Incorporating Output Projections into a Regional Input-Output Model: The Case of Forestry in Rural Scotland

By
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Abstract

The paper presents a method of investigating the impact of changes in timber supply associated with alternative forestry development scenarios, on the rural economy of Scotland, through a demand-driven input-output model. The projections of a Forestry Development Model, concerning gross output levels for the forestry planting, harvesting and wood processing sectors for the year 2050, are set as exogenous to a standard demand-driven input-output table for Scotland. Changes in the output of these sectors affect in turn - through the input-output backward linkages - the gross output and final demand of other sectors in the national economy. The estimation of new gross output and final demand levels in the national table is followed by the regionalization of the table to the 'Rural Scotland' level via the GRIT technique. Based on the interindustry structure of the estimated regional input-output table, the impact of the exogenously-set forestry output changes on the rural Scottish economy is assessed.

1. Introduction

The recent reform of the CAP and the Uruguay Round Agreement on agriculture are expected to result in the gradual transition of Western European agriculture towards world market conditions and therefore significantly influence development in rural areas. In the remoter areas, forestry is considered to be one of the most likely alternative uses of agricultural land: 'for the problems which beset the very marginal areas, ... development outlook will be jeopardized unless ... a forestry activity is gradually built-up' (Commission, 1988).

This paper describes work conducted at and from Aberdeen as part of the tripartite 1991-94 CEC study of Afforestation in Rural Development in Scotland, Northern Ireland and the Republic of Ireland (Gardiner *et al.*,1994)[1]. Much of the land

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in these countries shares the characteristics (common also to other parts of the EC) of depopulation, remoteness from main population centers, and adverse soil and climatic conditions. Additionally, most of new UK forestry planting has concentrated in these areas.

Preliminary aspects of this work focused upon: (i) the interrelationship between the forestry sector and other components of the rural economy investigated through input-output (I-O) analysis (Psaltopoulos and Thomson, 1993), and (ii) the implications of alternative national forestry development scenarios for land use, the production and processing of timber, agricultural employment displaced and forest employment created, over the next several decades (Thomson and Psaltopoulos, 1995).

The scenario-specific potential future levels of national timber production would affect the rural economy not only directly, but also indirectly, via the structure of interindustry linkages. Indirect effects can be distinguished into:

- 'backward linkage' effects, where an increase in forestry output increases demand for inputs used in the production process, inducing in turn a whole series of repercussions for output, income, and employment, as the economy adjusts to the new level of economic activity. These 'backward linkage' effects are estimated by a standard demand-driven Leontief model, which is based on the assumption of fixed input expenditures and in the case of a closed model, fixed consumption patterns of households; and
- 'forward linkage' effects, where an increase in forestry output increases sales to other sectors (such as timber processing, wood products, paper and board, etc.) and to final demand, triggering a whole series of round effects, as the economy re-adjusts to equilibrium. These 'forward linkage' effects can be estimated by a supply-driven Leontief model (Ghosh, 1958), which is based on the assumption of fixed output proportions and in the case of a closed model, fixed earnings pattern of households.

So far, forestry-centred national and regional I-O analysis has mostly concentrated on conventional demand relationships. However, Schallau and Maki (1983) suggested that in the case of forestry, attention should be given to gross output rather than final demand constraints ('...exogenous production, rather than exogenous market constraints...'), and consequently the supply I-O model should be preferred to the conventional demand-driven one. Similarly, Thomson and Psaltopoulos (1996) have argued that the standard I-O convention that primary and intermediate inputs can be made available and used to produce output mainly for sale within twelve months, can hardly be adopted for forestry with its production cycles of 40 to 100 years.

The first effort to take account of supply constraints in forestry I-O analysis was that of Darr and Fight (1974), who tried to assess the consequences of local timber supply constraints on the economy of Douglas County, Oregon. Arguing that supply-constrained changes in imports cannot be directly formulated within a demand-driven model, Schallau and Maki (1983) formulated a supply model from Darr and Fight's transaction table and estimated the economy-wide impacts resulting from an equivalent change of timber supply in surrounding regions.

However, Vincent (1986) suggested that, when comparing different types (local and those outside the study area) of timber supply changes, researchers should make an *ex ante* choice between the two models, because '...production increases in the two models feed into quite dissimilar sets of linkages...' and '...predicted impacts of supply increase are significantly influenced by the choice of the model, as well as by the type of increase... '. To illustrate his argument, Vincent (1986) formulated a supply model for Itasca County, Minnesota, and used both types of I-O models to estimate impacts of local timber supply changes; results proved that there were different economic effects, arising solely from the choice of the model.

In contrast to the above-mentioned supply-side forestry-centered I-O studies, this paper investigates the impact of changes in national (i.e. Scottish) timber supply on the rural economy of Scotland, by using **not** a supply I-O model (and thus diverging from the relevant traditional Leontief assumption), but a conventional demand-driven one which is adapted to make the gross output of forestry and wood processing industries exogenous to the I-O system (Miller and Blair, 1985). This process is carried out by combining forestry output estimates associated with alternative Scottish forestry development scenarios (i.e. not derived in an arbitrary manner) and the regionalization of an I-O table for Scotland.

The next section briefly presents some background material on the economic role of forestry in rural Scotland. Section 3 reports on preliminary aspects of this work, namely the construction of a regional I-O table for 'Rural Scotland' and the simulation analysis based on the development of a forestry development model. The methodology adopted for the estimation of the impacts of alternative national forestry development scenarios on the economy of Rural Scotland and the corresponding results are presented in Sections 4 and 5, respectively. The final section discusses the findings of this research effort.

2. Forestry in Rural Scotland

As a relatively rugged and sparsely populated British region, Scotland accounts for nearly half of the total UK forest area, which has expanded rapidly since World War II, but still accounts for only 10 percent of the land area of Britain compared to the European average of around 30 percent. During the 1980s, almost 75 percent of total UK planting took place in Scotland, where forestry has become important in land use and economic terms. With 1.12 million hectares, it now occupies 14 percent of the total Scottish land area, and in terms of employment share in rural Scotland, it represents 1 percent of the total (in terms of Full Time Equivalents), while wood industries a further 1.5 percent. Also, more than a third of UK timber production takes place in Scotland.

UK forest policy has been pursued via tax and grant incentives operated through the Forestry Commission, an executive authority independent of the Agricultural Departments. The Commission's primary objective was originally to increase timber production, in order to build a strategic reserve of timber for use in any possible future war. Amongst secondary objectives were 'import-saving' and the provision of rural

employment in remote areas. In 1957, when the strategic argument became overshadowed by the prospect of nuclear war, the promotion of rural employment became a primary policy objective for the Forestry Commission. Since the 1970s, conservation and recreation have also become very important issues. Over the last decade, in particular, there has been much public debate in Scotland concerning afforestation. Environmentalists suggest negative impacts on conservation of landscape and wildlife, while economists (NAO, 1987) have indicated that the cost of creating a forestry job in Northern Scotland is twice that of creating a job in agriculture.

Until recently, the determined protection of farming under UK and EC policy led to the concentration of forestry in upland areas, where land was cheap, and large (over 1000 ha) agricultural holdings made easier the transformation of use of substantial areas of land. Nowadays, as farm support is reduced, forestry may become a more attractive land use generally, with increased lowland afforestation. According to the Scottish Development Department (1987), '... the greatest alternative use of agricultural land is not physical development but the expansion of forestry'. Nevertheless, the bulk of any further expansion of forestry in Scotland is bound to be in upland areas, with large-scale coniferous planting on extensive grazings.

3. Input-Output and Forestry Development Scenario Analysis

3.1 Input-Output Analysis

The earlier stages of this work involved the further advancement of knowledge and understanding of the economic role of forestry in Rural Scotland via the development of a regional I-O model. The first task was the definition of the study area as 'Rural Scotland' (i.e. Local Authority Districts with population density of less than one person per hectare). The 1989 I-O table for Scotland was 'regionalized' to this area (which comprises most of Northern and Southern Scotland outside the Central Belt), using a 'variable-interference' non-survey technique (GRIT, see Jensen *et al.*, 1979).

The initial mechanically-derived coefficients of the forestry planting, harvesting and timber processing sectors were adjusted via the utilization of 'superior' data obtained from national forest authorities and timber-processor surveys, while forestry contractor surveys provided estimates of relevant transboundary income and expenditure flows (the regionalization process is reported in detail in Gardiner *et al.*, 1994). As a result, a 17-sector 1989 I-O table was constructed for Rural Scotland (for classification of economic sectors see Appendix A).

Table 1 presents output, income and employment multipliers and coefficients, calculated from the constructed regional I-O table for rural Scotland. Type 1 output multipliers express the regional significance of the backward linkages of each industry. Results show that the highest direct and indirect increase of gross output generated by an increase of £1 in sectoral final demand is observed in the Timber Processing sector (1.52), mostly due to the high degree of linkages with the region's Forestry Harvesting sector. Also, there are high Type 1 output multipliers for Wooden Furniture (1.31),

Pulp, Paper and Board (1.24) and Wood Products (1.23). Type 1 multipliers are low in Agriculture (1.17), Forestry Planting (1.16) and Forestry Harvesting (1.12), indicating weak linkages with other sectors. This is due to the high share of imports and income from employment in total inputs. In general, with the exception of Timber Processing, the level of Type 1 multipliers is rather low, and it is probably worth mentioning that, although Type 1 multipliers in Wood Products and Pulp, Paper and Board are comparatively high, these sectors are characterized by significant import leakages.

Table 1 also shows Type 2 output multipliers, which express the direct, indirect (i.e. from sales of input to other sectors) and induced (from household spending) increase of regional gross output generated by an increase of £1 in final demand for the relevant sector's output. As a consequence of high induced effects, and in contrast to the low Type 1 multiplier, the Type 2 multiplier for Forestry Planting (4.38) is the highest available, while the value of the Forestry Harvesting multiplier is of average magnitude (2.04). Similarly, Type 2 multipliers for Timber Processing (2.31) and Wooden Furniture (2.36) are amongst the highest. On the other hand, capital-intensive industries such as Pulp, Paper and Board (1.77) and Wood Products (1.81) have relatively low Type 2 multipliers. The multiplier for Agriculture is the lowest (1.63).

Also, the same Table presents sectoral income coefficients (which indicate the total increase in incomes generated by a unit increase in the output of a particular sector) and multipliers for the economy of Rural Scotland. Direct and indirect income coefficients (DIICs) are high for industries such as Forestry Planting (1.549), Wooden Furniture (0.509), and Forestry Harvesting (0.446). However, as the low Type 1 income multipliers for these industries prove, this is due to the high direct income linkages, rather than to indirect income effects. On the other hand, low DIICs in Pulp, Paper and Board (0.253), and Wood Products (0.275) are mostly due to low direct income linkages, as indirect income effects (and Type 1 income multipliers) are high in these sectors. The DIIC for Timber Processing is average (0.381), but the Type 1 income multiplier (2.25) is the highest available, due to a very low DIC in the sector. Agriculture has a low DIIC but a high Type I income multiplier, due again to very low direct income effects. Direct, indirect and induced income coefficients (DIIICs) follow the same pattern as the DIICs. Similarly, Type 2 multipliers follow the same pattern as the Type 1 multipliers.

Finally, employment coefficients and multipliers are also shown in Table 1. Direct employment coefficients (DECs) show that an additional £1 million of output from the labor-intensive Forestry Planting and Forestry Harvesting sectors creates 84 and 47 jobs, respectively in these industries. Increased output has also a relatively high direct job impact in Wooden Furniture (39 jobs), Agriculture (33 jobs), and Wood Products (28 jobs). Almost all the above industries are labor-intensive. On the other hand, increased output in the capital-intensive Pulp, Paper and Board (12 jobs) and Timber Processing (19 jobs) sectors seems to create a lower number of direct new jobs. Direct and indirect employment coefficients (DIECs) are high for industries such as Forestry Planting (89 jobs), Forestry Harvesting (52 jobs), and Wooden Furniture (48 jobs). However, as the low Type 1 employment multipliers for these industries prove - with the exception of Wooden Furniture for which both the DEC and indirect employment effects are high - this is due to the high direct employment linkages of these industries,

rather than to the indirect employment effects which are rather low. On the other hand, the low DIEC in Pulp, Paper and Board (18 jobs) is mostly due to low direct employment effects, as indirect effects are high in this sector. The DIEC for Timber Processing is average (42 jobs), while both DIEC and Type 1 employment multiplier are low for Agriculture.

Table 1. Output, Income and Employment Multipliers, Rural Scotland, 1989

Output

Industries	TYPE 1	TYPE 2
(1) Agriculture	1.17	1.63
(2) Forestry Planting	1.16	4.38
(3) Forestry Harvesting	1.12	2.04
(4) Timber Processing	1.52	2.31
(5) Wood Products	1.23	1.81
(6) Wooden Furniture	1.31	2.36
(7) Pulp, Paper and Board	1.24	1.77

Income

Industries	DIC	DIIC	TYPE 1	DIIIC	TYPE 2
(1) Agriculture	0.166	0.225	1.36	0.304	1.83
(2) Forestry Planting	1.494	1.549	1.04	2.093	1.40
(3) Forestry Harvesting	0.383	0.446	1.16	0.603	1.57
(4) Timber Processing	0.169	0.381	2.25	0.514	3.04
(5) Wood Products	0.186	0.275	1.48	0.372	2.01
(6) Wooden Furniture	0.415	0.509	1.23	0.688	1.67
(7) Pulp, Paper and Board	0.173	0.253	1.46	0.342	1.98

Employment

Industries	DEC	DIEC	TYPE 1	DIIEC	TYPE 2
(1) Agriculture	33	38	1.15	44	1.33
(2) Forestry Planting	84	89	1.06	132	1.57
(3) Forestry Harvesting	47	52	1.10	64	1.36
(4) Timber Processing	19	42	2.26	53	2.84
(5) Wood Products	28	37	1.32	44	1.59
(6) Wooden Furniture	39	48	1.24	62	1.63
(7) Pulp, Paper and Board	12	18	1.54	25	2.14

Source: Authors' Calculations

Note: DIC: Direct Income Coefficients; DIIC: Direct and Indirect Income Coefficients; DIIIC: Direct, Indirect and Induced Income Coefficients, DEC: Direct Employment Coefficients; DIEC: Direct and Indirect Employment Coefficients; DIIEC: Direct, Indirect and Induced Employment Coefficients, Type I Multipliers: Direct and Indirect Effects/Direct Effects; Type II Multipliers: Direct, Indirect and Induced Effects / Direct Effects

Direct, indirect and induced employment coefficients (DIIECs) indicate the total employment effect of increased sectoral output. The total number of jobs created by an increase in output in Forestry Planting (132) and Forestry Harvesting (64) is high. Other sectors with significant impact are Wooden Furniture (62) and Timber

Processing (53). Agriculture (44) and Wood Products (44) create a moderate amount of total jobs. Type 2 multipliers follow almost the same pattern as the Type 1 multipliers.

In overall, the above analysis has suggested that the labor-intensive forestry planting and harvesting sectors seem to offer a relatively high potential for improving economic activity in Rural Scotland, and therefore promoting rural development. This is due to the high direct impact of forestry in the economy rather than to its backward linkages (indirect and induced effects) with other industries. Timber processing and wood products seem to be capital-intensive industries, characterized by generally low direct economic effects, but unlike forestry planting and harvesting, they have strong backward linkages, which would be even stronger if the proportion of wood imports in total inputs was lower. It is worth mentioning here, that in the case of the timber processing sector, all timber purchases originated from Scotland, while a very significant proportion of timber purchased by the wood products and paper and board sectors originated from either Continental Europe or the American Continent.

From the above, it was concluded that the economic impact of the development of the forestry sector in Rural Scotland would be significant. Based on the quite reasonable assumption of almost perfect substitutability between increases in domestically produced and imported timber (McGregor and McNicoll, 1989), a substantial increase in the output of forestry *could* lead to a decrease in the import-dependence of the downstream industries. The expansion of the wood processing industries could create an important number of direct and indirect new jobs. Backward linkages would then further increase income and employment in the rural economy.

3.2 Forestry Development Scenario Analysis

The findings and conclusions of I-O analysis clarified the current situation in the study region, but their fuller usefulness only emerges when they are applied to the consideration of future development possibilities for forestry in Rural Scotland. For this purpose, a limited number of possible future national (i.e. Scottish) forestry development scenarios were selected, and their implications into the next century for land use, the production and processing of timber, agriculture, rural employment, and other policy-relevant areas were analyzed through a forestry development model (Thomson and Psaltopoulos, 1995).

The model was built on a spreadsheet, and consisted of two main parts, namely base-data for the 1980s, followed by successive projected decade blocks. Six alternative afforestation scenarios ranging from 'no further planting' to 'accelerated expansion' were defined, including 'lowland' and 'green forestry', and a 'most likely' scenario (see Appendix B). Based on a number of common background assumptions, including future labor productivity trends in both forestry and agriculture, calculations produced future values of national (i.e. Scottish) forest area, wood output, transfer of farmland, displaced agricultural employment, and forest employment created. In order to include at least part of the longer rotations involving broadleaved trees, and to bring in future cycles of conifers, the year 2080 was chosen as the ultimate time horizon. A

distinction was drawn between current (decade-specific) and accumulated (rotation-specific) forest jobs created on transferred agricultural land and existing forest areas. In this way, the future implications of different assumptions as to future forestry policy and practice in Scotland were produced.

The 'Accelerated Expansion' Scenario 2 generates the highest figures of forest area, timber production, and forestry jobs in Scotland, while the 'Maintained Expansion' and 'Lowland Forestry' Scenarios 1 and 4 create wood output and employment levels higher than present. The 'Most Likely' Scenario 6 creates a number of forestry jobs above present levels until the 2040s. Finally, the 'Green Forestry' Scenario 5 creates relatively low levels of forest area, timber production and forestry jobs. All Scenarios (except the 'No Further Expansion' Scenario 3) generate positive net employment effects associated with coniferous afforestation. On the other hand, net employment effects associated with broadleaved afforestation are negative.

4. Sector Inputs to I-O Model

As a first step in applying the scenario model results to the I-O method, average 1989 unit values regarding timber prices (£ per cubic metre) and establishment cost (£ per hectare established) were applied to the Scenario-specific (conifer and broadleaved) national timber output and new planting (including restocking) area projections of the forestry development model for the chosen year 2050 (using the Scenario background assumption of constant real timber prices and real establishment costs).

In this way, new planting (including restocking) area and total wood production were converted into gross output value estimates for the forestry planting and harvesting sectors, respectively. The input-output 'homogeneity' assumption means that the conversion of new planting area and wood production into gross output values for the forestry planting and harvesting sectors was carried out by applying a uniform average unit value for total (coniferous and broadleaved) projections. Undoubtedly, this gives rise to an inconsistency problem, as Scenario-specific projections do not retain the specific product mix observed in the 1989 I-O table. However, the very low Scenario-specific share of broadleaves, both in area and timber output terms, probably excuses a small error in the estimated values. In the case of agriculture, despite the existence of Scenario-specific transfers of farmland to forestry, it was assumed that there is no change in the value of farm output.

With regard to wood usage, three alternative assumptions were then considered:

Assumption A: Additional Timber Exported as Raw Material

Higher domestic wood production associated with each of the six forestry development scenarios is exported in the form of sawlogs and pulpwood; there is no change in the consumption level of home-grown timber by the domestic wood processing industry.

Assumption B: Additional Timber Processed by Wood Processors

Domestic wood production associated with each of the six forestry development scenarios is processed by the domestic wood processing industry, while the value of wood imports is adjusted accordingly (i.e. there is no change in the imports coefficients). The distribution of timber volume sales by the Scottish forestry harvesting sector to wood processing industries remains similar to that observed in 1989.

Assumption C: Home-Grown Timber Processing

Domestic wood processors process *only* home-grown timber associated with each of the six forestry development scenarios (i.e. there are no imports of raw timber for processing). The distribution of timber volume sales by the Scottish forestry harvesting sector to wood processing industries remains similar to that observed in 1989.

These three Assumptions represent extremes of correspondence between the domestic forestry and wood processing sectors and yield new levels of national outputs for the forestry planting, harvesting and wood processing industries.

In an I-O context, exogenous changes in sectoral gross output - as a result of forces outside the I-O model, such as production targets or natural disasters - have an impact on the gross output and final demand of other sectors in the economy (through the I-O backward linkages). To estimate these sectoral changes, consider a three-sector model, with Y_1, Y_2, and X_3 determined exogenously (where Y_i and X_i represent the final demand and gross output of sector i, respectively, and X_3 denotes - in this example - the exogenously determined national output of the forestry and wood processing sectors consistent with each of the three assumptions of timber distribution).

The basic balance equation of this system can be written as (Miller and Blair, 1985):

$$\begin{aligned} (1-a_{11})X_1 \quad & -a_{12}X_2 \quad & -a_{13}X_3 = Y_1 \\ -a_{21}X_1 + & (1-a_{22})X_2 \quad & -a_{23}X_3 = Y_2 \\ -a_{31}X_1 \quad & -a_{32}X_2 + & (1-a_{33})X_3 = Y_3 \end{aligned} \tag{1}$$

where a_{ij} are input-output coefficients (inputs required from sector i per unit of output of sector j).

Rearranging the above, gives:

$$\begin{aligned} (1-a_{11})X_1 \quad & -a_{12}X_2 + 0Y_3 = \quad Y_1 + 0Y_2 \quad & +a_{13}X_3 \\ -a_{21}X_1 + & (1-a_{22})X_2 + 0Y_3 = 0Y_1 + \quad Y_2 \quad & +a_{23}X_3 \\ -a_{31}X_1 \quad & -a_{32}X_2 - \quad Y_3 = 0Y_1 + 0Y_2 - & (1-a_{33})X_3 \end{aligned} \tag{2}$$

or, in matrix form:

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & 0 \\ -a_{21} & (1-a_{22}) & 0 \\ -a_{31} & -a_{32} & -1 \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ Y_3 \end{bmatrix} = \begin{bmatrix} 1 & 0 & a_{13} \\ 0 & 1 & a_{23} \\ 0 & 0 & -(1-a_{33}) \end{bmatrix} \cdot \begin{bmatrix} Y_1 \\ Y_2 \\ X_3 \end{bmatrix} \tag{3}$$

Denoting the matrix of coefficients on the left-hand side as **M** and using the results from the inverse of a partitioned matrix, the inverse of **M** is:

$$\mathbf{M}^{-1} = \begin{bmatrix} \gamma^{11} & \gamma^{12} & 0 \\ \gamma^{21} & \gamma^{22} & 0 \\ \beta_1 & \beta_2 & -1 \end{bmatrix}, \tag{4}$$

where γ_{ij} are the elements of the Leontief inverse matrix for the model containing only sectors 1 and 2,

$$\begin{bmatrix} (1-a_{11}) & -a_{12} \\ -a_{21} & (1-a_{22}) \end{bmatrix}. \tag{5}$$

Thus, the estimation of the endogenously determined X_1, X_2 and Y_3 will be in the form:

$$\begin{bmatrix} X_1 \\ X_2 \\ Y_3 \end{bmatrix} = \begin{bmatrix} \gamma^{11} & \gamma^{12} & 0 \\ \gamma^{21} & \gamma_{22} & 0 \\ \beta_1 & \beta_2 & -1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & a_{13} \\ 0 & 1 & a_{23} \\ 0 & 0 & -(1-a_{33}) \end{bmatrix} \cdot \begin{bmatrix} Y_1 \\ Y_2 \\ X_3 \end{bmatrix} \tag{6}$$

Thus, the economic impact (i.e. in the form of change in the level of gross output and/or final demand) of an exogenously-set change in the national output of the forestry planting, harvesting, and wood processing sectors, is estimated.

The adjustment of the national (Scottish) I-O tables was followed by their regionalization to the 'Rural Scotland' level (applying GRIT and assuming that for every sector, the regional/national employment ratio remained constant for the different scenarios / wood-usage Assumptions) and the estimation of 'scenario / wood-usage Assumption'-specific regional output levels. In this way, the regional output, income and employment effects of exogenous changes in timber supply were estimated.

5. Results

Following the procedure outlined in the previous section, Table 2 presents the impact

in the year 2050 of the six Forestry Development Scenarios on the economy-wide ('total') output, income and employment in Rural Scotland, associated with Assumptions A, B and C.

Table 2. Impact of Forestry Development Scenarios on Output, Income and Employment, Rural Scotland, 2050 (£ MILLION, FTE JOBS, at 1989 values)

Assumption A: Additional Timber Exported as Raw Material

	Output Effects	% Change from 1989	Income Effects	% Change from 1989	Employment Effects	% Change from 1989
SCENARIO 1	232.95	1.56	164.42	2.73	15670	3.13
SCENARIO 2	353.68	2.38	266.47	4.43	24544	4.91
SCENARIO 3	-4.84	-0.03	-32.63	-0.54	-1630	-0.33
SCENARIO 4	206.14	1.38	141.75	2.36	13700	2.74
SCENARIO 5	74.15	0.50	38.98	0.65	4393	0.88
SCENARIO 6	180.68	1.21	125.15	2.08	12048	2.41

Assumption B: Additional Timber Processed by Wood Processors

	Output Effects	% Change from 1989	Income Effects	% Change from 1989	Employment Effects	% Change from 1989
SCENARIO 1	1634.21	10.98	773.75	12.87	73684	14.73
SCENARIO 2	2396.65	16.10	1154.85	19.21	109125	21.81
SCENARIO 3	112.71	0.76	18.48	0.31	3236	0.65
SCENARIO 4	1464.98	9.84	689.16	11.46	65817	13.15
SCENARIO 5	587.23	3.95	262.09	4.36	25634	5.12
SCENARIO 6	1278.91	8.59	602.72	10.02	57517	11.50

Assumption C: Wood Processors Process only Home - Grown Timber

	Output Effects	% Change from 1989	Income Effects	% Change from 1989	Employment Effects	% Change from 1989
SCENARIO 1	1639.18	11.01	775.81	12.90	73906	14.77
SCENARIO 2	2403.41	16.15	1157.64	19.25	109427	21.87
SCENARIO 3	114.11	0.77	19.06	0.32	3299	0.66
SCENARIO 4	1469.56	9.87	691.05	11.49	66022	13.20
SCENARIO 5	589.73	3.96	263.13	4.38	25747	5.15
SCENARIO 6	1282.96	8.62	604.37	10.05	57696	11.53

Source: Authors' Calculations

Referring to Assumption A, Scenario 2 gives the highest positive changes in total output, income and employment; compared to 1989 levels, regional output increases by 2.4 percent, income by 4.4 percent, and employment by nearly 5 percent. Scenarios 1, 4 and 6 increase regional employment by 3.1, 2.7 and 2.4 percent respectively. Output, income, and employment increase marginally under Scenario 5, but marginally decrease under Scenario 3. With regard to Assumption B, again Scenario 2 generates the highest economic effects, as regional output increases by 16.1 percent, income by 19.2 percent, and employment by almost 22 percent. The economic impact of Scenarios 1, 4 and 6 is somewhat lower, but nevertheless quite significant (regional employment expands by 14.7, 13.1, and 11.5 percent respectively). Regional output

expands by nearly 4 percent if Scenario 5 is applied, while there is a marginal (under 1 percent) increase under Scenario 3. Finally, results associated with Assumption C are marginally higher (leakages are lower, but processors process a lower volume of timber) but generally similar in pattern compared to those of Assumption B. Due to the labor intensity which characterizes the forestry and wood processing industries, relative changes of regional income and employment are higher than those of output.

In general, Assumptions B and C generate a much higher level of economic activity, compared to Assumption A.

6. Discussion

The paper has presented a method of investigating the impact of exogenous forestry output changes associated with alternative Forestry Development Scenarios on the rural economy of Scotland, via the regionalization of a standard demand-driven national I-O model.

The main advantage of this method is that, while based on conventional demand relationships, it also takes account of local (within Rural Scotland) and adjacent (rest of Scotland) timber supply constraints, enabling therefore the formulation of supply-constrained changes in timber imports. The fact that the method cannot consider constraints in timber imports originating from areas other than those specific to the forestry development model (i.e. Scotland) is undoubtedly a shortcoming. However, this problem is irrelevant in the case of downstream industries which obtain raw material only from areas covered by the model (as in the case of the timber processing sector in Rural Scotland).

In general, the findings of this study indicate that alternative forestry development strategies in Scotland can bring about quite different long-run consequences, especially as regards output and employment generation in rural areas. The economic impact of most afforestation scenarios by the year 2050 seems to be significant, especially if all additional timber is processed by regional wood processors. The increase in the level of employment associated with 'production-oriented' scenarios ranges from 11 percent to 22 percent.

On the other hand, there is a low, but still positive, economic impact associated with the 'no further expansion' and the 'green forestry' scenarios. Not unexpectedly, the level of additional economic activity becomes much lower if all additional timber is exported (around 20 percent of the level generated if all additional timber is processed by domestic wood processors).

Appendix A. Industrial Classification for Input-Output Table for Rural Scotland, 1989

Industry Group	SIC Code
1. Agriculture	0100
2. Forestry Planting	0200 part
3. Forestry Harvesting	0200 part
4. Timber Processing	4610
5. Wood Products	4620, 4630, 4640, 4650, 4663, 4664
6. Wooden Furniture	4671, 4672
7. Pulp, Paper & Board	4710
8. Paper & Board Products	4721, 4722, 4723, 4724, 4725, 4728
9. Printing & Publishing	4751, 4752, 4753, 4754
10. Construction	5000, 5010, 5020, 5030, 5040
11. Distribution	6110, 6120, 6130, 6149, 6150, 6160, 6170, 6180, 6190, 6210, 6220, 6300, 6410, 6420, 6430, 6450, 6460, 6470, 6480, 6530, 6540, 6560, 6720, 6730
12. Road Transport	7210, 7220, 7230, 7260
13. Banking & Insurance	8140, 8150, 8200
14. Other Business Services	8310, 8320, 8340, 8350, 8360, 8370, 8380, 8394, 8395, 8396
15. Energy	1113, 1114, 1115, 1200, 1300, 1401, 1402, 1520, 1610, 1620, 1630, 1700
16. Other Manufacturing	2100, 2330, 2396, 2210, 2220, 2234, 2235, 2245, 2246, 2247, 2310, 2410, 2420, 2436, 2437, 2440, 2450, 2460, 2471, 2478, 2479, 2481, 2489, 2511, 2512, 2513, 2514, 2515, 2516, 2551, 2552, 2562, 2563, 2564, 2565, 2567, 2568, 2569, 2570, 2581, 2582, 2591, 2599, 2600, 3111, 3112, 3120, 3137, 3138, 3142, 3161, 3162, 3163, 3164, 3165, 3166, 3167, 3169, 3204, 3205, 3211, 3212, 3221, 3222, 3230, 3275, 3276, 3244, 3245, 3246, 3251, 3254, 3255, 3261, 3262, 3281, 3283, 3284, 3285, 3286, 3287, 3288, 3289, 3290, 3301, 3302, 3410, 3420, 3432, 3433, 3434, 3435, 3441, 3442, 3443, 3444, 3453, 3456, 3459, 3460, 3470, 3480, 3510, 3521, 3522, 3523, 3530, 3610, 3620, 3633, 3634, 3640, 3650, 3710, 3720, 3731, 3732, 3733, 3740, 4115, 4116, 4121, 4122, 4123, 4126, 4130, 4147, 4150, 4160, 4180, 4196, 4197, 4200, 4213, 4214, 4221, 4222, 4239, 4240, 4261, 4270, 4283, 4290, 4310, 4321, 4322, 4336, 4340, 4363, 4364, 4370, 4384, 4385, 4350, 4395, 4396, 4398, 4399, 4410, 4420, 4510, 4531, 4532, 4533, 4534, 4535, 4536, 4537, 4538, 4539, 4560, 4555, 4556, 4557, 4811, 4812, 4820, 4831, 4832, 4833, 4834, 4835, 4836, 4910, 4941, 4942, 4920, 4930, 4954, 4959
17. Other Services	6148, 6510, 6520, 6710, 6611, 6612, 6620, 6630, 6640, 6650, 6670, 7100, 7400, 7500, 7610, 7630, 7640, 7700. 7901, 7902, 8410, 8420, 8430, 8460, 8480, 8490, 8500, 9111, 9112, 9120, 9130, 9140, 9150, 9190, 9211, 9212, 9230, 9310, 9320, 9330, 9360, 9400, 9510, 9520, 9530, 9540, 9550, 9560, 9611, 9631, 9660, 9690, 9711, 9741, 9760, 9791, 9811, 9812, 9820, 9890, 9900

Appendix B. Scottish Forestry Development Scenarios

The following six alternative forestry development scenarios are considered, separately for conifer and broadleaved plantations in Scotland:

1. *Maintained Expansion* at the average rate and characteristics of new planting during the 1980s, i.e. mainly commercial planting of Sitka Spruce in upland and some poorer lowland areas, and clear-felling for bulk processing.

2. *Accelerated Expansion* with the rate of new plantings increased by 50 percent, but no other major changes in assumptions.

3. *No Further Expansion*, i.e. only replanting of felled areas with similar types of tree as in Scenario 1.

4. *Lowland Afforestation* with *new* planting confined to marginal arable land currently in crops, temporary grass or set-aside. These new plantings are assumed to be primarily commercial in nature (but with 20-30 percent broadleaves, compared to about 3 percent in Scenarios 1 to 3), and to have a (net) yield 20 percent higher than existing plantations.

5. '*Green*' *Forestry*, with afforestation at 50 percent of the 1980s rate, but with all forest management, i.e. planting, maintenance and harvesting, carried out to maximise non-market benefits such as visitor use and environmental enhancement. Thus, new planting and replanting are of native species, and there is less clear-felling and greater maturation allowed. Consequently, felling and yield rates are taken as 50 percent below base levels.

6. '*Most Likely*' *Scenario* comprises specific informed judgments as to the most probable developments during the foreseeable future, made partly on the basis of the information gathered in the field surveys, and partly on the basis of discussions with agricultural and forestry experts and officials. New planting continues at 1988-92 rates (i.e. some 20 percent less than the 1980s average), while smaller blocks lead (eventually) to lower yields.

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