207.387	5.401	43.596	976.435	0.000	4297.830
24	Retail Distribution	5.881	151.304	219.77	1664.866	166.404	316.916	18.502	71.886	1622.718	0.511	6802.280
25	Hotels, Catering, Pubs, etc	0.878	22.276	71.910	1577.783	12.152	0.000	-4.797	1095.881	231.442	0.000	3160.700
26	Land transport	4.592	77.185	35.934	514.634	47.355	21.777	-4.708	97.001	777.139	163.210	2775.523
27	Other transport	7.858	207.393	118.67	156.494	81.611	4.563	0.000	12.872	946.982	228.004	3502.523
28	Communications	26.543	215.757	62.996	632.516	80.202	0.000	-0.199	43.369	299.694	0.204	2024.983
29	Banking and finance	26.677	167.963	281.35	33.185	20.054	0.000	0.000	6.649	453.683	112.917	2946.820
30	Insurance	15.664	87.915	64.909	599.130	0.091	0.093	-0.099	45.733	1056.854	146.724	2819.767
31	Real estate	7.396	160.703	44.299	4648.616	65.836	6.463	-5.838	40.347	0.000	0.000	5782.885
32	Renting of Machinery	15.882	122.371	43.195	576.682	56.721	0.000	-3.984	42.993	0.000	0.000	1259.067
33	Legal Activities	5.478	55.486	32.060	29.157	0.000	23.593	-0.200	1.351	308.603	79.278	806.240
34	Other business services	35.228	640.731	111.14	45.477	1110.007	217.695	-3.047	2.219	649.969	241.295	7293.465
35	Other services	0.738	16.485	25.705	2602.733	10558.447	0.000	-2.117	182.777	1484.313	237.076	16122.110
	Imports from Rest of UK	21.606	749.530	372.79	11417.24	1089.031	2669.230	129.168	302.020	0.000	0.000	28941.100
	Imports from Rest of World	0.000	64.115	24.744	6890.253	360.768	973.924	44.630	142.699	0.000	0.000	16158.890
	Sales by Final Demand	0.000	1.964	0.084	11.340	-13.515	-8.395	0.000	1.606	1.187	4.205	2.200
	Taxes	32.101	242.468	304.07	2441.091	246.859	407.966	46.813	75.851	503.317	159.103	9993.620
	Subsidies	0.000	-29.058	-29.129	-109.810	0.000	0.000	0.000	0.000	-58.238	0.000	-965.857
	Income from Employment	337.785	2610.417	11621	0.000	0.000	0.000	0.000	0.000	0.000	0.000	33845.448
	Other Value Added	206.214	848.951	1012.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	18843.943
	TOTAL INPUTS		803.700	7288.0	16123.30	39099.700	14904.000	9054.900	1396.500	2366.000	20712.600	19118.700

Appendix 5 Multipliers from the Equilibrium 2 input-output table

As described in Chapter 4, in addition to the basic 1995 input-output table, two other balanced tables were constructed to accommodate for the fact that in 1995, two of the woodland types had yet to reach maturity and thus, in the base year of the model, generated no harvesting activity. This appendix describes the multipliers from one of the two additional tables known as Equilibrium 2 where it has been assumed that all of the area planted to farm woodlands and new native woodlands is eventually harvested.

Table A5 presents the output, employment and income effects from the Equilibrium 2 model, for comparative purposes, also indicating the level of output multipliers from the Equilibrium 1 model as discussed and presented in Chapter 4.

Table A5 Output multipliers, employment and income effects for forestry and forestry-related sectors, Equilibrium 2 input-output model.

	Open model				Closed model			
	Type I Output multiplier	*Equil 1 multiplier*	Employ. Effect (FTE)	Income effect (£m)	Type II Output multiplier	*Equil 1 multiplier*	Employ effect (FTE)	Income effect (£m)
Existing native planting/maint.	1.399	1.394	12.507	0.231	1.593	1.587	15.300	0.283
Existing native harvesting	1.392	1.392	36.412	0.345	1.683	1.683	40.585	0.423
New native planting & maint.	1.733	1.730	19.123	0.369	2.043	2.039	23.575	0.451
New native harvesting	1.401	1.549	34.270	0.331	1.679	1.846	38.266	0.405
Commercial con. plant/ maint.	1.582	1.581	36.294	0.717	2.185	2.184	44.957	0.878
Commercial conif. Harvesting	1.753	1.754	29.157	0.359	2.055	2.055	33.490	0.439
Farm planting and maint.	1.509	1.506	12.647	0.244	1.714	1.710	15.594	0.299
Farm harvesting	1.377	1.406	35.262	0.334	1.658	1.695	39.297	0.409
Timber and wood products	1.772	1.746	27.380	0.365	2.079	2.054	31.791	0.447
Paper and pulp	1.521	1.520	12.146	0.261	1.740	1.739	15.295	0.319
Paper products	1.464	1.463	14.348	0.332	1.743	1.742	18.361	0.407
Furniture	1.380	1.379	23.174	0.405	1.721	1.719	28.066	0.496

In most but not all cases, the Equilibrium 2 multipliers exceed those based on the Equilibrium 1 scenario. The multipliers from harvesting farm woodlands fall to relatively low levels with a £1m increase in demand for such harvesting output anticipated to create only an additional £377 thousand gross output in Scotland over and above the value of the increase in demand. The labour-intensive nature of harvesting ensures that this multiplier effect is increased significantly once induced effects, that is effects arising from the expenditure of harvesting workers, are accommodated: the total output multiplier effect relating to harvesting farm woodlands in the closed model is £1.658m.

Appendix 6 Areas classified as rural and urban in the spatial analysis of forestry-related flows