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Land Use and Transport Integration in Scotland (LATIS)

TELMoS:07
MODEL DESCRIPTION

Report prepared for Transport Scotland

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SUMMARY

This report documents the design and coefficients of TELMoS:07, the land-use/economic component of the LATIS modelling service. TELMoS:07 and the associated LATIS transport model, TMfS:07, can be used together to provide a national land-use/transport interaction model for Scotland.

After the introduction and a brief description of the structure of the model in Chapter 2, the core of the report is contained in:

- Chapters 3 and 4 which document the definitions of the variables in the model and its database files (which are both inputs and outputs);
- Chapters 5 to 7 which describe the preparation of the input data for the model;
- Chapters 8 to 16 which document the components and coefficients of the model, ending with the interface which outputs data from TELMoS:07 for use in TMfS:07;
- Chapter 17 documents the economic and demographic scenarios which define the growth of Scotland in total; and
- Chapter 17.4 which documents the planning policy inputs which influence the distribution of that growth at local levels.

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ABBREVIATIONS

Abbreviation	Meaning
APPI	Assembly of Planning Policy Information
CSTCS	Central Scotland Transport Corridors Study
DELTA	Land-use/economic modelling software package developed by DSC
DSC	David Simmonds Consultancy Ltd
FES	Family Expenditure Survey
GCVSP	Glasgow and Clyde Valley Structure Plan
GROS	General Register Office for Scotland
GVA	Gross value added
LATIS	Land-use and Transport Integration in Scotland
REM	Regional Economic Model (within DELTA and TELMoS)
TELMoS	Transport/Economic/Land-use Model of Scotland (application of the DELTA package)
TMfS	Transport Model for Scotland

1 INTRODUCTION

1.1 Background

LATIS Commission – Development of Modelling Framework

1.1.1 In August 2006 Transport Scotland commissioned MVA Consultancy to a Term Commission for the Maintenance and Enhancement of the Transport Model for Scotland (TMfS) and Transport Economic and Land-Use Model of Scotland (TELMoS).

1.1.2 A central element of the Commission was to develop and deliver an enhanced 2007-based land-use and transport modelling system. MVA proposed a hierarchical modelling framework, with a single National Strategic Travel demand and Land Use Modelling framework as the upper tier, Regional Travel Demand Models as the mid-tier and detailed local models (eg microsimulation) as the lower tier. The National Modelling Framework has now been developed. It incorporates a number of technical enhancements and new and more robust data and will, in time, replace its predecessor, TMfS/TELMoS:05.

1.1.3 On 6 November 2008, the TMfS Term Commission changed its name to Land-Use and Transport Integration in Scotland (LATIS). The service is provided by Transport Scotland and their supporting consultants and offers a wide range of support and technical advice.

1.1.4 The LATIS service currently includes four distinct elements, as follows:

- a user engagement programme, consultations, discussions and advice on a range of transport and travel planning issues;
- the collection and provision of land-use planning data;
- the collection of transport data through the use of the Data Collection Contract; and
- a travel demand and land-use modelling suite.

1.1.5 The TMfS:07 and TELMoS:07 models are designed to deliver the fourth of these elements.

TMfS:07 & TELMoS:07 Model Reports

1.1.6 This report describes the calibration of the TELMoS:07 Model Description Report and is one of a series of eight documents describing the construction, calibration and validation of the TMfS:07 and TELMoS:07 models, as shown below:

TMfS:07 National Travel Demand Model

1. TMfS:07 Demand Model Development Report.

TMfS:07 National Road Model

2. TMfS:07 National Road Model Development Report; and
3. TMfS:07 National Road Model Calibration & Validation Report.

TMfS:07 National Public Transport Model

4. TMfS:07 National Public Transport Model Development Report; and
5. TMfS:07 National Public Transport Model Calibration and Validation Report.

TELMoS:07 National Land Use Model

6. TELMoS:07 Model Description Report;
7. TELMoS:07 Assembly of Planning Policy Inputs; and
8. TELMoS:07 Model Demonstration Report.

1.2 Structure of the Report

1.2.1 Chapter 2 provides a brief reminder of the structure of the model. Chapters 3 and 4 document the definitions of the variables in the model and its database files (which are both inputs and outputs). Chapters 5 to 7 describe the preparation of the input data for the model. Chapters 8 to 16 describe the components and coefficients of the model, ending with the interface which outputs data from TELMoS:07 for use in TMfS:07 Chapter 17 documents the economic and demographic scenarios which define the growth of Scotland in total, and Chapter 17.4 documents the planning policy inputs which influence the distribution of that growth at local levels.

2 STRUCTURE OF THE MODEL

2.1.1 The general structure of the land-use economic model is illustrated in Figure 2.1, showing the key components and the key linkages within one year. There are numerous other linkages over time which are referred to later in the report. Note that what is called the "urban" level of the model is so-called because its original focus was on the location of activities within urban areas, but it operates in rural as well as urban or suburban areas - hence the table later in this report which shows the first "urban employment activity" is agriculture.

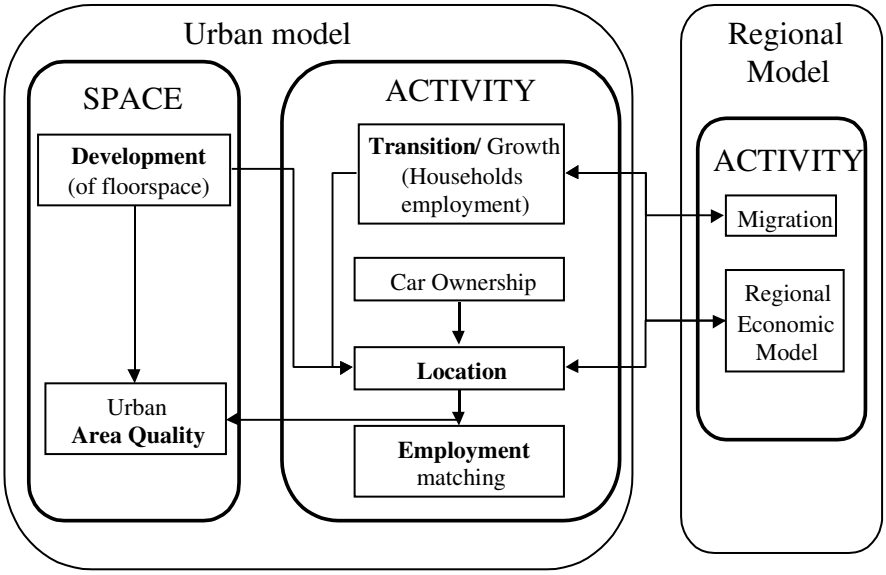


Figure 2-1 Structure of the land-use/economic model in one year

2.1.2 It has never been the intention that DELTA models should be extensively calibrated in each of the areas to which they are applied. The philosophy behind the model is that the coefficients should be chosen so that the model reflects the accumulated understanding obtained from past research and analysis. This may mean that particular coefficients (or ratios of coefficients) can be taken directly from previous work; more often, it means that the coefficients must be adjusted so that the model reproduces particular effects (such as elasticities) which are expected on the basis of previous work. In practice, many of the coefficients were chosen and tested in earlier DELTA applications and have been reapplied, with

limited testing of their individual effects. The earlier values themselves represent a mixture of:

- values derived from reports of other research;
- values taken from our own work on calibration of earlier models (eg research in collaboration with ITS on the valuation of accessibility and environmental factors in residential location choice, and previous work on car ownership);
- a limited element of direct calibration, where data was available;
- values chosen to reproduce expected elasticities or other relationships.

3 MODEL DEFINITION

3.1 Model definition file

3.1.1 The DELTA model definition file, DELTAMOD.DEF, defines the overall dimensions of the model and is used to specify the different elements to be operated in a particular model application. All the DELTA programs read this file.

3.1.2 The following sections document the various sections of the model definition file.

3.1.3 Additional sections at the end of this Chapter refer to the other definition files and to definitions included in other inputs.

3.2 DELTA and transport model years

3.2.1 The DELTA model is operated in one-year steps. The model definition file:

- lists all years from 1991 to 2031;
- defines 2001 as DELTA base year (year 0) for model running[1]; and
- defines the two-character alphanumeric codes used as abbreviations for the year.

3.2.2 DELTA needs to know in which years the transport model (TMfS:07) is run. This information is input via the **test** definition file. Note that other changes to TMfS:07 inputs may need to be made if the user wishes to change the years in which the transport model is run. When required, DELTA-only tests are carried out by deleting some transport model years. The base year for TMfS:07 is 2007, so standard TELMoS:07 runs now start at the point immediately following the 2007 transport model run, ie with the 2007 accessibility calculations. The transport model years are 2007, 2011, 2016, 2021, 2026 and 2031.

3.3 Zones, areas and other model dimensions

3.3.1 There are a number of key model dimensions which are input as numbers in the model definition file. Other dimensions, such as the number of household types, are input by listing the different categories, as shown below.

3.3.2 The different types of zones are defined as follows:

- Fully Modelled zones are modelled in full throughout all sub-models; and
- External zones are modelled only as sources and sinks for commuting and imports and exports (in DELTA) and for trips (in TMfS:07).

[1] Because of the need to run the model from the observed situation in 2001 to generate the "forecasting base year" situation in 2007.

Dimension	Value
Fully Modelled Area Zones	712
External Zones	8
Household socio-economic groups	2
Worker socio-economic groups	2
Person types	4
Car-ownership levels in household data	3
Car-ownership levels in matrix data	3
Modes in accessibility inputs	5
Purposes in accessibility inputs	6
Model Version	1240
Number of socio-economic groups in transport model	1
Number of car-ownership levels in transport model	3

Table 3-1 Model dimensions entered as values

3.3.3 The zone system was created in December 2007 by MVA. The two categories of zones – Fully Modelled and External – are numbered consecutively. Hence:

- the Fully Modelled Area consists of zones 1 to 712; and
- the External Zones are zones from 713 to 720.

3.3.4 The TELMoS:07 zones are identical to the TMfS:07 zones.

3.3.5 The regional level of the model works on internal and external areas as shown in Figure 3-1. These areas are simply an aggregation of zones to a specified area. TELMoS:07 defines internal areas of which there are 47 (broadly based on the 2001 Travel to Work Areas) and external areas in terms of trade routes. These are used only within the DELTA package; they do not appear in TMfS:07 or in any of the data passed between TMfS:07 and TELMoS:07.

3.3.6 The definition of the areas in terms of zones and local authorities is input in terms of the area to which each zone belongs. It also specifies the size (in square kilometres) of each zone.

Area	Name
1	Edinburgh
2	Berwick (pt)
3	Kelso and Jedburgh
4	Hawick
5	Galashiels and Peebles
6	Livingston & Bathgate
7	Falkirk
8	Dunfermline
9	Kirkcaldy & Glenrothes
10	St Andrews & Cupar
11	Stirling & Alloa
12	Perth & Blairgowrie
13	Dundee
14	Forfar & Montrose
15	Aberdeen
16	Peterhead
17	Fraserburgh

Area	Name
18	Banff
19	Moray
20	Badenoch
21	Inverness & Dingwall
22	Invergordon
23	Dornoch & Lairg
24	Wick
25	Thurso
26	Ullapool & Gairloch
27	Skye & Localsh
28	Fort William
29	Oban
30	Pitlochry
31	Mull & Islay
32	Lochgilphead & Campbeltown
33	Dunoon & Bute

Area	Name
34	Dumbarton
35	Glasgow
36	Greenock
37	Irvine & Arran
38	Lanarkshire
39	Ayr & Kilmarnock
40	Carlisle (pt)
41	Dumfries & Annan
42	Kirkcudbright
43	Newton Stewart & Wigtown
44	Stranraer
45	Eilean Siar
46	Orkney Islands
47	Shetland Islands

Figure 3-1 List of Areas

3.4 Activity definitions

3.4.1 The term "activity" is used throughout DELTA to refer to the various detailed categories of households and of employment. Activities 1 to 20 inclusive are household types, which are based on a mixture of age, composition and employment status, further disaggregated by socio-economic group. There are 20 household types, 27 employment types and two socio-economic groups. Table 3-2 shows the household activity number by each type and socio-economic group. These definitions in turn rely upon the person types defined in Table 3-3 and the socio-economic groups defined in Table 3-5.

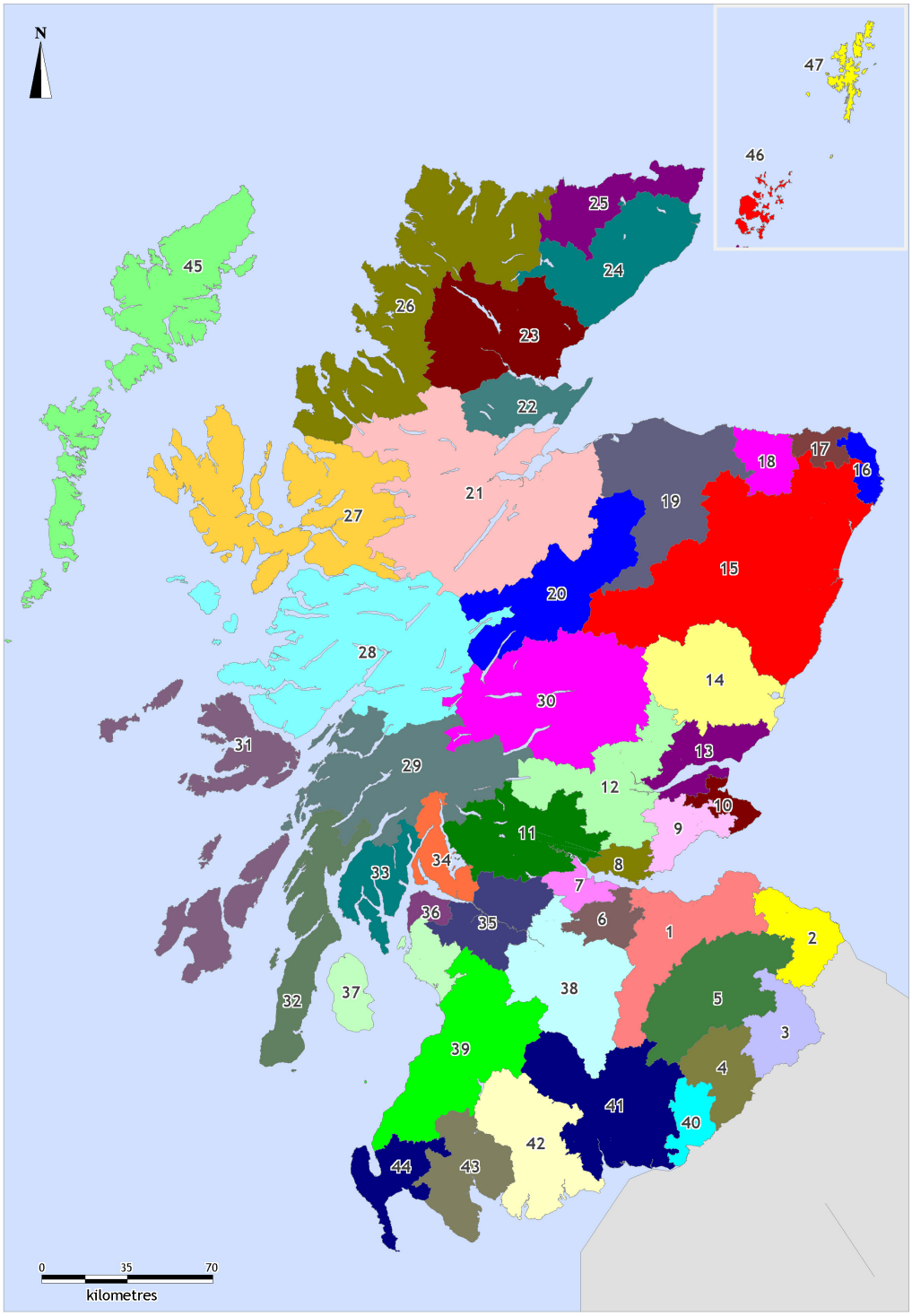


Figure 3-2 TELMoS:07 areas (regional model units)

Activity	Description
1	Single adult younger (16-44), manual
2	Single adult younger (16-44), non-manual
3	Single adult non-retired older (45-74), manual
4	Single adult non-retired older (45-74), non-manual
5	Single adult retired, manual
6	Single adult retired, non-manual
7	Single adult parent (16-74, with children), manual
8	Single adult parent (16-74, with children), non-manual
9	2 adults household younger (both 16-44), at least one non-retired, no children, manual
10	2 adults household younger (both 16-44), at least one non-retired, no children, non-manual
11	2 adults household older (one or both 45+), at least one non-retired, no children, manual
12	2 adults household older (one or both 45+), at least one non-retired, no children, non-manual
13	2 adults household with children, manual
14	2 adults household with children, non-manual
15	Couple, both retired, manual
16	Couple, both retired, non-manual
17	3+ adults no children, manual
18	3+ adults no children, non-manual
19	3+ adults with children, manual
20	3+ adults with children, non-manual

Table 3-2 Household activity definitions

Note that in activities 13, 14 and 17 to 20, ie 2 or more adults with children, one or more of the adults may be retired.

3.4.2 The person types are defined as shown in Table 3-3.

Type	Description
Children	Any person under 16 years of age
Non-workers	Any person between the ages of 16 and 74 inclusive, who is not in employment and who is not retired
Workers	Any person between the ages of 16 and 74 inclusive who is in paid employment
Retired	Any person aged 75 or over and any person between the ages of 16 and 74 inclusive who is classified as 'economically inactive retired'

Table 3-3 Person types

3.4.3 Table 3-4 shows the employment activity classification. Many activities are split into separate activities by socio-economic group, on the basis that different types of workers occupy different types of floorspace. The socio-economic groups are defined in Table 3-5 and the floorspace types in Table 3-6.

Activity	Description (with SIC code to which the activity belongs)		Floorspace occupied
31	A - Agriculture, hunting and forestry	Non-manual	office
32	A - Agriculture, hunting and forestry	Manual	-
33	B – Fishing	Non-manual	office
34	B – Fishing	Manual	-
35	C – Mining and quarrying	Non-manual	office
36	C – Mining and quarrying	Manual	-
37	D – Manufacturing	Non-manual	office
38	D – Manufacturing	Manual	industrial
39	E - Electricity, gas and water supply	Non-manual	office
40	E - Electricity, gas and water supply	Manual	industrial
41	F – Construction	Non-manual	office
42	F – Construction	Manual	industrial
43	G – Wholesale and retail trade, repairs (retail) (see 5.7.4 below)	Manual and Non-manual	retail
45	G – Wholesale and retail trade, repairs (other)	Non-manual	office
46	G – Wholesale and retail trade, repairs (other)	Manual	industrial
47	H – Hotels and restaurants	Manual and Non-manual	leisure/hotel
48	I – Transport, storage and communications	Non-manual	office
49	I – Transport, storage and communications	Manual	industrial
50	J – Financial intermediaries (financial management)	Manual and Non-manual	office
51	J – Financial intermediaries (local financial services)	Manual and Non-manual	office
52	K – Real estate, renting and business activities	Manual and Non-manual	office
53	L – Public administration & defence, social security	Non-manual	office
54	L – Public administration & defence, social security	Manual	industrial
55	M – Education	Manual and Non-manual	education

Activity	Description (with SIC code to which the activity belongs)		Floorspace occupied
56	N – Health and social work	Manual and Non-manual	health
57	O, P, Q – Other	Non-manual	office
58	O, P, Q – Other	Manual	industrial

Table 3-4 Employment activity definitions

3.4.4 The DELTA definition file only tells the model that a certain activity exists; it does not specify the composition of that activity. The definition of the numbers of persons of each type in each household activity, ie the information which actually tells the software that a household of activity one contains a single manual adult, is input in the ME12<><>.INP file (see Section 12.1 of this report)

DELTA SEG	Title	Contains 2001 Census of Population SEGs:	
1	Non-manual workers	AB	Higher and intermediate managerial/administrative/professional
		C1	Supervisory, clerical, junior managerial/administrative/professional
2	Manual workers	C2	Skilled manual workers
		D	Semi-skilled and unskilled manual workers
		E	On state benefit, unemployed, lowest grade workers

Table 3-5 Definition of DELTA socio-economic groups

3.4.5 The information on number of households and on numbers of persons by type is recorded in the activity database file. The process of changing employment status within the model is carried out in the employment sub-model, and is documented in Section 12.1 of this report.

3.5 Activity group definitions

3.5.1 The DELTA software uses "activity groups" to specify (a) categories of activities which have to be distinguished, e.g. to identify which activities are households and which are employment; and (b) to provide an abbreviated way for the user to refer to multiple activities in setting up input files. The definitions are critical to the interpretation of other model inputs and should not be changed, but they are not significant in this Report.

3.6 Floorspace

3.6.1 The model works with seven categories of floorspace, all measured in square metres. These are shown in Table 3-6.

DELTA floorspace category	Represents	Greenfield develop-ment process	Brownfield develop-ment process	Edinburgh and Glasgow High Density Residential Develop-ment	Residential develop ment outwith Edin-burgh and Glasgow
1	Housing			1	8
2	Retail	2	9		
3	Office	3	10		
4	Industrial	4	11		
5	Leisure\Hotel	5	12		
6	Education	6	13		
7	Health	7	14		

Table 3-6 DELTA floorspace category and development process definitions

3.6.2 The DELTA model does not represent land directly. The software is designed to expect a category of land corresponding to each category of floorspace, but in the present implementation any data about "land" is a measure of floorspace.

3.7 Development model definitions

3.7.1 TELMoS:07 is set up to represent fourteen development processes. For residential land use two development processes are defined; development process one represents high density development within the City of Edinburgh and Glasgow City. An expected occupier function is applied to this development process whereby new floorspace is occupied by single adult or two adult households. Development process 8 is applied to residential development elsewhere in Scotland. Development processes 2 to 14 represent greenfield and brownfield development of each of the other six floorspace types, as specified in Table 3-6.

3.8 Definition of car-owning activities

3.8.1 Car ownership is modelled for all 20 household activities. The model works with three levels of car-ownership, as shown in Table 3-7.

DELTA car ownership level	Represents households with….
1	no car
2	one car
3	two or more cars

Table 3-7 DELTA car ownership levels

3.8.2 Beware of the possible confusion between the **numbering** of the levels (1,2,3) and their **meaning** (0 cars, 1 car, 2+ cars).

3.9 Migration model definition

3.9.1 This definition specifies which activity groups are to be considered as possible migrants. The present implementation allows all non-retired households to migrate. This is done by specifying an appropriate activity group, defined as all non-retired household activities, in the migration model definition.

3.10 Regional Economic Model Definition

3.10.1 Two blocks of input are required to create the basic definition of the regional economic model (REM).

3.10.2 The first block specifies

- which of the defined activities are to be treated as sectors in the REM, and
- which of the defined activities are to be treated as the urban model employment activities corresponding to these sectors.

3.10.3 The following block specifies the matching between urban model activities (measured as employment by zone) and regional economic sectors (measured primarily by output and value-added by area). This is shown in Table 3-8.

Urban Activities		REM Sectors	
31	Agriculture, hunting and forestry	101	Agriculture, forestry and fishing
32			
33	Fishing		
34			
35	Mining and quarrying	102	Mining
36			
37	Manufacturing	103	Manufacturing
38			
39	Electricity, gas and water supply	104	Energy and water
40			
41	Construction	105	Construction
42			
43	Wholesale & retail trade, repairs - retail	106	Distribution and catering
45	Wholesale & retail trade, repairs - other		
46			

Urban Activities		REM Sectors	
47	Hotels & restaurants		
48	Transport, storage & communications	107	Transport and communication
49			
50	Intermediaries – financial management	108	Finance and business
51	Intermediaries – local financial services		
52	Real estate, renting & business activities		
53	Public administration, defence, social security	109	Public administration
54			
55	Education		
56	Health		
57	Other	110	Other services
58			

Table 3-8 Match of urban model activities to REM sectors

3.10.4 The additional sectors used to represent different categories of imports to Scotland are as shown in Table 3-9.

Sector	represents
111	Goods from Rest of UK
112	Goods from Rest of World through England
113	Goods from Rest of the World, not through England
114	Services from Rest of UK
115	Services from Rest of World through England
116	Services from Rest of the World, not through England

Table 3-9 Definition of import sectors

3.10.5 Note that these sectors are defined as special sectors representing different categories of imports by the area capacities database. This is set up so that each of these sectors has a non-zero capacity only in the External Area to which it refers. This ensures that these imports cannot be supplied from anywhere except that Area.

3.10.6 The demand for these imports is specified in the technical coefficients of the input-output model (see 14.6). Note that this specification means that as these coefficients are fixed input values, the proportion of imports in the total inputs of each sector cannot be changed by the model itself. In particular, changes in the transport system will not change the ratio of imported to domestic (Scottish) inputs in any sector's consumption.

3.11 Quality change sub-model definition

3.11.1 The quality model is set up so that:

- housing quality is adjusted by the quality model, by the quality of exogenously defined housing construction and by the quality of endogenously forecast new housing; and
- retail quality is changed only by exogenous inputs.

3.12 Activity:floorspace relationships

3.12.1 The Model Definition file specifies:

- which type of floorspace, if any, each activity uses; and
- which of the utility and/or cost functions controls how the activity changes its use of floorspace in response to rent changes.

3.12.2 Activities not listed in the input file do not occupy modelled floorspace. The activities in TELMoS:07 which do not occupy floorspace are

- 32: Manual agriculture;
- 34: Manual fishing; and
- 36: Manual mining.

3.12.3 The activities which occupy each modelled floorspace type are shown in Table 3-10.

3.12.4 The floorspace/rent relationships are

- for all employment types, a simple rent-density elasticity; and
- for all household activities, the utility-maximising function with the cost per unit activity and the floorspace per unit activity forming two of the variables in the location choice model.

Floorspace category		Activity	
1	Housing	1 to 20	Households
2	Retail	43	Retail trade
3	Office	31	Non-manual agriculture
		33	Non-manual fishing
		35	Non-manual mining
		37	Non-manual manufacturing
		39	Non-manual electricity
		41	Non-manual construction
		45	Non-manual other trade
		48	Non-manual transport
		50	Financial management
		51	Local financial services
		52	Real estate
		53	Non-manual public administration
		57	Non-manual other
4	Industrial	38	Manual manufacturing
		40	Manual electricity
		42	Manual construction
		46	Manual other trade
		49	Manual transport
		54	Public administration
		58	Manual other
5	Hotel	47	Hotels
6	Education	55	Education
7	Health	56	Health & social

Table 3-10 Activities using each floorspace category

3.13 Location model timelags

3.13.1 The model definition input file also specifies:

- the timelags used in the location model; and
- the choice of location model function and related options.

3.13.2 The timelags are documented in Sections 12.1 (households) and 12.4 (employment activities) of this report.

3.14 Land-use/transport interface definition

3.14.1 Some additional definitions used in the land-use/transport model interfaces are documented in Section 16.2 of this Report.

3.15 Accessibility measure definitions

3.15.1 These are documented in Section 8.1 of this Report.

3.16 Other definitions

3.16.1 It should be kept in mind that the model definition file sets up and names different activities, but most of the information which makes them behave in accordance with those names is introduced elsewhere.

3.16.2 Important aspects of "definition" input to specific sub-models include the following:

- the "life-cycle" processes are defined by inputs to the transition model, MT12 (see 10.1) - it is these that define (for example) that younger households age into older households, etc;
- the numbers of persons within households are defined by inputs to the employment status model, ME12; and
- whilst the definition file identifies household activities as belonging to different socio-economic groups, the corresponding differentials in incomes are input to the location model, ML12 (see 12.1) and the relationships between the socio-economic groups of workers and the economic sectors are input to the regional economic models, MK12 and MP12 (see 15.4.3 and 15.6).

4 URBAN DATABASE DEFINITIONS

4.1 Introduction

4.1.1 This Chapter documents the data contained in the urban database (ie by zone). This data is generally:

- **input** for the base year (and in some cases for previous years); and
- **output** for forecast years. (Note that this includes **outputs** from the transport model which are **inputs** to the land-use/economic model.).

4.1.2 There are one or two exceptions where the files contain input assumptions for future years, though most of the zonal assumptions about future change are input in the planning policy file. These exceptions are noted where they occur.

4.2 Activity database file

4.2.1 The main function of this file, AVZN<year><test>.DAT, is to record the number of units of each activity in each zone, i.e. the number of households and of jobs by activity.

4.2.2 For household activities, the file also records the numbers of persons by type within households of each activity in each zone.

4.2.3 The file also records the persons not in households.

4.2.4 For employment, the file shows

- the nominal number of workers by employment activity and workplace zone, and
- the actual/forecast number of workers by activity, zone and socio-economic group.

4.2.5 In the base year, the nominal number of workers by activity and zone equals the total over socio-economic groups for that activity and zone. In forecast years, the nominal number represents the number of workers which firms expect to employ and for whom they provide floorspace, in line with their investment decisions, whilst the actual number represents the outturn given current levels of production; these may vary.

4.2.6 The derivation of the 2001 figures is documented:

- for households and resident persons, in Section 5.3 of this report; and

- for employment by workplace in Section **Error! Reference source not found.** of this report.

4.2.7 The Activity Database File records the number of households whose employment status has been changed by the employment status model ME12 within the year just modelled.

4.3 Space database file

4.3.1 The Space Database File contains the total quantity of floorspace (occupied plus vacant) in square metres, the rent in £/m^2 per week, the amount of vacant floorspace and the quality of the floorspace, all for each zone and space category,

4.3.2 Future versions of the model may also detail the amount and type of land occupied by each space category in each zone, and the amount of land available for further development. This would allow for the definition of, for example, high-density office blocks with a large amount of floorspace occupying a much smaller amount of land.

4.3.3 However, in the current implementation of the model, land is not explicitly modelled. The figures in this database file are quantities of floorspace, actual and permitted. The permitted figures are the total permitted but not yet used, ie the accumulated, unused allocation of permissible development. If the model forecasts that all permissions for development of a particular type in a particular zone will be used as fast as they are allocated, the permitted development figures in this section of the database file will remain zero.

4.3.4 The preparation of the residential space data is documented in Section **Error! Reference source not found.** of this report, while the preparation of the non-residential data is described in Section 5.6.

4.4 Space-activity database file

4.4.1 The space-activity database file relates the model activities (the 20 household types and 24 of the 27 employment categories) to the space they occupy. It defines the utility of consumption and density for households and employment activities and the consumption of other goods and services, in terms of expenditure, for household activities only.

4.4.2 The preparation of the space-activity data in relation to both household and employment activities is documented in Chapter 6.

4.5 Car ownership database file

4.5.1 The car ownership database file contains proportions by activity and zone for the 20 household activities. Employment activities do not have car ownership and are omitted from the file. Three categories of car ownership are defined; 0, 1 and 2+ cars (see Table 3-7). For each household type the proportion of all households in

each of the three car ownership categories is given (ie the three values always some to one).

4.5.2 The preparation of the base-year car-ownership proportions is documented in Section 11.1 of this report.

4.6 Development database file

4.6.1 This file records the amount of development which is under construction in each zone at the end of each one year period. The data is classified by the development process as specified in the model definition file and by the year in which it will be completed (and hence available to activities for occupation).

4.7 Travel-to-work database file

4.7.1 The main travel-to-work database files in the TELMoS:07 system are the TTWM<><>.DAT files. These contain the zonal travel-to-work matrix, disaggregated by car ownership and socio-economic group. In forecasts years (ie all years other than 2001) these are output by the employment status model ME12.

4.7.2 Note that in these files, socio-economic group is that of the individual workers, not that of the households to which they belong. The destination (workplace) totals are therefore directly comparable and consistent with the data for workers by workplace and socio-economic group, summed over employment activities. The origin (home) totals are comparable and consistent with the data on working adults by home zone and car ownership, but are not directly comparable with the breakdown by household and socio-economic group.

4.7.3 In the present implementation of TELMoS:07 the TTWM files are effectively copied as TTWS[2] files by the program IB12 in each year. This is the result of

- the fact that the initial TTW files (2001) are based on Census data rather than being synthetic; the approach used in TELMoS:05, of overwriting the matrices with a new synthetic matrix after each transport model run, using the latest generalised costs of travel to work, would obviously lose the benefit of starting from observed Census matrices and was therefore rejected
- the intended version of the ME12 program, which would have adjusted the TTWM files in response to changes in generalised cost (and hence would have retained the benefit of the Census-based matrices), could not be made to converge reliably on TELMoS:07 data in the time available for testing it on changing generalised costs;

[2] TTWM is simply an abbreviation for Travel To Work Matrices, and TTWS is a variant name to identify those matrices after modification (in transport model years only) by the transport model – the "S" standing for START, the transport model used in the first DELTA application where these matrices were used (the original Greater Manchester Strategy Planning Model).

- the method used in a number of previous studies, of adjusting the travel-to-work matrix for generalised cost changes by scaling in accordance with changes in trips-to-work, cannot be used in this case because TMfS:07 does not account for non-motorised travel to work.

4.7.4 As a consequence of these problems and constraints, the TELMoS:07 TTW matrices are (so far) providing a representation of who-works-where which is adjusted for land-use changes (including changes resulting directly or indirectly from changes in accessibility) but not for changes in the distribution of travel-to-work resulting directly from changes in generalized cost. We are continuing to work on solving the convergence problems in the new version of ME12 as applied to TELMoS:07. The limited use made so far of the new version of ME12 is described in section 13.4.

4.8 Space-development database file

4.8.1 The Space-development database file contains the amount of unconstrained development that is occurring for each floorspace category. The data is classified by the floorspace category as specified in the model definition file. The preparation of this data is documented in Section 6.2 of this report.

4.9 Land-use/transport interface database file

4.9.1 The Land-use/transport interface database file specifies exogenous weights for use in the accessibility calculations in AC12 (described in see Section 8.1 of this report).

4.10 Environmental database file

4.10.1 DELTA allows for environmental data to feed back from the transport model (or, in principle, a wider environmental model taking account of transport and other impacts) as an influence on the location of residents (and, again in principle, of businesses). This has not been implemented in TELMoS:07.

4.11 Active and passive accessibilities by measure

4.11.1 The ACDZ<year><test>.DAT and ACOZ<year><test>.DAT files hold the accessibility measures output by program AC12 grouped into:

- active accessibilities – how easily people located in zone *i* can get to "opportunities" (eg for work, for shopping) given the numbers of such opportunities in every zone *j* and the generalised costs of travel from *i* to each *j*; and
- passive accessibilities – how easily opportunities in zone *j* can be reached by people (potential workers, potential shoppers) who might come from each zone *i*, given their distribution across the zones *i* and the generalised costs of travel from each *i* to *j*.

4.11.2 These accessibility measures relate to a specific set of opportunities and a specific set of generalised costs (eg off-peak, non-work travel). These are input to program IA12 which combines them into measures of accessibility by activity – see below.

4.12 Accessibility and environmental values by activity

4.12.1 The file ASRV<year><test>.DAT contains the information about transport-related variables in the main forms in which they are used by the land-use model, ie

- accessibility by activity and (for households) car-ownership level; and
- zonal environment quality by activity (not used in TELMoS:07). (This is distinct from the area environmental quality, which is used in the TELMoS:07 migration model).

5 DATABASE DEVELOPMENT – 2001

5.1 Introduction

5.1.1 This chapter outlines the process by which the 2001 Census data was used to produce base-year data for the 20 household types and the 27 employment types required by DELTA.

5.1.2 There are three main stages to the work relating to households and population that will be described in the following sections:

- to extract household data to determine the number and types of households and employment in each zone;
- to determine the number, composition and employment status of the population of the households in each zone; and
- to deduce the number and composition of the non household population in each zone.

5.2 Sources of Data

5.2.1 Whilst the 2001 Census data was used to generate the base-year data for population, household and employment, two separate sources were used:

- Special 2001 Census tables were commissioned from GROS. These provided a disaggregation by (TELMoS:07) household categories at datazone Level. This commissioning provides information on households that wasn't available from the standard Census output; and
- The standard 2001 Census output that is produced at output area.

5.3 Assembly of the Scotland's Census 2001 data

5.3.1 The initial stage was to aggregate data published at output and datazone area to TELMoS:07 zone. As described previously, the TELMoS:07 zoning system comprises 720 zones (with 712 zones within the Fully Modelled Area), and each Fully Modelled Area zone comprises one or more of the 6,505 datazones, which in turn are aggregates of the 42,604 census output areas. This nesting of output areas within datazones within TELMoS:07 zones allowed for a relatively straight forward aggregation of data to TELMoS:07 zone.

5.3.2 In cases where the data required, by TELMoS:07, is unavailable from the 2001 Census then we have resorted to secondary data sources. The 1999-2000 Scottish Households Survey (SHS) was one such source.

5.4 Household data

5.4.1 TELMoS:07 households are split into 20 activities as defined in Table 3-2 Household activity definitions

5.4.2 Note that in activities 13, 14 and 17 to 20, ie 2 or more adults with children, one or more of the adults may be retired.

5.4.3 There are 10 base household categories that define the people who live in the household each split between manual and non manual socio-economic levels. Each type of household contains a person or persons in one or more of the categories listed in Table 3-3 Person types.

5.4.4 The 2001 Census tables commissioned from the GROS provided the numbers of households in each TELMoS:07 zone for the 20 base categories[3]. The tables contain data for the 26 types of households listed below:

GROS household groups	Household definition [and corresponding TELMoS:07 household activity]
1	One younger (16-44) person, non-manual [2]
2	One younger (16-44) person, manual [1]
3	One older (45-74, not retired) person, non-manual [4]
4	One older (45-74, not retired) person, manual [3]
5	One adult (16-74, not retired) and child(ren), non manual [8]
6	One adult (16-74, not retired) and child(ren), manual [7]
7	One adult (16+, retired) and child(ren) [7 or 8]
8	One person retired, non manual [6]
9	One person retired, manual [5]
10	One person retired, social grade not classified (5 or 6]
11	2 adult households, both retired, non manual [16]
12	2 adult households, both retired, manual [15]
13	2 adult households, both retired, social grade not classified [15 or 16]
14	2 adult households (household representative person aged 16-44), no children, non manual [10]
15	2 adult households (household representative person aged 16-44), no children, manual [9]
16	2 adult households (household representative person aged 45+), no children, non manual [12]

[3] The file "Social Grade by Datazone.csv" was received, by email, from Linda Taylor (GRO Scotland) on 14 February 2008.

GROS household groups	Household definition [and corresponding TELMoS:07 household activity]
17	2 adult households (household representative person aged 45+), no children, manual [11]
18	2 adult households (household representative person aged 45+), no children, social grade not classified [11 or 12]
19	2 adult households with children, non manual [[14]
20	2 adult households with children, manual [13]
21	3+ adults, no children, non manual [18]
22	3+ adults, no children, manual [17]
23	3+ adults, no children, social grade not allocated [17 or 18]
24	3+ adults, children, non manual [20]
25	3+ adults, children, manual [19]
26	Other household types [any]

Table 5-1 GROS household groups

5.4.5 The allocated social grade for the household was that of the household reference person.

5.4.6 Most of the GROS household groups related directly to the required TELMoS:07 household activities, as shown in the Table above. Those household groups which were undefined only in social grade were distributed to the relative activities in proportion to mix of households by known social grade within the zone. The final residual category (group 26 in the data from GROS) was distributed to all the TELMoS:07 activities pro rata.

5.5 Population Data

5.5.1 Data was taken from Census tables as follows:

- Children: CAS 004 (total all people aged 0-15 inclusive);
- Non-workers and workers: CAS 061 (those in the categories of 'economically active employee' and 'economically active self employed' are classified as working and all others with the exception of those 'economically inactive retired' are classified as not working). In particular 'economically active full time student' are classified as not working.; and
- Retired: people aged 75 or over from CAS 004 and people aged 16 to 74 inclusive who are classified as economically inactive retired from CAS 061.

5.5.2 The population assignment is complicated because the question of splitting the working/non-working population between the various household categories needs to be addressed, as well as the fact that the working age population is split between all household categories apart from those that are all retired.

5.5.3 Proportions from the SHS are used to estimate the number of workers/non-workers living in each of the household categories.

5.6 Non-Household Population

5.6.1 The population not in households includes people in institutions, boarding schools, halls of residence etc. Within TELMoS:07 the number of children, working adults, non-working adults and retired persons not in households is calculated.

5.6.2 The methodology adopted for calculating numbers mot in household is to take both the total population within each zone (derived from the 2001 Census) and the population resident in households (also derived from the 2001 Census) and subtract the latter from the former.

5.6.3 This approach allows the same definitions of children, working and non-working adults and retired to be used for those in and not in households.

5.6.4 An alternative methodology would be to use the univariate Census tables (UV 70 et seq) that refer to persons in communal establishments. One limitation of these tables is their definitions of elderly, children etc. Further calculations would be necessary to translate those tables output so that they are consistent with the TELMoS definitions.

5.7 Employment Data

5.7.1 This section relates to data by workplace.

5.7.2 The employment activities considered in TELMoS:07 (see Section 3.4 of this report) are defined in Table 3-4.

5.7.3 Data from Census UV77 provide the number of jobs in SIC categories A to Q in each TELMoS:07 zone (by workplace). (Note that data on employment by industry is available from the 2001 Scottish Census in more spatial detail that is released from the 2001 English Census; this as considerably helped the development of TELMoS.)

5.7.4 The first manipulation required is to split the category G, "Wholesale and retail trade, repairs", in "Retail" and "Other". In the absence of comprehensive information on how his division should be made, the split has been based upon the relative size of the two activities J and K in each TELMoS:07 zone.

5.7.5 The second manipulation required is to split the category J, "Financial intermediaries", in "Financial management" and "Local financial services". This split has been made considering the proportion of the activity J in each TELMoS:07 zone compared to the national average and applying a locational quotient .

5.7.6 The third manipulation required is to determine in each workplace zone what proportion of the jobs is manual or non-manual. This is needed partly to complete the disaggregation of the workplace employment data into the 27 TELMoS:07 employment activities, where these are are identified by the socio-economic level

of the workers; in addition, it is needed to complete the database with the mixture of socio-economic levels for those activities which employ workers of both. The resulting numbers of workers by workplace zone and socio-economic level must match the observed data on workers by workplace zone and socio-economic level, given in Census table UV78. This contains exactly the data that is required to achieve the manual/non manual split because it gives the number of jobs by workplace by approximated social grade.

5.7.7 The proportion of manual/ non manual workers in each workplace zone is found by classifying those in the 'higher and intermediate managerial/ administrative/ professional' and 'supervisory, clerical, junior managerial/ administrative/ professional' categories as non manual. Those in the remaining categories of 'skilled manual workers', 'semi-skilled and unskilled manual workers' and 'on state benefit, unemployed, lowest grade workers' are classified as manual.

5.8 Travel to work matrices

5.8.1 The travel-to-work matrices have been created using the ward-level travel to work matrices from the 2001 census.

5.8.2 Two sources of data have been used, namely the tables travel-to-work by occupation and travel-to-work by method of travel to work.

5.8.3 The conversion of the travel-to-work matrices to TELMoS:07 format is summarised in Figure 5.1

5.8.4 Travel to Work data from table TV205_OUT was aggregated into SEG1 (non-manual) and SEG2 (manual). For this process, only data relating to full-time and part-time workers was used. The correspondence between occupation types in TV205 and SEG is as follows:

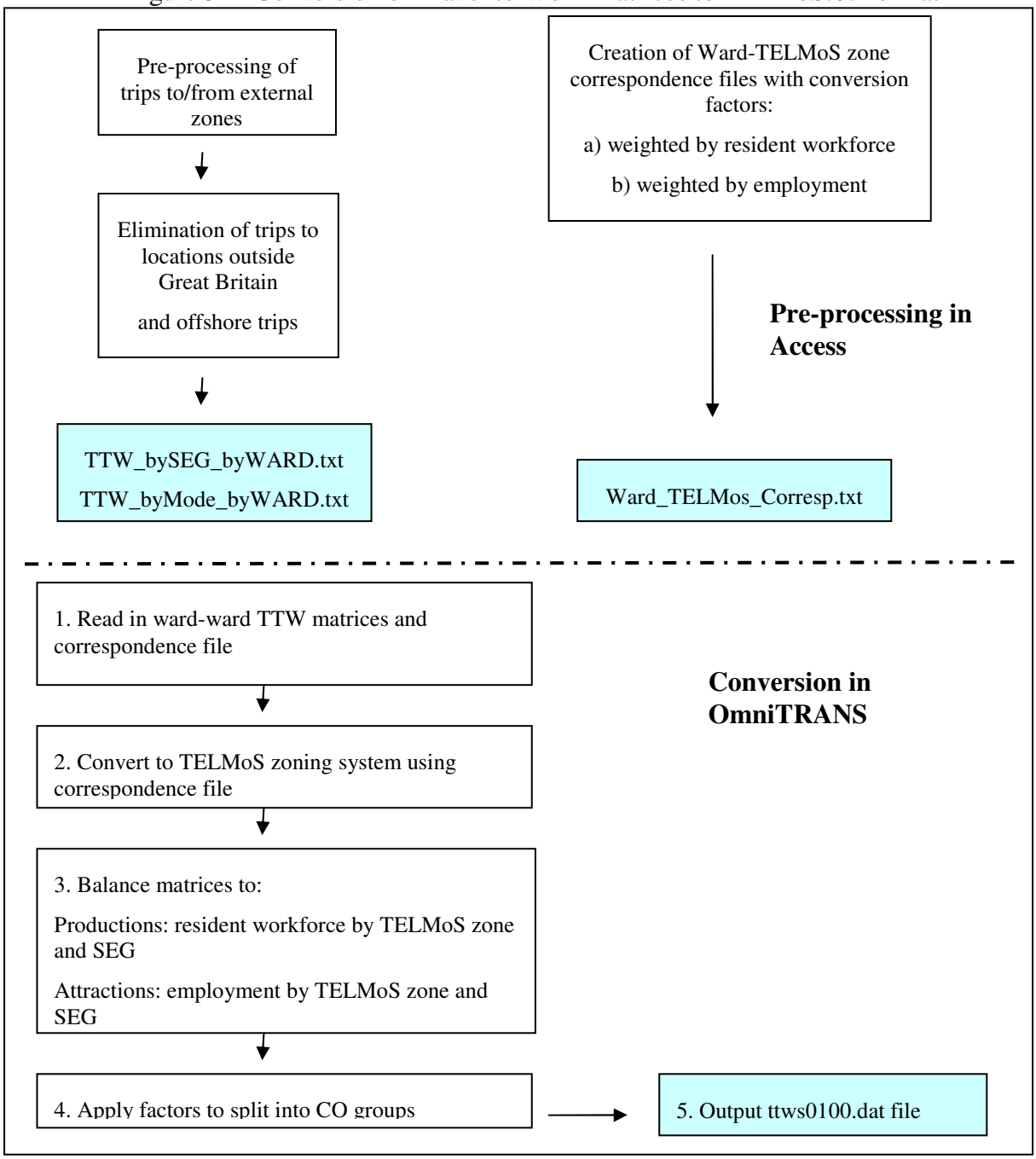
- SEG1: Managers and Senior Officials, Professional occupations, Associate professional and technical occupations, administrative and secretarial occupations
- SEG2: Skilled trades occupations, personal service occupations, sales and customer service occupations, process, plant and machine operatives, elementary occupations.

5.9 Use of the data

5.9.1 The data about households and their members, the non-household population and employment, is used in the main activity database file.

5.9.2 Census data on dwellings by type was also used as the basis for the residential floorspace data.

Figure 5-1 Conversion of Travel to Work Matrices to TELMoS:07 format



6 PROCESSING OTHER 2001 DATA

6.1 Introduction

6.1.1 This chapter documents the other components of the TELMoS:07 database which were created for 2001.

6.2 Space database file

6.2.1 Floorspace is a fundamental component in the DELTA model as it provides an indication of the capacity of zones in terms of their ability to hold households and employment. When floorspace is used alongside rents and densities it provides a key supply side constraint essential in analysing the effects of particular policies.

6.2.2 DELTA uses rents as the mechanism by which activities (households or employment) compete for and allocate floorspace. The interaction between supply and demand determines forecast rents.

6.2.3 The 2001 Census dwelling data was aggregated into four dwelling categories: detached, semi-detached, terraced and flats for both occupied and vacant dwellings. To calculate the total floorspace in each dwelling category by zone the number of dwellings by type were multiplied by an average size for each type. The average size was taken from Valuation Office Property Market Report, autumn 1991. This procedure was followed for both occupied and vacant dwellings.

6.3 Area environment database file

6.3.1 This file provides exogenous variables as inputs to the migration model. Since Reference Case KR this contains a single population density variables, calculated from base year TELMoS:07 data as DI_a where

$$DI_a = \frac{\sum_{i \in a} \left\{ P_i \left[\frac{P_i}{A_i} \right] \right\}}{\sum_{i \in a} P_i}$$

where: P*i* is population in zone *i*

A*i* is area of zone *i*

6.3.2 This provides a population-weighted density variable: for example, the value for the Edinburgh area, which includes both the densely-populated City of Edinburgh and some very sparsely populated rural areas, is largely dominated by the density

for the City of Edinburgh because a majority of the area's residents are living in the high density part of the area.

6.3.3 At present these values are taken as fixed but a possible future refinement would be to recalculate them each year based on the current population distribution forecast by the model itself.

6.4 Distance matrices

6.4.1 The migration model database files contain information on the distances between origin and destination for the migration matrices. The distances are straightline distances between area centroids.

6.5 Generalised cost data

6.5.1 Generalised cost data is supplied from TMfS:07 to DELTA. The purposes, modes and household car ownership levels that are considered in the DELTA side of the TELMoS:07 application are defined in Table 6-1, Table 6-2 and Table 6-3 respectively. Note: Modes and car ownership levels are only applicable to purposes 1, 2 and 3.

Purpose	Definition
1	Travel to work
2	Shopping and leisure trips
3	Business travel
4	Light goods vehicle trips
5	Heavy goods vehicle trips

Table 6-1 Purposes in TELMoS:07

Mode	Definition
1	Car
2	Public transport
3	'Slow modes' (walk and pedal cycle)

Table 6-2 Modes in TELMoS:07

Car Ownership level	Definition
1	No car
2	1 car
3	2+ cars

Table 6-3 Car Ownership levels in TELMoS:07

6.5.2 Mode constants and mode split parameters are only required for those purposes for which more than one mode is available (ie a mode choice is at all possible). Purposes 1, 2 and 3 fall into this category. Therefore, purposes 4 and 5 are ignored in the calculation procedure for these variables.

6.5.3 TMfS:07 produces generalised costs for 2 modes, car and public transport. The aim in DELTA is to consider 3 modes, these being car and public transport as in TMfS:07, along with an additional mode to represent non-motorised travel by walk or pedal cycle.

6.5.4 In order to calculate mode constants and mode split parameters, generalised costs along with the number of trips undertaken by each mode are required. This data is only available for those modes that are modelled in TMfS:07, ie car and public transport. Therefore, the calculation procedure is carried out for these two modes only.

6.5.5 The extra DELTA mode representing non-motorised travel will only be available for trips that are less than 10 km in length. Therefore, this will only act as an extra mode possibility in the calculations for trips within that range of distances.

6.5.6 The generalised costs for the DELTA mode representing 'slow modes' are calculated directly from the distance travelled. When calculating the generalised cost it is assumed that the monetary cost is zero and therefore that only the time component is to be considered. A speed of 6 km per hour is assumed in calculating the time component of the generalised cost and that each minute after the first 20 will count as double. Therefore, for a 6 km trip by 'slow mode' the generalised cost before any mode constant is applied will be 100 minutes. This comprises of 20 minutes for the first 2 kilometres and then 40 minutes for the final 4 kilometres, which are doubled to arrive at a total of 100 minutes.

6.5.7 TMfS:07 does not consider household car-ownership levels whereas DELTA considers three household car-ownership levels as defined in Table 6-3. Different mode constants and mode split parameters would be expected not only for each purpose but also for each car ownership level. As we do not have the data at zone-to-zone level to enable us to calculate separate mode constants and mode split coefficients for each car ownership level in each purpose, assumptions have to be made to make it possible to obtain the required inputs.

6.5.8 It is assumed that the coefficients (mode-split parameter and mode constant) calculated for each purpose from the data produced by TMfS:07 represents the central (and most common) household car ownership level of 1 car. Adjustments are then made to the mode constants to reflect the fact that people living in households with no cars will find it more difficult (though not always impossible) to use a car as a mode of transport and those people living in households with two or more cars are more likely to use a car to make a trip regardless of the availability or cost of the equivalent trip by any other mode. Checks are made at the end of the process to ensure that the resulting mode shares in the different car ownership

categories and the mode share for the 'slow modes' appear reasonable in all categories of purpose and car ownership level.

7 REGIONAL ECONOMIC MODEL DATABASE

7.1 Introduction

7.1.1 The Regional Economic Model (REM) database has been developed for Scotland in 2001. The database has been developed using Table 1.7: Aggregate Industry by Industry 2001 (Basic prices) of Scottish Economic Statistics 2001. The outputs of the REM for 2001 reproduce this table exactly.

7.1.2 In order to create the 2001 database three programs have been run and calibrated, these are;

- PX12 which calculates consumer final demand using information on household expenditure provided by the urban model;
- MP12 which calculates the pattern of trade and volumes of production by area; and
- PC12 which calculates prices and transport costs.

Together these three programs make up the production and trade model.

7.1.3 The creation of the files necessary to run these programs is discussed in the rest of this chapter.

7.2 Definitions

7.2.1 Table 3-8 and Table 3-9 show the REM sectors and their correspondence with the employment activities in the urban model.

7.3 Consumer final demand

7.3.1 Consumer final demand by sector and area is generated by running PX12. PX12 requires the AVZN activity database and the SAZN space-activity data from the urban model. It also requires the MP12 input file to contain the following data:

- MPINCF: Convert household expenditure to consumer demand;
- MPIN01: Mark-up on costs; value added; and
- MPIN03: Input-output technical coefficients.

7.3.2 These coefficients were calculated directly from the 2001 input-output table. Some adjustment to the coefficients in MPINCF was necessary so that consumer demand in the ARCD file was equal to consumer demand by sector in the 2001 data. These adjustments were as a result of some differences between the income definitions in the urban model and those of the Scottish Economic Statistics Data.

7.4 Capacities

7.4.1 The Capacity data file contains capacity data by area and sector. These capacities were calculated by aggregating the activity database file matching zones to areas and employment activities to REM sectors (using the matching in Table 3-8).

7.5 Exports and Government Expenditure

7.5.1 The ARFD<><>.dat file details the final demand from exports and government expenditure by area. The figures in the 2001 file are taken directly from the 2001 input-output table.

7.6 Generalised Costs

7.6.1 The REM requires ARMC<><>.dat files containing generalised costs by area and sector. In order to generate these, two programs have been run on the costs provided to us by the transport model (which are by zone and purpose). The first, AC12, is run to generate an ARMX<><>.dat file containing costs by area and purpose, the second, IT12, is run to convert the ARMX file into a matrix of costs by area and REM sector.

7.7 Area distances

7.7.1 MMDS0100.DAT contains the distances between the model areas.

7.8 Costs of Production

7.8.1 The ARCS<><>.dat file contains information on costs of production by sector and area, specifically;

- Production price;
- Consumption cost;
- Consumption transport cost;
- Production labour cost; and
- Production space cost.

7.8.2 This file is generated by running PC12.

7.9 Production, Value Added and Consumption

7.9.1 The MPPR0100.dat file contains 2001 production, value added and consumption values by sector and area, this is generated by running the MP12 program on the files listed above.

7.10 Trade volumes

7.10.1 Trade volumes by sector between production and consumption areas for 2001 have been generated by running MP12 for the base year. They are stored in MPTR0100.dat.

8 ACCESSIBILITY MODEL

8.1 Accessibility calculations by measure

8.1.1 The first stage in the accessibility calculations is carried out by program AC12. This is run in each year, whether or not it is a transport model year. It takes as input:

- matrices of generalised costs for different purposes, by mode, from the most recent year of TMfS:07 outputs;
- vectors of production and attraction weights, derived from the current DELTA database; and
- modal constants, mode choice coefficients and destination choice coefficients. These are all input by purpose, mode and car ownership level.

8.1.2 These data and coefficients are used to calculate active (origin) and passive (destination) accessibility measures[4] for each combination of purpose and weights defined in the accessibility definition file. The accessibility definition file specifies seven different pairs of accessibility measures, each pair being an active accessibility (eg residents' access to jobs of seg 2) and the corresponding passive accessibility (how easily workplace zones can be reached by workers of seg 2). The definitions of the seven pairs of measures are shown in Table 8-1. Not all of the accessibilities calculated are necessarily used - the choice of accessibility measures is controlled in the next step, accessibility calculations by purpose (see following sections).

8.1.3 The calculations are standard logsum forms. First an average generalised cost over modes is found using equations of the form

$$g_{ij} = \frac{1}{-\lambda_{ij}^{M}} \ln \sum_{m} \exp\left(-\lambda_{ij}^{m} \cdot g_{ijm}\right) \qquad \textbf{(1)}$$

where

g_{ijm} is the generalised cost from i to j by mode m (input from TMfS:07 modified by mode-specific constants).

λ_{ij}^{M} is a value for the mode choice coefficient over the distance ij.

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[4] Note that we have generally used the terms origin and destination accessibility in the past, but are moving to active and passive as these are slightly clearer about the distinction between "ease of reaching places" and "ease of being reached".

Measure	Purpose	Origin (active) accessibility definition [Destination weights]	Destination (passive) accessibility definition [Origin weights]	Trip purpose supplying generalised costs
1	1	Access to work, non-manual workers [non-manual jobs - by workplace]	Access to non-manual labour [non-manual workers - by residence]	AM and PM peaks, not in work
2	1	Access to work, manual workers [manual jobs - by workplace]	Access to manual labour [manual workers - by residence]	AM and PM peaks, not in work
3	2	Access to shop [retail floorspace]	Access to customers [total population]	Off-peak, not in work
7	2	Access to Education [education floorspace]	Access to Education [total population]	Off-peak, not in work
4	3	Access to business [employment]	Access to business [employment]	Off-peak, in work
5	4	Access for LGV movement [employment]	Access for LGV movement [employment]	LGV
6	5	Access for OGV movement [employment]	Access for OGV movement [employment]	OGV

Table 8-1 Definitions of accessibility measures

8.1.4 Then active accessibilities are calculated using the form

$$A_i = \frac{1}{-\lambda^D}\left(\ln\left\{\sum_j W_j \exp\left(-\lambda^D g_{ij}\right)\right\} - K^J\right) \qquad \textbf{(2)}$$

where

λ^D is the destination choice coefficient

W_j is the relevant weight for zone *j,* and

$$K^J = \ln\sum_j W_j^{base\_year} \qquad \textbf{(3)}$$

8.1.5 Similarly passive accessibilities are found using the form

$$A_j = \frac{1}{-\lambda^D}\left(\ln\left\{\sum_i W_i \exp\left(-\lambda^D g_{ij}\right)\right\} - K^I\right) \qquad \textbf{(4)}$$

where

λ^D is the destination choice coefficient

W_i is the opportunity weight for zone i

$$K^I = \ln \sum_i W_i^{base\_year} \qquad \textbf{(5)}$$

8.1.6 Note that for ease of presentation the superscripts for car-ownership level, travel purpose/time-of-day and weight identifier have been omitted from these equations.

8.1.7 The constants recorded in the Accessibility Calculation database file are the natural logarithms of the totals of the corresponding weights in the base year. These have the effect of ensuring that the resulting accessibilities are scaled in units of generalised cost.

8.1.8 The mode and destination choice coefficients have been chosen on the basis of previous experience, including the logit model mode choice estimation carried out in 2004 on cost and trip data from the original version of TMfS.

8.1.9 The calculation of the modal constants requires the identification of one mode that fulfils the criteria (or at least is the mode that comes nearest to fulfilling the criteria) of being available to everybody and available for trips between all zone pairs. This mode can then be used as a standard against which the mode constants for the other modes can be calculated. The mode chosen is public transport; therefore public transport (mode 2 in AC12 inputs, see Table 6-2) always has a zero mode constant and the other mode constants can be considered to be in relation to bus travel.

8.1.10 The values for mode choice coefficients and mode constants remain the same over all years of the forecast period.

Measure(s)	Car ownership level(s)	Mode choice coefficient	Destination coefficient
1,2,3	1,2,3	-0.05	-0.02
4	1,2,3	-0.05	-0.05
5	n/a	n/a	-0.026
6	n/a	n/a	-0.026
7	1,2,3	-0.05	-0.02

Table 8-2 Choice coefficients in accessibility calculations

Source: own judgement based on previous transport modelling work

8.1.11 Table 8-3 shows the mode constants by purpose and car ownership level which were estimated so as to produce appropriate mode shares within each category.

Purpose	Car ownership level	Mode	Mode constant (minutes)
1	1	1	40
1	2	3	20
1	3	1	-40
1	3	3	30
2	1	1	100

Purpose	Car ownership level	Mode	Mode constant (minutes)
2	2	3	20
2	3	1	-100
2	3	3	40
3	2	1	-20
3	2	3	10
3	3	1	-40
3	3	3	20

Table 8-3 Mode constants

8.1.12 It should be kept in mind that the mode split coefficients and constants, and the distribution coefficients, are used only in the DELTA accessibility calculations and not in TMfS:07 itself. The possibility of modifying the DELTA accessibility calculations so that the implied distribution and mode choice models would be strictly consistent with those in TMfS:07 was considered in recent work[5]. The conclusion was that this was not immediately practical and poses a number of theoretical difficulties.

8.2 TMfS:07 cost files read by TELMoS:07

8.2.1 Four modes are defined in the cost outputs from TMfS:07 to TELMoS:07, for three time periods and two purposes as shown in the following tables.

Mode	Description
C	Car
P	Public Transport
L	Light Good Vehicle
O	Other Good Vehicle

Table 8-4 Modes in cost files

Time	Description
A	AM peak
O	Off peak
P	PM peak

Table 8-5 Time periods in cost files

Purpose	Description
W	In work
N	Not in work

Table 8-6 Purposes in cost files

8.2.2 Generalised costs are available for all four purposes for in-work travel, but only for "Car" and "Public Transport" for "not in work" travel. A separate file of costs is supplied for each of the resulting mode/period/purpose combinations; therefore 18

[5] see TELMoS PN 75.

cost files are present in the database for each transport model year and are identified by the naming scheme shown below.

Filename XXXXYYTT.DAT represents...			
XXXX	**YY**	**TT**	name of the Cost files read by DELTA
XXXX			letters and/or numbers to identify the file
CXXX			the first character **C** to denote cost file
X**A**XX			the second character **A** to denote AM peak
X**O**XX			the second character **O** to denote Off peak
X**P**XX			the second character **P** to denote PM peak
XX**W**X			the third character **W** to represent in work
XX**N**X			the third character **N** to represent not in work
XXX**C**			the fourth character **C** to denote Car
XXX**L**			the fourth character **L** to denote LGV
XXX**O**			the fourth character **O** to denote OGV
XXX**P**			the fourth character **P** to denote Public transport
	YY		numbers to identify the year
		TT	letters to identify the DELTA test code

Table 8-7 Cost files: file naming

8.2.3 The zonal outputs of AC12 are the ACOZ and ACDZ files of origin (active) and destination (passive) accessibilities respectively.

8.3 Accessibility calculations by activity - household activities

8.3.1 The second stage in the accessibility calculations is carried out by program IA12. This finds values of zonal accessibility for each activity from the various accessibility measures calculated by AC12. The DELTA activities are separated into two groups for this purpose; household activities (explained in this section) and employment activities (explained in the following section).

8.3.2 For households, the different accessibility measures are multiplied by the expected frequency (trips per household per week) for each individual household activity. For this each household category is disaggregated into its constituent members (ie number of children, working adults etc.) and values for the number of trips per week by each measure by each household member predicted. This is then summed by each measure to generate the total number of trips by each measure that each household type is typically expected to make.

8.3.3 The accessibility value for a household therefore represents an expected generalised cost of travel per week. The differences between household types arise from the differences in household composition and in the types of trips they are likely to make.

8.3.4 Input file IA12<><>.INP defines household accessibilities in terms of different measures of more specific. This input is the same in all years. The outputs from

IA12 are the household-related parts of ASRV<><>.DAT file. These values are recalculated in each year, whether or not it is a transport model year.

8.4 Accessibility calculations by activity - employment activities

8.4.1 Accessibility measures for employment activities are based on varying combinations of

- accessibility to the labour force (by socio-economic group);
- accessibility to consumers; and
- accessibilities to other businesses, for varying proportions of business travel, LGV movement and OGV movement.

8.4.2 The weights on different types of accessibility (further broken down by car-ownership level) are specified in the IA12 input file. These data are different every transport model years, to take into account the different values of time. The outputs from IA12 are the employment-related parts of relevant data in the ASRV<><>.DAT file.

9 DEVELOPMENT MODEL

9.1 Development model – overview

9.1.1 The TELMoS:07 development model is applied to each of the floorspace categories except for health and education (ie it is applied to categories 1 to 5, but not to 6 or 7 – see Table 3-6).

9.1.2 The development model involves two calculations:

- a national development calculation that represents the decisions of developers and investors operating across the whole of the fully-modelled area. This involves calculating, in each year, a total quantity of new floorspace of each type which is then distributed (subject to planning policy controls) to zones across the whole of Scotland; and
- an area development calculation that represents the decisions of locally-based agents (including businesses or households developing space they intend to occupy themselves). This involves calculating, in each year, a total quantity of new floorspace of each type in each of the 47 areas, which is then distributed (subject to planning policy controls) to the zones within that area.

9.1.3 The two development calculations are described in the following sections. The areas are defined in Figure 3-2.

9.2 The national development model

9.2.1 The model involves the following three stages:

- Calculation of the total unconstrained development: estimate of the total quantity of floorspace across the Fully Modelled Area by type, that developers would seek to begin during the period if not constrained by the planning system;
- Calculation of the total constrained development: estimate the degree to which developers will restrict their output if the planning system is constraining development activity overall; and
- Allocate development to zones: the total amount of constrained development is allocated between corresponding development processes and between zones, taking account of the profitability of alternative locations and of the limits imposed by planning permissions in each zone.

9.2.2 The amount of development of each floorspace type is if necessary constrained by the total amount of development permitted (in the planning policy inputs). In

addition, the amount of development by processes and zone is constrained to what is permissible in the year modelled.

9.2.3 The development models for each floorspace type are independent of one another.

9.2.4 For residential, retail, office and industrial floorspace types we use a version of the model which is sensitive to the forecast changes in average rent (from the location model). A base rate of development has been defined, and an elasticity of one is specified so that (subject to the constraints due to the planning policy) this rate of development will vary in proportion to the average rent.

9.2.5 For leisure/hotel floorspace the model calculates the amount of floorspace that developers will seek to build as a fraction of the existing stock. The fraction varies according to the average expected profitability of development, based on the rent calculated in the last period, and a comparable indicator of the average cost of construction.

9.2.6 For the other two floorspace categories (health and education), the development model is turned off and development of these categories is entirely exogenous to the model (ie input via the planning policy files).

9.2.7 Within the calculation of the total constrained development, the model allows for the likelihood that national developers will tend to maintain a "land bank" of unused permissible development, since this represents their "stock" for future activity. These effects operate on the total quantity of development before the model considers constraints on development in individual zones.

9.2.8 All new residential development is assumed to have a quality index 10% higher than that of the existing floorspace within the zone in question. The quality index for other space categories has been set to 15%. (Currently this is only relevant to retail floorspace).

9.2.9 Inputs for density and average development costs are also entered here.. A density of 1 is has been specified: this is required because the "land" inputs to the model are actually measures of permissible floorspace, rather than of land on which floorspace would be permitted.

9.2.10 Alternative total development functions coded in DELTA can use interest rate and building cost indices and yield rates. These are present in the TELMoS:07 inputs but not used.

9.2.11 The third step of the model concerns the allocation of development to zones. The hypothesis for this is that:

- development is likely to be concentrated in zones where it is expected to be more profitable;
- other things being equal, development will be proportional to the amount of development permitted; and
- developers do not attempt to maintain a 'development land bank' in individual zones, ie development may take place up to the limit of what is permitted in any one zone.

9.2.12 The distribution of development to zones is forecast by a logit model of the form

$$F(P)^{u}_{pi} = F^{u}_{p*} \frac{F(\max, P)^{u}_{pi} . \exp(\gamma^{u}_{p} . r^{u}_{ti})}{\sum_{p}\sum_{i} F(\max, P)^{u}_{pi} . \exp(\gamma^{u}_{p} . r^{u}_{ti})}$$

where

$F(\max, P)^{u}_{pi}$ is the maximum permissible floorspace of development process P (producing floorspace type u) in zone i;

r^{u}_{ti} is the rent of floorspace category u in zone i at time t at the beginning of the current period;

γ^{u}_{p} is the sensitivity of development location of floorspace type u to expected profitability.

9.2.13 The program then checks that the constraints on development are satisfied, ie that:

$$F(P)^{u}_{pi} \leq F(\max, P)^{u}_{pi}$$

9.2.14 Any development in excess of the constraint is subtracted, so that constraint is just satisfied. Excess development is accumulated and reallocated using a revised version of the above equation in which the weights are the amount of additional development permissible. This is repeated until the total quantity of development has been located.

9.2.15 The coefficients of the development model are shown in the table below**Error! Reference source not found.**. (Note that the input file also contain some dummy values for floorspace types whose development is wholly exogenous; these do not affect the working of the model and are not included in the table.) These are inputs via the MD12<><>.INP files.

Space category	Constant in total unconstrained development	Constraints on total development (b^{u}_{p})	Constraints on total development (f^{u}_{p})	Coefficients of development location model (γ^{u}_{p})
1	.01156	0.5	0.33	0.03
2	.00477	0.6	0.4	0.004
3	.00985	0.6	0.4	0.04
4	.01196	0.6	0.4	0.12
5	.12	0.6	0.4	0.004

Table 9-1 Development model coefficients

Source: own judgement, informed by previous modelling work

9.3 The area development model

9.3.1 The area development model is applied to those space categories (and development processes) that are modelled within the Fully Modelled Area Development model space category. It is applied to each Area within the Fully Modelled Area.

9.3.2 There is a similar three stage process to that of the Fully Modelled Area model involving:

- Calculating the unconstrained development local developers would seek to build;
- Calculate a total constrained development that would apply to local developers within each area; and
- Allocate the additional development that is generated by the previous two stages of the area model to zones.

9.3.3 Whereas the national development model calculates a proportionate increase in floorspace, the area model calculates an absolute amount based upon the difference between the amount of floorspace that would be required if the activities (households for residential floorspace, employment activities for other activities) using the space category occupied it at the activity/floorspace ratio observed in the base year and the available floorspace in the current year (including the floorspace that has been identified for development by the Fully modelled area model).

9.3.4 Mathematically, this involves finding the (unconstrained) "area requirement"

$$F(UAR)^{u}_{pj} = \sum_{v \in Occ(u)} \left[X^{v}_{tj} . \frac{\sum_{i \in j} \left(F^{u}_{(t=0)j} - F(V)^{u}_{(t=0)j} \right)}{\sum_{v \in Occ(u)} \sum_{i \in j} X^{v}_{(t=0)i}} \right]$$

where

$F(UAR)^{u}_{pj}$ is the unconstrained "area requirement" at period p for additional floorspace type u in area j

$Occ(u)$ is the set of activities v that can occupy floorspace type u (note that this is all the activities permitted to occupy u, not expected occupiers)

X^{v}_{tj} is the quantity of activity v located in area j at time t

$F^{u}_{(t=0)i}$ is the quantity of floorspace type u in zone i at time $t=0$, ie in the base year

$F(V)^{u}_{(t=0)i}$ is the quantity of vacant floorspace type u in zone i at time $t=0$, ie in the base year

$X^{v}_{(t=0)i}$ is the quantity of activity v located in area j at time $t=0$.

9.3.5 The calculated 'area requirement' is then tested to ensure that it is greater than the existing stock plus any development resulting from the national process ie whether

$$F(UAR)^{u}_{pj} > \left(F^{u}_{tj} - F(N)^{u}_{pj} \right)$$

where

F^{u}_{tj} is the stock of floorspace type u in area j at time t

$F(N)^u_{pj}$ is the quantity of floorspace type *u* to be build in area *j* starting in period *p* resulting from the "national" development model (above).

9.3.6 If so, then the "local" development is a proportion of this shortfall

$$F(UA)^u_{pj} = \alpha^u_p \left[F(UAR)^u_{pj} - \left(F^u_{tj} - F(N)^u_{pj} \right) \right]$$

where

$F(UA)^u_{pj}$ is the unconstrained amount of development of floorspace type *u* in area *j* started in period *p* by the "area model"

α^u_p is a parameter scaling the whole equation in area *j* (the proportion of the local requirement that will be built).

9.3.7 The second stage of the Area Model involves the calculation of constrained development. This is a simple check against the total permissible development available in the area. If the unconstrained development is greater than the current total permissible development, it is constrained to that total; otherwise it is unchanged.

9.3.8 The final stage of the development model process is to allocate the additional development that is generated by the Area Development Model to zones and development processes. The approach is identical to that used in the national model (see paragraph 9.2.12), except that the calculation is done separately for each area, with the choice of location being limited to the zones within that area.

10 TRANSITION

10.1 Transition model (i) demographic scenario

10.1.1 The household transition sub-model represents three main processes of change affecting households within the Modelled Area:

- formation;
- transformation; and
- dissolution.

10.1.2 All three processes are defined as the probability that a particular change will happen to a particular kind of household within a one-year modelled period. Formations are therefore defined as the probability that an existing household of one kind will "generate" a new household (usually of a different kind) within one year.

10.1.3 Some of the events modelled are represented by a single rate. For example, the probability that a couple's first child will be born during the year gives the probability of a simple transformation of the household from couple-without-children to couple-with-child(ren). Other events require two or more changes, the obvious example being that the marriage or cohabitation of two single persons is treated as the transformation of one household from single person to couple, and the dissolution of another single person household.

10.1.4 Migration is treated separately. Rates for migrating out of the Modelled Area (Scotland) are specified by household category, along with a set of coefficients defining the rate of migration into the Modelled Area as a multiple of the rate of out-migration. Migration between areas within Scotland is modelled explicitly in the migration sub-model.

10.1.5 The remaining function of the transformation sub-model is to define which households are "mobile" in the location sub-model. All newly formed, newly arrived or newly transformed households are assumed to be mobile. In addition, a proportion of wholly unchanged households is assumed to be mobile; this represents mobility in the housing market which is unrelated to any change in household composition or status.

10.1.6 Note that at present, all these processes are assumed to apply equally and independently to each socio-economic group. All calculations are simple applications of the relevant rates to numbers of households, carried out separately for each zone.

10.1.7 The coefficients of the household transition model are documented in section 17.3, as the demographic component of the current overall scenario for TELMoS:07.

10.2 Transition model (ii) employment activity inputs

10.2.1 There are no "transition" or "growth" coefficients for employment activities in the MT12 inputs, since changes in employment activities are driven by the outputs of the regional economic model.

10.2.2 A set of coefficients specifies that 25% of employment in each sector is mobile in each one-year period.

11 CAR OWNERSHIP MODEL

11.1 Car-ownership model

11.1.1 TELMoS:07 has a new version of the DELTA car ownership model. It is a zonal and incremental form of the national (GB) car-ownership the model calibrated by Whelan[6]. The original model was developed using data from the Family Expenditure Survey (FES), at five yearly intervals from 1971-1996, and the National Travel Survey (NTS) 1991. Within TELMoS:07. the converted form of model is applied separately to each household type in each zone.

11.1.2 The model uses different coefficients in different locations depending whether zones are metropolitan, urban, surburban or rural. TELMoS:07 zones were assigned to one or other of these categories according to the density of population in 2001:

- Rural zones – population density within range 0-500 persons per hectare
- Suburban zones – population density within range 501-1000 persons per hectare
- Urban zones – population density within range 1001-3000 persons per hectare
- Metropolitan zones – population density greater than 3000 persons per hectare

11.1.3 Figure 11.1 shows the distribution of zones by category.

11.1.4 The car ownership model is constructed as a choice model with the alternatives of owning zero, one, or two-or-more vehicles. The model works by adjusting

- the probability p1+ that a household owns one or more cars;
- the probability p2+|1+ that a household which owns one or more cars owns two or more cars (rather than just one).

11.1.5 "Owning" is taken in the usual sense of "having the use of", so (as in the Census and other surveys) it may include company cars, leased vehicles etc. The adjustment of ownership probabilities over time is carried out separately for each household type in each zone. (Note that as households locate they are assumed to take up the car-ownership probabilities of the zone they move to, ie car-ownership is assumed to be conditional upon household type and location.)

[6] Whelan G (2004): 'Modelling Car Ownership in Great Britain. *Transportation Research Part A: Policy and Practice*, volume 41 pages 205-219.

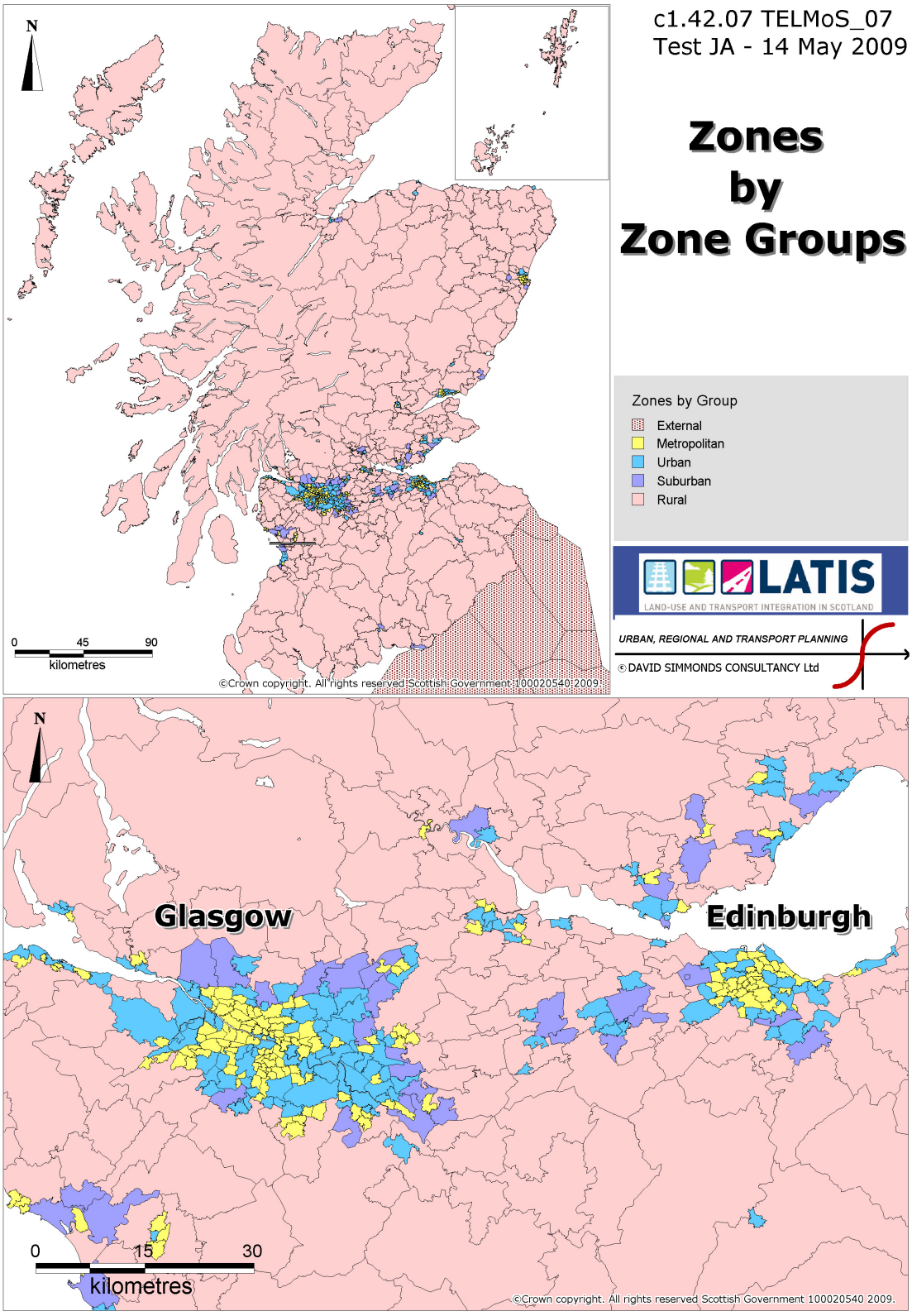

Figure 11-1 Car Ownership Model Zone Classification

11.1.6 The new probability of car ownership is calculated as a function of the previous car ownership and of the changes in the variables which enter into the equation of the predictor X:

$$p^h_{(t+1)i(1+)} = \frac{s^h_{i(1+)}}{1+\left[\frac{s^h_{i(1+)} - p^h_{ti(1+)}}{p^h_{ti(1+)}}\right]\exp\left(-\Delta X^{\,h}_{pi(1+)}\right)} \qquad \textbf{(10)}$$

$$p^h_{(t+1)i(2+\mathrm{ll}+)} = \frac{s^h_{i(2+)}}{1+\left[\frac{s^h_{i(2+)} - p^h_{ti(2+)}}{p^h_{ti(2+)}}\right]\exp\left(-\Delta X^{\,h}_{pi(2+)}\right)} \qquad \textbf{(11)}$$

where

- 1+, 2+3+ are levels of car ownership;
- $s^h_{i(\#+)}$ is a saturation level of car ownership level #+ (# = 1 or 2) cars for household type *h* in zone *i*;
- *t+1* is the year being forecast, *t* is the preceding year, and *p* is the period from *t* to *t+1*; and
- *X* is a predictor, as defined below.

11.1.7 The following formulas are implemented to calculate the change in the predictor:

$$\Delta X^{\,h}_{pi(1+)} = \beta^h_{p(1+)}\left(l^h_{(t+1)i} - l^h_{ti}\right) + \gamma^h_{p(1+)}\left(I^h_{(t+1)i} - I^h_{ti}\right)*52 + \varepsilon^h_{p(1+)}\left(d^h_{ti(1+)} - d^h_{(t-1)i(1+)}\right) +$$
$$+\varphi^h_{p(1+)}\left(U^h_{(t+1)i} - U^h_{ti}\right) + \theta^h_{p(1+)}\left(E^h_{(t+1)i} - E^h_{ti}\right) + \xi^h_{p(1+)}\left(R^h_{(t+1)i} - R^h_{ti}\right)$$

(13)

$$\Delta X^{\,h}_{pi(2+)} = \beta^h_{p(2+)}\left(l^h_{(t+1)i} - l^h_{ti}\right) + \gamma^h_{p(2+)}\left(I^h_{(t+1)i} - I^h_{ti}\right)*52 + \varepsilon^h_{p(2+)}\left(d^h_{ti(2+)} - d^h_{(t-1)i(2+)}\right) +$$
$$+\varphi^h_{p(2+)}\left(U^h_{(t+1)i} - U^h_{ti}\right) + \theta^h_{p(2+)}\left(E^h_{(t+1)i} - E^h_{ti}\right) + \xi^h_{p(2+)}\left(R^h_{(t+1)i} - R^h_{ti}\right) +$$
$$d1^h_{p(2+)}\left(CC1^h_{(t+1)i(2+)} - CC1^h_{ti(2+)}\right)$$

(14)

11.1.8 Here

- $\beta^h_{p(\#+)}$ is a licence parameter (input to MC12<><>.INP, block MC12PR);
- $\gamma^h_{p(\#+)}$ is an income parameter (ditto);
- $\varepsilon^h_{p(\#+)}$ is an accessibility parameter (ditto);
- $\varphi^h_{p(\#+)}$ is an ownership cost parameter (ditto);

- $\theta^{h}_{p(\#+)}$ is an employment parameter (ditto);
- $\xi^{h}_{p(\#+)}$ is a running cost parameter (ditto);
- $q1^{h}_{p(\#+)}$ is a company car 1 parameter (ditto);
- $q2^{h}_{p(\#+)}$ is a company car 2 parameter (ditto);
- l is a licence variable (input to MC12<><>.INP, block MC12V1);
- I is an income variable (input to MC12<><>.INP, block LCML01);
- $d^{h}_{ti(\#+)}$ is an accessibility variable (read from ASRV<><>.DAT, block ASRV01);
- U is an ownership cost variable (input to MC12<><>.INP, block MC12V1);
- E is an employment variable (number of workers per households) (from AVZN);
- R is a running cost variable (input to MC12<><>.INP, block MC12V1);
- $CC1^{h}_{ti(\#+)}$ is a company car 1 variable; (input to MC12<><>.INP, block MC12V2); and
- $CC2^{h}_{ti(\#+)}$ is a company car 2 variable (input to MC12<><>.INP, block, MC12V2).

11.1.9 The car-ownership variables are not used, ie it is assumed that the influence of company car arrangements on households of any one type is constant over time.

11.1.10 These formulae are expressed entirely in terms of the previous level of car ownership, the changes in the independent variables and the coefficients. The program calculates the probabilities that households own one or more cars, and the conditional probability that a car-owning household owns, two or more cars. These results are then converted into the simple proportions of 0, 1 and 2+ car-owners and output to the COZN<><>.DAT file.

11.1.11 The coefficients of the car-ownership model are assumed constant for all forecast years. They are input in the MC12<><>.INP file.

12 LOCATION MODEL

12.1 Location model (i) household location: design

12.1.1 The process of locating households includes a calculation of 'pool' households and 'mobile' households. The 'pool' households are those that do not have a previous location (ie they are newly formed households or new in-migrants to the area), the 'mobile' households are those with a previous location within the area. It follows that the 'pool' households have to be located whilst the 'mobile' households may be relocated.

12.1.2 The pool households are located by the formula:

$$H(LP)^h_{pi} = \sum_a \left\{ H(P)^h_{pa} \cdot \frac{H(XA)^h_{pi} \cdot \exp(\Delta V^h_{pi})}{\sum_i H(XA)^h_{pi} \cdot \exp(\Delta V^h_{pi})} \right\} \qquad (12.1)$$

where

$H(LP)^h_{pi}$ are the "pool" households of type h locating at i in period p;

$H(P)^h_{pa}$ are the "pool" of households type h to be located in area a in period p (resulting from the transition and migration model);

$H(XA)^h_{pi}$ is the expected number of households of zone i in available housing (new, vacant or vacated-by-mobile-households) during period p in zone i;

ΔV^h_{pi} is the change in utility of location of zone i influencing households type h locating in period p.

12.1.3 The number of located "mobile" households is found by summing the matrix of moves arriving, ie

$$H(LM)^h_{pi} = \sum_o H(LMR)^h_{poi} \qquad (12.2)$$

where

$H(LM)^h_{pi}$ is the mobile households type h located to zone i in the period p;

$H(LMR)^h_{poi}$ is the mobile households type h relocated from zone o to zone i.

12.1.4 Note that the relocation process is written in terms of moves from o to i.The numbers of moves are found by

$$H(LMR)^h_{poi} = H(M)^h_{po} \left\{ \frac{H(XA)^h_{pi}.\exp(\Delta V^h_{pi}).d^h_{poi}}{\sum_i H(XA)^h_{pi}.\exp(\Delta V^h_{pi}).d^h_{poi}} \right\} \qquad (12.3)$$

where

$H(LMR)^h_{poi}$ is the number of mobile households type h relocated from zone o to zone i;

$H(XA)^h_{pi}$ is the number of households type h in zone i "expected" to locate in period p (calculated from floorspace and floorspace changes);

ΔV^h_{pi} is the change in utility of location influencing households of type h locating in zone i during period p (the same value as for pool households);

d^h_{poi} is a deterrence function for households type h relocating from o to i in period p.

12.1.5 The cost of location is simply the rent multiplied by the space per unit activity:

$$c^h_{pi} = a^{hH}_{pi} .r^H_{pi} \qquad (12.4)$$

12.1.6 The change in utility of location is

$$\begin{aligned} \Delta V^h_{pi} = {} & \theta^{hC}_p (c^h_{pi} - c^h_{(tB(U,h))i}) \quad + \theta^{hA}_p (A^h_{ti} - A^h_{(tB(A,h))i}) \\ & + \theta^{hQ}_p (Q^h_{ti} - Q^h_{(tB(Q,h))i}) \quad + \theta^{hH}_p (a^{hH}_{pi} - a^{hH}_{(tB(U,h))i}) \end{aligned} \qquad (12.5)$$

12.1.7 Ignoring for a moment the time subscripts, the variables on the RHS are:

c^h_{pi} the cost of location for a household of type *h* choosing to locate in zone *i* in period *p* (see below);

A^h_{ti} the accessibility of zone *i* for a household of type *h* at time *t*;

Q^h_{ti} the quality of zone *i* for a household of type *h* at time *t* (i.e. the quality of housing);

a^{hH}_{pi} the floorspace per household which will be occupied by a household of type *h* choosing to locate in zone *i* in period *p* (see below).

12.1.8 The time subscripts are as follows:

p is the current time period;

t is the immediate previous year (i.e. data from the database at the beginning of the current period *p*);

tB(U,h) is the "before" year applicable for variable U for household type *h,* and likewise for variables *A* and *Q*.

12.1.9 The timelags defined by the time subscripts are implemented so that each household type is influenced by change

- in cost of location and floorspace/household, over a period of *N* years ending with the present period (and hence responding to the rents and densities which are being adjusted in the present run of the location model);
- in the other variables, over an equal period of *N* years from *N+1* years ago to one year ago.

12.1.10 The **cost of location** is the rent multiplied by the space per unit activity:

$$c_{pi}^{h} = a_{pi}^{hH} \,.r_{pi}^{H} \tag{12.6}$$

where the space per household is in turn calculated by:

$$a_{pi}^{hH} = q_{i}^{hH} \left[b_{p}^{hH} + \frac{\alpha_{p}^{hH} (y_{p}^{h} - b_{p}^{hH} \cdot r_{pi}^{H} - b_{p}^{hO})}{r_{pi}^{H}} \right] \tag{12.7}$$

where

q_i^{hH}	an adjustment factor, reconciling densities and rents in the base period)
y_p^h	income of households type h during period p
r_{pi}^H	rent per unit of housing floorspace.

12.1.11 The **distance-deterrence function** is a negative logistic function:

$$d_{poi}^{h} = \frac{\alpha_{p}^{h} + \exp(\beta_{p}^{h}.D_{oi} + k_{p}^{h})}{1 + \exp(\beta_{p}^{h}.D_{oi} + k_{p}^{h})} \tag{12.8}$$

where

D_{oi}	the distance from o to i;
$\alpha_p^h \;\; \beta_p^h \;\; k_p^h$	coefficients of the distance deterrence function for households type h in period p.

12.1.12 The inner loop in the solution of the model involves iterative adjustments of the rents r_{pi}^{H} until all households are located and the total floorspace occupied, summed over households in each zone, equals the non-vacant stock of housing in that zone. The outer loop is the adjustment of the vacant floorspace in response to rent changes.

12.2 Location model (iiii) incomes for variable-worker households

12.2.1 Household location is strongly influenced by household incomes, so these are documented first.

12.2.2 The household incomes (ie the average income of the households of a given type in a given zone) are calculated by the income model (MI12) based on the household type and the average number of workers per household (if any) in that household type in that zone.

12.2.3 The variable-worker approach includes:

- inputting household incomes as a minimum plus a marginal rate per worker;
- using these inputs to calculate the average income of each household activity in each zone based on the previous year's workers per household;
- using that calculated income in MC12; and
- using that calculated income in ML12 as the "expected income" for households moving to (or remaining in) that zone.

12.2.4 The household income y (for each zone and relevant activity) is calculated as $y = aw + b$, where a and b are input coefficients, and w is the workers-per-household in that zone and activity, calculated from the numbers of workers and of households read from the AVZN<><>.DAT file output for the previous year.

Household activity	Minimum income	Marginal income per worker
1	113.41	141.77
2	84.95	246.8
3	119.54	150.02
4	88.31	253
5	153.62	0
6	230.87	0
7	153.07	119.77
8	88.33	204.89
9	165.92	145.19
10	147.57	251.25

Household activity	Minimum income	Marginal income per worker
11	165.28	145.03
12	148.23	249.4
13	192.49	138.68
14	156.5	243.63
15	233.54	0
16	371.17	0
17	133.03	94.36
18	115.59	144.98
19	156.58	99.11
20	132.84	158.01

Table 12-1 Income calculations 2001

Unit: £/hhld/week, 2001

Source: analysis of Family Expenditure Survey data adjusted to TELMoS:07 household types

Note: household activities 5, 6, 15, and 16 are retired households and are defined elsewhere as not having workers; the marginal income per worker is therefore irrelevant but input as zero.

12.2.5 In setting up the model for forecasting, the rates of income growth for each type of household are input in the files UP1_<year><test>.INP. Note that the UP1 programs have to be run in advance of the model proper, as part of the process of preparing the inputs for a given scenario. The resulting "minimum income" and "additional income per worker" are shown in the ML12<><>.INP input files for each activity. Note also that if UP1 is used, only incomes will vary over time; if any other coefficients need to change from year to year, the ML12<><>.INP files need to be edited "manually".

12.3 Location model (i) household location: coefficients

12.3.1 The following tables show:

- the minimum floorspace per household and the proportions of remaining income spent on floorspace or on other goods and services;
- the coefficients on the cost of location, accessibility, housing quality and housing quantity (floorspace/household);
- the timelags on the "before" variables in the utility of location; and
- the distance deterrence coefficients.

12.3.2 The assumptions for calculations of minimum floorspace and coefficients were based upon previous modelling work and other research.. The Minimum floorspace, for each household type is calculated as a function of both floorspace and household income. The coefficients on floorspace and Other Goods sum to one.

Household activity	Minimum Floorspace	Coefficient on Space	Coefficient on Other Goods and Services
1	22.760	0.200	0.800
2	36.220	0.085	0.915
3	21.540	0.200	0.800
4	35.230	0.085	0.915
5	20.000	0.200	0.800
6	28.280	0.200	0.800
7	24.080	0.200	0.800
8	31.370	0.200	0.800
9	36.880	0.085	0.915
10	59.830	0.085	0.915
11	36.880	0.085	0.915
12	59.830	0.085	0.915
13	43.610	0.085	0.915
14	65.680	0.085	0.915
15	28.610	0.200	0.800
16	43.830	0.085	0.915
17	39.860	0.085	0.915
18	59.720	0.085	0.915
19	46.260	0.085	0.915
20	68.000	0.085	0.915

Table 12-2 Utility of Consumption parameters, households

Source: own judgement informed by analysis of Family Expenditure Survey data

Household activity	Coefficient on cost of location	Coefficient on Accessibility	Coefficient on Housing Quality	Coefficient on floorspace/hhld
1	-0.0648	-0.00720	0.10345	0.026035
2	-0.0648	-0.00720	0.60828	0.026035
3	-0.0648	-0.00720	0.05793	0.026035
4	-0.0648	-0.00720	0.57103	0.026035
5	-0.0648	0.00000	0.00000	0.026035
6	-0.0648	0.00000	0.31035	0.026035
7	-0.0648	-0.00360	0.15310	0.026035
8	-0.0648	-0.00360	0.42621	0.026035
9	-0.0648	-0.00360	0.63310	0.026035
10	-0.0648	-0.00360	1.49379	0.026035
11	-0.0648	-0.00360	0.63310	0.026035
12	-0.0648	-0.00360	1.49379	0.026035
13	-0.0648	-0.00360	0.88552	0.026035
14	-0.0648	-0.00360	1.71310	0.026035
15	-0.0648	0.00000	0.32276	0.026035
16	-0.0648	0.00000	0.89379	0.026035
17	-0.0648	-0.00180	0.74483	0.026035
18	-0.0648	-0.00180	1.48966	0.026035
19	-0.0648	-0.00180	0.98483	0.026035
20	-0.0648	-0.00180	1.80000	0.026035

Table 12-3 Utility of Location parameters, households

Source: own judgement informed by ScotTAG values of time, assumptions on willingness to pay for quality and quantity of housing, and adjustment to match reported values of accessibility.

Household activity	Timelag on utility of consumption	Timelag on other variables
1	-2	-3
2	-2	-3
3	-2	-3
4	-2	-3
5	-5	-6
6	-5	-6
7	-4	-5
8	-4	-5
9	-7	-8
10	-7	-8

Household activity	Timelag on utility of consumption	Timelag on other variables
11	-5	-6
12	-5	-6
13	-4	-5
14	-4	-5
15	-4	-5
16	-4	-5
17	-7	-8
18	-7	-8
19	-4	-5
20	-4	-5

Table 12-4 Timelags in household location model

Source: derived from proportions of households that have moved in past year (see 17.3.4 below)

Household activity	*Alpha*	*Beta*	*K*
All	0.001	-0.6	6.0

Table 12-5 Coefficients on distance deterrence

Source: adjusted to get a distribution of local move distances that is judged reasonable

12.4 Location model (ii) employment location: design

12.4.1 There is in effect a separate location/property market model for each floorspace type and for the employment activities that occupy that type of floorspace; there are no direct interactions between these location/property market models when they run in any one year.

12.4.2 The majority of employment location is a distribution of the "pool" of jobs of one activity to be located to the zones of one area in one year. Some employment is also redistributed from its initial location. Pool employment of employment activity *s* is located by:

$$E(LP)^s_{p(i\in a)} = E(P)^s_{pa} \cdot \frac{E^s_{ti} \cdot \left(\frac{F(A)^u_{pi}}{F(O)^u_{ti}} \right) \cdot \exp(\Delta V^s_{pi})}{\sum_{i\in a} \left\{ E^s_{ti} \cdot \left(\frac{F(A)^u_{pi}}{F(O)^u_{ti}} \right) \cdot \exp(\Delta V^s_{pi}) \right\}} \qquad (12.9)$$

and "mobile" activities are located by:

$$E(LM)^s_{p(i\in a)} = \left[\sum_{i\in a} E(M)^s_{pi}\right].\left\{\frac{E(M)^s_{pi}.\left(\frac{F(A)^u_{pi}}{F(M)^u_{pi}}\right).\exp(\Delta V^s_{pi})}{\sum_{i\in a}\left[E(M)^s_{pi}.\left(\frac{F(A)^u_{pi}}{F(M)^u_{pi}}\right).\exp(\Delta V^s_{pi})\right]}\right\} \quad (12.10)$$

where

$E(LP)^s_{pi}$ is the employment sector s located from the pool to zone i;

$E(P)^s_{p*}$ is the total "pool" of employment in sector s to be located;

$E(LM)^s_{pi}$ is mobile employment in sector s located to zone i;

$E(M)^s_{pi}$ is mobile employment in sector s initially located in zone i;

$F(A)^u_{pi}$ is available floorspace type u within which s can locate;

$F(O)^u_{ti}$ is previous occupied floorspace of type u; and

$F(M)^u_{pi}$ is space of type u previously occupied by employment (of any sector) now classified as "mobile".

12.4.3 In both cases, changes in distribution (compared with the previous distribution) tend to be strongly influenced by changes in the quantity of floorspace which landlords make available (which in general will vary as the rent changes) and rather less strongly by a utility term reflecting changes in cost and accessibility. The utility term is calculated as

$$\Delta V^s_{pi} = \theta^{sC}_p (c^s_{pi} - c^s_{(tB(U,s))i}) + \theta^{sA}_p (A^s_{(tA(A,s))i} - A^s_{(tB(A,s))i}) \quad (12.11)$$

12.4.4 The timelags here work in the same way as for households and again the variables c and A are cost of location and accessibility respectively. The cost of location is calculated as the space occupied per employee times the cost per unit of floorspace:

$$c^s_{pi} = a^{su}_{pi} \cdot c(L)^s_{pi} \quad (12.12)$$

12.4.5 The cost of location per unit floorspace is calculated as:

$$c(L)^s_{pi} = r^u_{pi}\left(1+\xi^s_{pi}+f^s_p\right)+g^s_{pi}+h^s_p \quad (12.13)$$

where:

ξ^s_{pi} is property tax for activity s as a proportion of rent;

f^s_p is other floorspace costs for activity s as a proportion of rent;

g^s_{pi} is fixed property tax for activity s;

h^s_p is fixed other floorspace costs for activity s.

12.4.6 Floorspace per unit activity is found as:

$$a_{pi}^{su} = a(\min)_{p}^{su} + \phi_{p}^{s} \cdot \left(a_{(p-1)i}^{su} - a(\min)_{p}^{su} \right) \cdot \left(\frac{c(L)_{pi}^{s}}{c(L)_{(p-1)i}^{s}} \right)^{\gamma^{s}} \qquad (12.14)$$

where:

a_{pi}^{su} units of floorspace type *u* occupied per worker in employment activity *s* in zone *i* at time *t+1*;

$a(\min)_{p}^{su}$ minimum floorspace type *u* per worker in employment activity *s* locating in period *p*;

φ_{p}^{s} (phi) proportional increase in the variable amount of space per job in activity *s* during period *p* (if rents remain constant);

$c(L)_{pi}^{s}$ is the cost per unit floorspace for locating activity *s* in zone *i* during period *p*;

γ^{s} elasticity of floorspace per employee with respect to rent per unit space.

12.4.7 Note that (like the rest of the location model) the increase factor φ_{p}^{s} applies only to mobile or pool employment; it does not affect the demand for space from immobile employment.

12.4.8 Note that the composition of these accessibility terms differs significantly across employment activities.

12.5 Location model (ii) employment location: coefficients

12.5.1 The coefficients of the employment location model are shown in Table 12-6.

12.5.2 The assumed elasticity of floorspace per worker is shown in Table 12-7.

12.6 Location model (iii) floorspace vacancy changes

12.6.1 There are two slightly different processes which can change the amount of floorspace left vacant.

12.6.2 The first and more usual process is that the level of vacancy changes from year to year in immediate response to the changes in rents. This is implemented by applying the elasticities to the **occupied** quantity of floorspace (ie these are in effect elasticities of supply, and are therefore positive), subject to the amount of floorspace occupied not exceeded the quantity physically existing at the time in question (after developments completed and demolition occurring in the year, and excluding all the floorspace occupied by immobile activities). The effect of this response is therefore that the vacancy rate, for any floorspace type in one zone, will increase from one year to the next if the rent falls over the same period, and will decrease (unless it was already zero) if the rent increases.

12.6.3 The second and exceptional process is in effect a safety net for the first. This is that a minimum value is defined for the rent of each type of floorspace: if the rent falls to this value, the model calculates the amount of floorspace occupied at this rent, and simply assumes that all remaining floorspace is left vacant. (By

definition of the short-term equilibrium which the model is trying to find for each floorspace type, the rent cannot fall to the minimum value if the floorspace that activities are attempting to occupy is greater than the available stock of floorspace in the zone.)

Employment activity	Coefficient on Cost of Location	Coefficient on Accessibility
31	-0.05000	-0.02830
32	0.00000	0.00000
33	-0.05000	-0.02830
34	0.00000	0.00000
35	-0.05000	-0.02830
36	0.00000	0.00000
37	-0.05000	-0.02830
38	-0.05000	-0.03635
39	-0.05000	-0.02830
40	-0.05000	-0.03635
41	-0.05000	-0.02830
42	-0.05000	-0.03635
43	-0.05000	-0.00237
45	-0.05000	-0.02830

Employment activity	Coefficient on Cost of Location	Coefficient on Accessibility
46	-0.05000	-0.03635
47	-0.05000	-0.03224
48	-0.05000	-0.02830
49	-0.05000	-0.03635
50	-0.05000	-0.02830
51	-0.05000	-0.02830
52	-0.05000	-0.02830
53	-0.05000	-0.02830
54	-0.05000	-0.03635
55	-0.05000	0.00170
56	-0.05000	-0.03390
57	-0.05000	-0.02830
58	-0.05000	-0.03635

Table 12-6 Coefficients of employment location model

Source: own judgement from previous modelling and other work

Employment activity	Elasticity
All	-1.00

Table 12-7 Elasticity of floorspace per worker with respect to cost

Source: own judgement

Space Category	Elasticity of occupied floorspace supply
1	0.500
2	0.500
3	0.500
4	0.500

Space Category	Elasticity of occupied floorspace supply
5	0.500
6	0.500
7	0.500

Table 12-8 Elasticity of available floorspace supply

Source: own judgement

13 EMPLOYMENT STATUS

13.1 Employment status model: functions

13.1.1 The employment status sub-model has three main functions:

- to convert employment by zone and sector into employment by zone and socio-economic group, i.e. to calculate the demand for labour in terms which can be related to the supply of labour (ie to the number of located households);
- to adjust the numbers of persons in work to match the current demand for labour, at the same time adjusting the travel-to-work matrices used within the land-use model in line with the changes in labour demand and supply; and
- to update the database for all categories of non-working persons.

13.1.2 The last of these steps deals with

- non-working, non-retired adults;
- children; and
- retired persons.

13.1.3 The changes in numbers of non-working, non-retired adults calculated within the employment submodel (program ME12), after the demographic, migration and location processes documented above, result entirely from adults gaining or losing jobs - if the number of residents in work increases, the number of non-working, non-retired adults must reduce to maintain the correct total population of that household type in the zone. The numbers of children and retired persons, in contrast, have nothing to do with employment status, but are calculated within the ME12 program simply because this is the one program in the DELTA model sequence which deals with persons rather than with households.

13.2 Convert employment

13.2.1 The absolute number of jobs by area and activity is determined by applying the rates of growth in numbers of workers by seg, area and sector as determined by the results of the REM. The distribution of these jobs is determined by the changes in job location (i.e. jobs by zone and activity) calculated in the location model. There are therefore no parameters to report in relation to this component.

13.3 Adjust residents-in-work and commuting: standard process

13.3.1 The application of the changes in jobs by zone and socio-economic group to residents and commuting is essentially a scaling process: in brief:

- the previous commuting matrices for each socio-economic group are adjusted in proportion to the changes in residents and car-ownership;
- they are then rescaled to match the current numbers of jobs;
- the numbers of residents in work are adjusted to match the numbers of workers being taken up by the commuting matrices; and
- if the supply of workers hits a constraint (eg the maximum number of non-working adults in work), that constraint is respected and the flows of workers from other zones are adjusted so as to obtain the required numbers of workers.

13.3.2 One significant enhancement to TELMoS:07 compared with previous versions is that the base commuting matrices have been derived from Census data rather than being synthesized. The preparation of these matrices was described earlier.

13.3.3 TELMoS:07, like previous versions of TELMoS, treats households of each activity as having variable numbers of workers. The maximum number of workers by household type is an input which obviously has to be consistent with the definition of the household composition. These maxima are shown in Table 13-1; households of retired persons have no workers by definition and are not listed.

Activity Group	Max Workers
Younger single person households Older single person households Single parent households	1
Younger couple no children Older couple no children	1.826
Couple with child(ren)	1.994
3+ adult households	3.18

Table 13-1 ME12 coefficients: maximum workers by household type

Source: derived from Census 2001 data

13.3.4 These inputs are held constant over time, though they could be varied as part of the demographic scenario.

13.4 Adjust residents-in-work and commuting: response to transport change

13.4.1 The intention in implementing TELMoS:07 was always to use a form of the ME12 employment status/commuting model which would respond to changes in generalised cost so as to make incremental adjustments to the pattern of commuting and the proportions of residents in work. Progress on this was hindered by major difficulties in getting the model to converge[7].

[7] An earlier version of ME12 with this direct response to generalised cost changes, which was intended to be used in TELMoS:07, and which had worked well in another DELTA application, was found not to be satisfactory when applied to the much larger and less open TELMoS situation.

13.4.2 The situation now (August 2009) is that the improved ME12 is still too slow in convergence to be used in every year of every TELMoS:07 run, as would be ideal, but it can be used in the years following transport model runs.

13.4.3 This version of ME12 essentially replaces the scaling processes described in the preceding section with explicit incremental logit models of whether-to-work and where-to-work. These can be jointly considered as a model of the competition between workers for the available jobs, and simultaneously of competition between employer organizations for the available supply of labour (by socio-economic level). The model is solved by iteratively adjusting a wage-like variable for each socio-economic level of workers in each zone until the numbers of potential workers living in each zone and choosing to work, and their choices of work zone, result in commuting patterns such that the numbers of workers working in each zone match the numbers of jobs there. Since the wage-like variable is critical to this (and serves the same function as rents in solving the location model), this version of the model is usually known as "wages-based ME12".

13.4.4 A major advantage of this form of model, compared with that based on iteratively scaling previous matrices, is that the key equations can be made explicit. That for where-to-work is an incremental logit distribution model in which the pattern of commuting is scaled by the changes in labour supply and labour demand, and adjusted in response to the changes in generalised costs (which are exogenous to this sub-model) and the changes in wages (which are endogenous to it)

$$W^{go}_{(t+1)ij} = W^{go}_{(t+1)i} \cdot \frac{\frac{W^{go}_{tij}}{W^{go}_{ti}} \cdot \frac{E^{g}_{pj}}{E^{g}_{tj}} \cdot \exp\left(\lambda^{g}_{p}\left[\Delta w^{g}_{j} - \Delta g^{go}_{ij}\right]\right)}{\sum_{j}\left\{\frac{W^{go}_{tij}}{W^{go}_{ti}} \cdot \frac{E^{g}_{pj}}{E^{g}_{tj}} \cdot \exp\left(\lambda^{g}_{p}\left[\Delta w^{g}_{j} - \Delta g^{go}_{ij}\right]\right)\right\}}$$

where

p is the period being modelled

$t, t+1$ are the times at the start and end of the period (corresponding to the previous database and that resulting from this model run)

i is the residential zone

j is the work zone

g is the socio-economic group

o is the car-ownership level

W^{go}_{ti} is the number of workers of socio-economic group g and car-ownership level o living in zone i at time t

W^{go}_{tij} is the number of such workers who worked in zone j

E^{g}_{tj} is the number of workers of socio-economic group g working in zone j at time t

λ^{g}_{p} is a coefficient measuring sensitivity of where-to-work choices to net

wages (ie wages less generalised cost of commuting)

Δw_j^g is the change in wages *compared with the value for time t,*

$$\Delta w_j^g = w_{pj}^g - w_{tj}^g$$

where

w_{pj}^g is the current wage (converted to generalised cost units) paid to workers of socio-economic group *g* working in zone *i,*

w_{tj}^g is the previous wage (converted to generalised cost units) paid to workers of socio-economic group *g* working in zone *i*; and

Δg_{ij}^{go} is the change in generalised costs of commuting from zone *i* to zone *j* for to workers of socio-economic group *g* and car-ownership level *o,* ie the period *p* value minus that at time *t:*

$$\Delta g_{ij}^{go} = g_{tij}^{go} - g_{(t-1)ij}^{go}$$

where

g_{tij}^{go} is the (scaled) generalised cost of commuting from zone *i* to zone *j* for workers of socio-economic group *g* and car-ownership level *o* at time *t*

$g_{(t-1)ij}^{go}$ is the (scaled) generalised cost of commuting from zone *i* to zone *j* for workers of socio-economic group *g* and car-ownership level *o* at time *t-1*

13.4.5 The whether-to-work model, which controls the present supply of workers from each zone, is of the form

$$\sum_o W_{pi}^{go} = \frac{N(\max)_{(t+1)i}^g}{1 + \left[\frac{N(\max)_{(t+1)i}^g - N(1)_{pi}^g}{N(1)_{pi}^g}\right].\exp\left(-\beta_p^g\left[\Delta\overline{w_{pi}^g} - \Delta\overline{g_{pi}^g}\right]\right)}$$

where

$N(\max)_{(t+1)i}^g$ is the maximum supply of workers of socio-economic group *g* from relevant households now living in zone *i*;

$N(1)_{pi}^g$ is the initial supply of workers of socio-economic group *g* from relevant households now living in zone *i* (assuming the same proportions of potential workers in work as at time *t*);

$-\beta_p^g$ is the sensitivity of labour supply to "net earnings" ie to wages less generalised costs of commuting;

$\Delta\overline{w_{pi}^g}$ is the change in the average wage for workers of socio-economic group *g* from relevant households now living in zone *i*, given the present wages and commuting pattern, compared with the wage in the previous year;

$\Delta\overline{g_{pi}^g}$ is the change in average generalised cost, similarly defined.

13.4.6 The model is solved by adjusting the values of w_{tj}^g until the numbers of potential workers who choose to work at all, and then choose to work in zone *j*, matches the

employment in zone *j*. The $N(\max)^{g}_{(t+1)i}$ term is calculated from the number of potential workers of socio-economic group *g* in relevant households living at *i*; the use of this term in the whether-to-work model ensures that the result of the employment status/commuting model is always consistent with the potential labour supply, though a lot of detailed calculation is required to convert the final values of W^{go}_{pi} , the number of persons in work by zone, car-ownership and socio-economic group, into the numbers of working residents by household type and car-ownership.

13.4.7 The where-to-work distribution coefficient λ^{g}_{p} is the same as that used in the accessibility calculations. The whether-to-work coefficient $-\beta^{g}_{p}$ is adjusted so that at the base levels of employment the elasticity of labour supply with respect to wages matches the elasticity of labour supply defined by the Department for Transport in its guidance on wider economic impacts (+0.1).

13.5 Non-working persons

13.5.1 The numbers of non-working adults are the difference between the actual numbers of residents working and the maximum working adults per household shown in Table 13-1 (ie the minimum number of non-workers is zero except in retired households). The definitions of the household activities are such that children and retired persons are found only in certain activities. The numbers of such persons by household composition are shown in Table 13-2.

Activity	Children	Retired
5	0	1
6	0	1
7	1.5027	0
8	1.4922	0
9	0	0.2537
10	0	0.2332
11	0	0.2775
12	0	0.27
13	1.6728	0.0415
14	1.6625	0.0393
15	0	2
16	0	2
17	0	0.2705
18	0	0.2588
19	1.2773	0.0424
20	1.269	0.0402

Table 13-2 Children and retired persons per household

Note: for activity codes see Table 3-2 Household activity definitions

Note that in activities 13, 14 and 17 to 20, ie 2 or more adults with children, one or more of the adults may be retired.

Household activities not listed have neither children nor retired persons.

Source: derived from Census 2001 data

13.5.2 These inputs are held constant over time, though they could be varied as part of the demographic scenario.

14 HOUSING QUALITY

14.1 Housing quality model

14.1.1 The sub-model is intended to represent the impact which residents have on the area in which they live, and hence the externality effects which residents have on each other. The specific hypothesis implemented is that quality is positively influenced by:

- residents with higher incomes (because they are more likely and better able to spend money on maintenance and improvement); and
- low levels of vacancy (because vacancy is associated with rapid decay and with vandalism).

14.1.2 The quality effect is important for representing the way in which virtuous or vicious circles of change – in general, positive feedback mechanisms - can operate in urban areas. The effect is assumed to be strong but gradual. The sub-model therefore works by:

- calculating the "eventual quality" towards which the area will tend, given the present average income and occupancy level; and
- adjusting the current quality part of the way towards that eventual quality.

14.1.3 If average income and vacancy rate remain constant in a zone, its actual quality will therefore be asymptotic to its eventual quality. Note that the impact of changing quality (the completion of the positive feedback loop) is dependent upon the coefficients in the utility of location function for households.

14.1.4 The quality variable itself is defined such that in the base year, a value of one represents "average quality", a value of 1.1 represents quality which attracts a 10% premium on rents or prices, etc.

14.1.5 The calculation assumes that eventual quality is a function of income and the occupancy rate, each raised to a power. The average income and occupancy for the study area were used, and it was assumed that quality rose proportionally with the occupancy rate, but was less sensitive to income. These assumptions were used to calculate the remaining coefficient, alpha. The resulting coefficients are shown in Table 14-1. These are input to the MQ12<><>.INP file.

Variable	Value
Alpha (constant)	0.061835
Beta (coefficient on income)	0.5
Gamma (coefficient on occupancy)	1.0

Table 14-1 Housing quality model: coefficients for eventual quality

Source: own judgement regarding effects of income and vacancy on quality

14.1.6 It is assumed that the change in quality in one year is one tenth of the difference between current quality and eventual quality. This specification is input to file MQ12<><>.INP.

14.1.7 Both the eventual quality coefficients and the rates of changes are assumed the same for all forecast years.

14.2 Quality of new housing

14.2.1 When exogenous development takes place, the quality of the new floor space that is being constructed must be specified.

14.2.2 For development taking place between 2002 and 2007, the quality of each zone in the model was calculated in 2001, and any development taking place in that zone would enter the model with a 10% premium over that 2001 quality. New homes in already higher quality zones will have an absolutely higher quality.

14.2.3 For exogenous development taking place 2008-2011, the quality premium was recalculated based upon the 2007 zonal qualities. This was to ensure that new development would still be developed at a quality premium over the existing stock in that zone. It is possible that the quality of some zones had risen above the premium specified for exogenous development.

14.2.4 Permissible development quality is calculated in a different way. Using a new model option, the quality of new permissible development is input as 1.1 times the existing quality, thus giving new floor space the 10% premium over existing stock as already discussed.

15 REGIONAL MODEL INPUT FILES

15.1 Introduction

15.1.1 Like the inputs to the urban level of DELTA, the inputs to the regional model are a mixture of scenario and behavioural coefficients. They are discussed here first in relation to the regional economic model, including its accessibility calculations, and then for the migration model.

15.1.2 This section describes the full REM which is run together with the urban model. It is run in this form from 2008 onwards. However there are two important distinctions between the REM for 2001-7 and the REM for 2008 onwards, namely;

- The REM is run as a stand-alone model for 2001-7 rather than being linked to the urban model; and
- Only the production and trade model programs are run for the 2001-7 period, these programs are PX12, MP12, PC12 and AA12. The investment model is not run.

15.1.3 Running these programs in isolation from the urban model whilst excluding the investment model (MK12) means that the link from the urban model to the REM exists but there is no link back from the REM to the urban model. This has allowed us to use the observed changes in employment as estimates of the changes in capacity whilst at the same time not over complicating the running of the constrained to observed data urban model by trying to impose REM outputs on it.

15.1.4 The regional economic model for the 2001-22 period has been calibrated using the population and GVA forecasts from the OEF 2006-based forecasts, whilst at the same time introducing a constraint so that by 2007 the levels of employment in the REM are broadly consistent with those forecast by the urban model. These forecasts were not available for the 2022-31 period, it was therefore decided that the economic growth rate after 2022 would be 1.9% per capita per annum.

15.2 Transport costs per unit of trade

15.2.1 The transport model measures the generalised costs of transport per unit of transport demand – for passenger travel per trip, and for goods movement, per vehicle. Program AC12 converts these costs into money costs for use in the REM. Program IT12 converts these costs per unit of transport demand into costs per unit of trade, ie into transport costs (in £M) per £M of trade.

15.2.2 To do this, inputs specify the number of goods vehicle and person movements needed to deliver each unit of trade from producer to consumer. These figures include business travel as well as goods movement.

15.3 Relationship of travel model purposes to freight model categories

15.3.1 There is one other input to IT12 which defines the relationship between the transport model freight purposes and the freight demand categories output by MF12. This information is used when MF12 uses the IT12 input ratios in the opposite direction, to convert trade flows into transport demands. These data are not relevant here, since the freight outputs from MF12 are currently not used elsewhere in the TMfS/TELMoS model.

15.4 Area accessibilities

15.4.1 Program AA12 calculates accessibility measures by area and sector, as input to the investment model. This program does not require any inputs of its own: the coefficients it uses in calculating accessibilities are the distribution coefficients of the trade model.

15.4.2 The area accessibilities output by AA12 are "size" measures rather than "cost" measures. Hence, in contrast with the majority of the urban model accessibilities,

- the values should always be positive values; and
- larger (more positive) values indicate better accessibilities.

15.4.3 The equations are of the form

$$A_{ta}^{s} = \sum_{z} W_{tz}^{s} \exp\left(\lambda_{t}^{s} c_{taz}^{s}\right) \qquad \textbf{(26)}$$

where

A_{ta}^{s} is the accessibility of area a for sector s (ie accessibility to the demand for sector s at time t;

W_{tz}^{s} is the demand for the outputs of sector s in area z at time t

c_{taz}^{s} is the cost of delivering one unit of s from a to z at time t

λ_{t}^{s} is the distribution coefficient of the trade model for s at time t.

15.5 Investment model inputs

15.5.1 The inputs to the investment model, MK12, are as follows:

- the depreciation rate, ie the proportion of capacity in each sector which expires in each year (see 15.5.3 below);
- the reference rate of total regional investment (see 15.5.4);
- the sensitivities to accessibility and cost change in allocating total investment to areas (see 15.5.5); and
- the expected level of employment per unit of capacity (see 15.5.6).

15.5.2 The depreciation rate and sensitivities to accessibility and cost change are assumed to be constant over time whereas the reference rate of total regional investment and the expected level of employment per unit of capacity have been adjusted in five year time periods so as to match the GVA and employment forecast.

Depreciation rate

15.5.3 The depreciation rates are input in the MK12 input file and are fixed at 10% per year for sectors 101 to 110.

Rate of total investment

15.5.4 The rates of total investment are also input here. They have been adjusted as part of the implementation of the economic scenarios so that GVA annual growth matches the forecast taking into account the depreciation rate.

Investment location coefficients

15.5.5 The investment location coefficients are contained in MKIN23 and are set to values of +0.5 on accessibility and –0.6 on cost of production for all sectors. The investment distribution models are of the form

$$K(N)^s_{pa} = K(N)^s_{p*} \frac{K^s_{ta} \cdot \left(\frac{A^s_{ta}}{A^s_{(tB)a}} \right)^{\lambda(A)^s_p} \left(\frac{c^s_{ta}}{c^s_{(tB)a}} \right)^{\lambda(c)^s_p}}{\sum_a \left[K^s_{ta} \cdot \left(\frac{A^s_{ta}}{A^s_{(tB)a}} \right)^{\lambda(A)^s_p} \left(\frac{c^s_{ta}}{c^s_{(tB)a}} \right)^{\lambda(c)^s_p} \right]} \qquad \textbf{(27)}$$

where:

$K(N)^s_{pa}$ is the additional capacity of sector *s* in area *a* resulting from investment during period *p*

$K(N)^s_{p*}$ is the total additional capacity of sector *s* resulting from investment in the modelled economy during period *p* (ie the product of the rate of total investment and the previous capacity)

K^s_{ta} is the existing capacity of sector *s* in area *a* at time *t*

A^s_{ta} is the accessibility of area *a* for sector *s* at time *t* (see above)

$A^s_{(tB)a}$ is the accessibility of area *a* for sector *s* at time *(tB)* (ten years before *t*)

c^s_{ta} is the cost of producing outputs of sector *s* in area *a* at time *t*

$c^s_{(tB)a}$ is the cost of producing outputs of sector *s* in area *a* at time *(tB)* (ten years before *t*)

$\lambda(A)^s_p$, $\lambda(c)^s_p$ are the coefficients for the distribution of investment.

Expected employment per unit of capacity

15.5.6 The expected numbers of jobs per unit of capacity are input into the MK12 input file. Given the assumption that capacity-related employment is white-collar employment, there are positive values for socio-economic group one and zero values for group two. These coefficients, together with those contained in the MP12 input file are used to control total employment across the modelled area so as to keep total employment in line with the targets.

15.6 Trade and production model inputs

15.6.1 The trade and production model, MP12, is a conventional spatial input model in which the key equations are of the form

$$T^s_{(t+1)ij} = Y^s_{(t+1)j}\left[1 - m^s_p\right]\frac{K^s_{(t+1)i}.\exp\left[-\lambda^s_t(p^s_{(t)i} + c^s_{Tij} + b^s_{(t+1)ij} + r^s_{ij})\right]}{\sum_i K^s_{(t+1)i}.\exp\left[-\lambda^s_t(p^s_{(t)i} + c^s_{Tij} + b^s_{(t+1)ij} + r^s_{ij})\right]} \qquad (28)$$

where:

$T^s_{(t+1)ij}$ is the trade in *s* from *i* to j at time *t+1*

$Y^s_{(t+1)j}$ is the total demand for *s* at *j*

m^s_p is the proportion of demand for *s* which is met by implicitly modelled imports in period *p*

$K^s_{(t+1)i}$ is the capacity of zone *i* to produce *s* at time *t+1*

$-\lambda^s_t$ is the distribution coefficient for *s* in period *p*

$p^s_{(t)i}$ is the production price of *s* at area i and time *t* – in TELMoS:07, set to 1

c^s_{Tij} is the cost of transporting one unit of *s* from *i* to *j* in the previous transport model year *T*

$b^s_{(t+1)ij}$ and r^s_{ij} are not used in TELMoS:07.

15.6.2 The total demand is the sum of:

- consumer final demand (calculated from household numbers and expenditure);
- government final demand (user-defined); and
- intermediate demand calculated by applying technical coefficients to the total production.

15.6.3 Hence:

$$Y^s_{(t+1)j} = Y(F)^s_{(t+1)j} + \sum_r a^{sr}_p.P^r_{(t+1)j} \qquad \textbf{(29)}$$

where

$$P^r_{(t+1)i} = \sum_j T^r_{(t+1)ij} \qquad \textbf{(30)}$$

15.6.4 The co-efficients used in the trade and production model itself (program MP12) are also applied when:

- calculating consumer final demand from urban model outputs (program PX12);
- calculating the costs of occupied floorspace from urban model outputs (program PC12);

- converting area-level trade to zone-level transport demand; and
- calculating area-level accessibilities for use in the investment location model (program AA12).

15.6.5 The last two of these are at least partly a reuse of coefficients which are used within MP12 itself. The other cases simply reflect a reluctance to create additional, separate input files for each of the "data-processing" programs.

15.6.6 The following trade and production model inputs are used in TELMoS:07:

- scaling factors to convert consumer expenditure to final demand by sector;
- value-added per unit of production by sector;
- sensitivities of trade to cost;
- input-output coefficients (including demand for imports);
- expected employment per unit production; and
- scaling factors for space costs.

15.6.7 The expected employment per unit production changes and the input output coefficients change from year to year, as explained below. All other inputs are assumed constant over time.

Convert consumer expenditure to final demand

15.6.8 These are contained in the MP12 input file. They have been calibrated for 2001 such that they will convert total household expenditure (all households, Scotland model total) to the consumer final demand by sector reported in Scottish Economic Statistics 2005.

Value-added per unit of production

15.6.9 These values are input into MPIN01 and were derived from Scottish Economic Statistics 2005. The coefficients, for each sector, are equal to the ratio of that sectors gross value added at basic prices to that sectors output at basic prices.

Sensitivities of trade to cost, and accessibility constants

15.6.10 These coefficients are the result of direct calibration of the DELTA model itself. Trade distances have been calibrated by adjusting the cost parameter coefficients the MP12 input file. Table 15-1 shows both target and model trade distances. For some sectors the target trade distance was smaller than the intra-area distances contained in the MMDS file, where this was the case the trade distance in the model is slightly higher than desired. Target distances for goods movement were based on average lengths of haul estimated in previous Scottish projects. Those for services were based more on business trip distances.

REM Sector	Target Distance	Model Distance
101	74	74.7
102	45	45.0
103	78	75.7

REM Sector	Target Distance	Model Distance
104	45	45.0
105	30	30.1
106	13	20.0
107	30	30.1
108	25	25.0
109	11	19.8
110	11	20.1

Table 15-1 Trade distance calibration

Input-output coefficients

15.6.11 The technical coefficients of the conventional input-output model are input into the MP12 input file. For 2001-12 they were derived from the inter-sector trade statistics in Scottish Economic Statistics 2005.

15.6.12 From 2013 onwards the input output coefficients are allowed to vary in order to match the forecast employment and GVA scenario.

15.6.13 Imports are treated as special sectors within the definition of the REM.

Expected employment per unit production

15.6.14 The ratios of expected employment per unit production are input into MPINP5. These were estimated so as to reconcile the economic scenario in monetary terms with the employment scenario in terms of numbers of jobs. These ratios have been adjusted in five year steps so as to match the employment scenario.

Scaling factors for space costs

15.6.15 These are simple conversion factors to scale space costs from the units of rent (£/week) to the REM units (£M/year).

15.7 Freight model MF12

15.7.1 The freight model, MF12, estimates goods vehicle movements for each zone pair from the area-to-area trade patterns calculated in the regional economic model. The process of producing the matrices

- takes the area-to-area trade matrices output from MP12;
- disaggregates these into zone-to-zone matrices using the zonal distribution of the relevant employment categories as the basis for disaggregation;
- converts the matrices into vehicle movements using the same coefficients used to scale transport costs from per-trip to per-unit-of-trade (see 15.2 above); and
- aggregates the resulting matrices by trade and vehicle type into two matrices, simply by vehicle type.

15.7.2 The calculations include an allowance for delivery vehicles returning empty.

15.8 Migration model inputs

15.8.1 The migration model is influenced by:

- the total number of households in the origin area;
- the "push" factor for the origin area;
- the deterrence factor of the origin-to-destination distance;
- the total number of households in the destination area;
- the "pull" factor for the destination area; and
- an overall scaling factor.

15.8.2 It is of the form

$$M(U)^{hs}_{paz} = H^{h}_{ta}.v(O)^{hs}_{pa}.d^{hs}_{paz}.H^{h}_{tz}.v(D)^{hs}_{pz}.s^{hs}_{p} \qquad \textbf{(6)}$$

where:

$M(U)^{hs}_{paz}$	is the migration of households type *h* in stream *s* from area *a* to area *z* during period *p* (before considering constraints)
H^{h}_{ta}	is the total number of households of type *h* in area *a* at time *t*
$v(O)^{hs}_{pa}$	is the origin area *a* push factor for stream *s* migration of households *h* in period *p*
d^{hs}_{paz}	is the deterrence effect of distance from *a* to *z* for stream *s* migration of households *h* in period *p*
H^{h}_{tz}	total households of type *h* in area *z* at time *t*
$v(D)^{hs}_{pz}$	origin area *z* pull factor for stream *s* migration of households *h* in period *p*
s^{hs}_{p}	a scaling factor for overall level of migration of households *h* in period *p*.

15.8.3 The following inputs are defined for each year:

- distance controls on the migration stream;
- distance deterrence effect, and scaling of the migration flow; and
- weights on the different variables affecting migration.

15.8.4 The input file can also be used to specify constraints by activity group and area. This feature is not normally used in forecasting.

Distance controls on the migration stream

15.8.5 This used to specify that

- the minimum distance for the modeled migration stream (Stream 2) is zero (ie migration is modeled between all area pairs, no matter how close together); and
- the distance for full effect of the modeled migration flow is 40Km.

Distance deterrence and scaling of migration

15.8.6 The model takes inputs for different household categories to specify

- the deterrence effect of distance; and
- the scaling of the migration flows.

15.8.7 The deterrence coefficient is to be adjusted.

15.8.8 The scaling factor has different values by household type, which were estimated so as to obtain a reasonable mixture of migrants by age.

Weights on variables affecting migration

15.8.9 This input takes a set of coefficients to weight the migration-influencing variables as "push" and "pull" factors. It seems reasonable to expect that the "push" and "pull" factors are the same variables with opposite signs, and this condition has been imposed in applying the model. The factors and corresponding coefficients are assumed to be the same for all household types.

15.8.10 The "push" and "pull" variables are

- the proportion of working-age residents in work, for the socio-economic group to which the household type belongs;
- the average rent of housing floorspace; and
- the population density variable defined in section 6.3.

15.8.11 The proportion of working-age residents in work is a negative "push" variable and a positive "pull" variable, so that households tend to move from areas with lower probabilities of being in work to those with higher probabilities.

15.8.12 The average rent is a (weak) positive "push" and negative "pull", so that it tends to discourage moves from low to high rent areas and conversely to encourage moves from high to low rent areas.

15.8.13 The population density has different effects for different households types:

- for young singles and young couples without children it is a negative "push" and positive "pull", ie these households are attracted to higher densities;
- for older households, it has the opposite effect, if these households are attracted to lower densities – representing the tendency for families with children, and older households, to move from urban to suburban or rural areas.

16 DELTA/TMFS:07 INTERFACE

16.1 Introduction

16.1.1 The interface between TELMoS:07 and TMfS:07 is the same as in the previous versions.

16.1.2 An automated interface is being developed to have the model running on one PC.

16.1.3 This chapter documents the interface programs and files through which DELTA passes information to TMfS:07. The interface in the opposite direction is defined by the generalised cost files documented in Section 6.5 of this report..

16.2 Interface definition file

16.2.1 The interface definition file is used to specify a miscellany of information used in the DELTA/transport interface programs, including:

- information regarding the aggregation of the DELTA socio-economic groups;
- links between floorspace category and relevant TMfS journey purposes (notably shopping and education); and
- .links between TELMoS activities and TMfS freight demand.

16.3 Interface programs and files

16.3.1 TELMoS:07 uses a program, ITMFS, to tabulate DELTA outputs in the formats required by TMfS:07. This outputs two files:

- TMfS<><>.CSV, containing zonal information on persons by person and household type; and
- TAV_<><>.CSV, containing zonal information on households and on employment in selected aggregations of sectors.

16.3.2 In addition the synthesized matrix of freight vehicle movements is passed from DELTA to TMfS:07.

17 SCENARIO INPUTS

17.1 Introduction

17.1.1 The purpose of this chapter is to identify those elements of the inputs which are typically regarded as defining the scenario within which strategies are being tested, and to point out some of the linkages between the various scenario inputs and between these inputs and other modelled variables.

17.1.2 For convenience we classify the scenario inputs into:

- the economic scenario;
- the socio-demographic scenario; and
- other elements.

17.1.3 The "other" category includes variables which bring together aspects of both the economic and socio-demographic inputs.

17.2 The economic scenario

17.2.1 TELMoS:07's economic scenario is constrained to Oxford Economics' 2006-based National Forecasts for the 2001-22 period. These were commissioned, on behalf of Transport Scotland and were used to support the Strategic Transport Project Review.

17.2.2 The forecasts were provided for total employment and gross value added. The TELMoS:07 regional economic model has been calibrated for the time periods, 2001-7, 2008-12, 2013-17, 2018-22, 2023-27 and 2028-32. Since no forecast was provided for 2007, the 2004 and 2010 (or 2012 for GVA) forecasts were interpolated to provide a 2007 target.

17.2.3 The employment forecasts are shown in Table 17-1 and the GVA forecasts are shown in Table 17-2 .

	2004	2010	2012	2017	2022
Primary and Utilities	73501	63088	59456	49198	43212
Traditional Manufacturing	184253	146037	136533	109897	94641
Advanced Manufacturing	51724	43196	40421	32635	28165
Construction	126539	126534	126519	126496	126507
Wholesale/Retail	371141	373593	371983	367227	364155
Hotels and Catering	171152	174692	174835	189930	197947

	2004	2010	2012	2017	2022
Transport and Communications	127493	132652	133270	135151	136442
Financial and Business Services	418927	468142	479323	513721	537793
Public Services, Health and Social Work	680160	715674	724888	752993	772348
Other service activities	125693	129619	129919	130840	131485
Total	2330583	2373227	2380746	2408088	2432694

Table 17-1 Employment Forecast

	2004	2012	2017	2022
Primary and Utilities	4620	5001	5209	5755
Manufacturing	12446	13410	13568	14842
Construction	4712	5102	5454	5815
Wholesale/Retail, Hotels	12654	14861	17708	20119
Transport and Communications	5675	7650	8891	10180
Financial and Business Services	16873	22948	27635	32380
Public Services, Health and Social Work	17806	19243	21078	22576
Other service activities	3914	4740	5223	5722
FSIM	-3502	-4405	-5099	-5829
Total	75199	88550	99666	111531

Table 17-2 GVA Forecast

17.2.4 TELMoS:07's economic growth rate beyond 2022 is assumed as 1.9% per capita per annum. The GDP growth rate of 1.9% per annum per capita gives a total growth in the economy of approximately 22% over the decade 2022-2032.

17.2.5 All sectors of the economy are assumed to grow equally during that decade. The input-output coefficients (defining the relationships between sectors within the Scottish economy) are constant and the growth will therefore be driven by growth in final demand.

17.2.6 During that decade productivity also grows at 1.9% per annum, marginally less than the "usual" 2% pa. This implies that employment growth will be in proportion to population growth.

17.2.7 The main components of the overall economic scenario which are input into the regional economic model are:

- the annual totals of non-consumer final demand (see 7.5);
- the technical coefficients of the input-output model (see 15.6);

- the productivity assumptions in the production and capacity models (see 15.4.3 and 15.6); and
- household incomes in the urban model (see 15.6).

17.2.8 Note that the household income inputs, in combination with all the factors affecting employment status, generate the consumer component of final demand and hence play a significant part in determining the overall level of economic activity.

17.2.9 Other components of the economic scenario include:

- development costs per unit floorspace, for the Fully Modelled Area in general and (optionally) by zone (in the development model – see 15.6).

17.2.10 The non consumer final demand is shown in Table 17-3 and Table 17-4 .

REM Sector	2007	2012	2017	2022	2027	2031
101: Agriculture, forestry and fishing	1254.0	1303.2	1360.6	1505.3	1653.8	1783.2
102: Mining	2429.5	2550.5	2670.8	2954.5	3246.1	3499.9
103: Manufacturing	29418.5	30412.8	30003.2	32527.1	35736.3	38531.2
104: Energy and water	862.4	778.5	736.3	754.9	829.1	894.4
105: Construction	257.9	141.2	94.0	47.1	51.7	55.8
106: Distribution and catering	5215.6	6041.5	6580.1	7810.9	8445.3	8974.5
107: Transport and communication	5820.4	7288.8	8965.4	10328.9	11347.7	12235.8
108: Finance and business	10576.4	15348.3	16400.4	17288.9	18992.0	20480.1
109: Public Administration	1503.7	1222.9	1126.0	1048.2	1150.6	1241.9
110: Other services	88.6	87.6	71.1	60.9	66.7	72.1

Table 17-3 Exports by sector (£m)

Source: data from Scottish Economic Statistics adjusted to match target economic scenario

REM Sector	2007	2012	2017	2022	2027	2031
101: Agriculture, forestry and	105.2	110.7	115.9	127.9	140.5	151.5

REM Sector	2007	2012	2017	2022	2027	2031
fishing						
102: Mining	43.9	46.2	48.4	53.4	58.6	63.3
103: Manufacturing	695.8	730.0	742.7	811.7	891.8	961.5
104: Energy and water	16.2	17.0	17.2	19.0	20.9	22.5
105: Construction	6142.1	6463.6	6810.7	7187.5	7896.8	8514.3
106: Distribution and catering	442.0	489.4	632.9	720.8	791.9	853.8
107: Transport and communication	130.5	157.5	183.4	209.9	230.6	258.6
108: Finance and business	1039.0	1260.9	1681.4	2110.5	2318.8	2500.1
109: Public Administration	21006.6	22080.3	24279.0	25795.7	28341.2	30557.3
110: Other services	1.2	1.3	1.4	1.6	1.8	1.9

Table 17-4 Government Expenditure by sector (£M)

Source: historic data from Scottish Economic Statistics adjusted to match target economic scenario

17.2.11 The coefficients of the regional economic model that generate the economic scenario are listed in Table 17-5 .

REM Sector	Conversion Factor Household Expenditure to final Consumer Demand	Coefficients for value added per unit of production	Coefficients for Sensitivities of trade to cost
101: Agriculture, forestry and fishing	3.01E-07	0.309195	-4.5
102: Mining	2.73E-08	0.449912	-27.864
103: Manufacturing	2.71E-06	0.32081	-0.5
104: Energy and water	2.51E-06	0.322037	-10.316
105: Construction	3.40E-07	0.437703	-19.148
106: Distribution and catering	2.52E-05	0.571133	-73.0
107: Transport and communication	3.68E-06	0.443512	-29.313
108: Finance and business	1.53E-05	0.473967	-21.367

REM Sector	Conversion Factor Household Expenditure to final Consumer Demand	Coefficients for value added per unit of production	Coefficients for Sensitivities of trade to cost
109: Public Administration	7.54E-06	0.528365	-12.5
110: Other services	1.17E-06	0.798086	-9.6

Table 17-5 REM Coefficients

Sources:

(i) conversion factor calculated so that synthesized 2001 household consumption matches totals in Scottish Economic Statistics

(ii) coefficients for VA derived from Scotland total data in Scottish Economic Statistics (total VA by sector)

(iii) sensitivities of trade to trade cost adjusted to match estimated trade distances in 2001, the distances being derived from data in Transport Statistics GB adjusted to Scotland (as shown in Table 15-1).

17.2.12 The input output coefficients used for generating the economic scenario are shown in Table 17-6 to Table 17-9 below.

	Producing Sector									
Supply Sector	101	102	103	104	105	106	107	108	109	110
101	0.217548	0.000708	0.031726	0.000176	0.001572	0.00511	0.001027	0.000641	0.000513	0
102	0.000601	0.019115	0.008764	0.023003	0.013099	0.000652	0.000342	0.000732	0.000392	0
103	0.102464	0.024071	0.075875	0.007726	0.068427	0.036967	0.041167	0.034731	0.032438	0.020096
104	0.009916	0.005664	0.009501	0.431255	0.001572	0.010981	0.004878	0.006958	0.008721	0.000957
105	0.012921	0.020531	0.000928	0.006848	0.198051	0.003588	0.005306	0.032717	0.015993	0.000957
106	0.05018	0.017699	0.02531	0.00878	0.012889	0.020169	0.013352	0.009949	0.011044	0.003828
107	0.036358	0.054867	0.012013	0.006497	0.009012	0.04523	0.097398	0.058078	0.013579	0.013397
108	0.0622	0.193982	0.0409	0.076734	0.127738	0.103126	0.056402	0.225417	0.07239	0.11866
109	0.012019	0.002124	0.003877	0.007375	0.002829	0.003099	0.004878	0.023958	0.184611	0.01244
110	0.003005	0	0.0000273	0.000176	0.000314	0.001033	0.001455	0.005158	0.003742	0.013397
111	0.08688	0.025706	0.143515	0.076044	0.054422	0.033593	0.055594	0.016419	0.014064	0.000688
112	0	0.061593	0.220117	0	0.013727	0	0	0	0	0
113	0.058894	0	0	0.000878	0	0	0	0	0	0
114	0.041426	0.098541	0.092957	0.016143	0.029409	0.101226	0.182937	0.06989	0.069129	0.005054
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0.039141	0.043393	0.008179	0.027399	0

Table 17-6 Input Output Coefficients 2001 – 2012

Source: calculated from total quantities reported in Scottish Economic Statistics, plus estimates to disaggregate imports

	Producing Sector									
Supply Sector	101	102	103	104	105	106	107	108	109	110
101	0.217548	0.000708	0.031726	0.000176	0.001572	0.00511	0.001027	0.000641	0.000513	0
102	0.000601	0.019115	0.008764	0.023003	0.013099	0.000652	0.000342	0.000732	0.000392	0
103	0.102464	0.024071	0.075875	0.007726	0.068427	0.036967	0.041167	0.034731	0.032438	0.020096
104	0.009652	0.005513	0.009249	0.419794	0.00153	0.010689	0.004748	0.006773	0.008489	0.000932
105	0.012729	0.020226	0.000914	0.006746	0.195113	0.003535	0.005227	0.032232	0.015756	0.000943
106	0.054643	0.019273	0.027561	0.009561	0.014035	0.021963	0.01454	0.010834	0.012026	0.004168
107	0.036358	0.054867	0.012013	0.006497	0.009012	0.04523	0.097398	0.058078	0.013579	0.013397
108	0.068834	0.214673	0.045263	0.084919	0.141363	0.114126	0.062418	0.249461	0.080111	0.131317
109	0.012019	0.002124	0.003877	0.007375	0.002829	0.003099	0.004878	0.023958	0.184611	0.01244
110	0.003005	0	0.000027	0.000176	0.000314	0.001033	0.001455	0.005158	0.003742	0.013397
111	0.08688	0.025706	0.143515	0.076044	0.054422	0.033593	0.055594	0.016419	0.014064	0.000688
112	0	0.061593	0.220117	0	0.013727	0	0	0	0	0
113	0.058894	0	0	0.000878	0	0	0	0	0	0
114	0.041426	0.098541	0.092957	0.016143	0.029409	0.101226	0.182937	0.06989	0.069129	0.005054
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0.039141	0.043393	0.008179	0.027399	0

Table 17-7 Input Output Coefficients 2013 – 2017

Source: 2001-12 values adjusted to match economic scenario, including changes in exports

	Producing Sector									
Supply Sector	101	102	103	104	105	106	107	108	109	110
101	0.217548	0.000708	0.031726	0.000176	0.001572	0.00511	0.001027	0.000641	0.000513	0
102	0.000601	0.019115	0.008764	0.023003	0.013099	0.000652	0.000342	0.000732	0.000392	0
103	0.102464	0.024071	0.075875	0.007726	0.068427	0.036967	0.041167	0.034731	0.032438	0.020096
104	0.009652	0.005513	0.009249	0.419794	0.00153	0.010689	0.004748	0.006773	0.008489	0.000932
105	0.012552	0.019945	0.000901	0.006652	0.192402	0.003486	0.005154	0.031784	0.015537	0.00093
106	0.054643	0.019273	0.027561	0.009561	0.014035	0.021963	0.01454	0.010834	0.012026	0.004168
107	0.036358	0.054867	0.012013	0.006497	0.009012	0.04523	0.097398	0.058078	0.013579	0.013397
108	0.073796	0.230147	0.048526	0.09104	0.151553	0.122352	0.066917	0.267442	0.085885	0.140782
109	0.011934	0.002109	0.00385	0.007323	0.002809	0.003077	0.004844	0.023789	0.183308	0.012352
110	0.002946	0	0.000026	0.000173	0.000308	0.001013	0.001427	0.005057	0.003669	0.013136
111	0.08688	0.025706	0.143515	0.076044	0.054422	0.033593	0.055594	0.016419	0.014064	0.000688
112	0	0.061593	0.220117	0	0.013727	0	0	0	0	0
113	0.058894	0	0	0.000878	0	0	0	0	0	0
114	0.041426	0.098541	0.092957	0.016143	0.029409	0.101226	0.182937	0.06989	0.069129	0.005054
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0.039141	0.043393	0.008179	0.027399	0

Table 17-8 Input Output Coefficients 2018 – 2022

Source: 2013-17 values adjusted to match economic scenario, including changes in exports

	Producing Sector									
Supply Sector	101	102	103	104	105	106	107	108	109	110
101	0.217548	0.000708	0.031726	0.000176	0.001572	0.00511	0.001027	0.000641	0.000513	0
102	0.000601	0.019115	0.008764	0.023003	0.013099	0.000652	0.000342	0.000732	0.000392	0
103	0.102464	0.024071	0.075875	0.007726	0.068427	0.036967	0.041167	0.034731	0.032438	0.020096
104	0.009652	0.005513	0.009249	0.419794	0.00153	0.010689	0.004748	0.006773	0.008489	0.000932
105	0.012552	0.019945	0.000901	0.006652	0.192402	0.003486	0.005154	0.031784	0.015537	0.00093
106	0.054643	0.019273	0.027561	0.009561	0.014035	0.021963	0.01454	0.010834	0.012026	0.004168
107	0.036358	0.054867	0.012013	0.006497	0.009012	0.04523	0.097398	0.058078	0.013579	0.013397
108	0.073796	0.230147	0.048526	0.09104	0.151553	0.122352	0.066917	0.267442	0.085885	0.140782
109	0.011934	0.002109	0.00385	0.007323	0.002809	0.003077	0.004844	0.023789	0.183308	0.012352
110	0.002946	0	0.000026	0.000173	0.000308	0.001013	0.001427	0.005057	0.003669	0.013136
111	0.08688	0.025706	0.143515	0.076044	0.054422	0.033593	0.055594	0.016419	0.014064	0.000688
112	0	0.061593	0.220117	0	0.013727	0	0	0	0	0
113	0.058894	0	0	0.000878	0	0	0	0	0	0
114	0.041426	0.098541	0.092957	0.016143	0.029409	0.101226	0.182937	0.06989	0.069129	0.005054
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0.039141	0.043393	0.008179	0.027399	0

Table 17-9 Input Output Coefficients 2023 – 2032

Source: 2018-22 values adjusted to match economic scenario, including changes in exports

17.3 The demographic scenario

17.3.1 The total number of households and population within TELMoS:07 are constrained so that its demographic trends are consistent, at the national level with GRO(S) mid-year estimates for the period 2001-2007 and with population forecasts for the period of 2008-2032.

17.3.2 The demographic scenario is defined (for the Modelled Area, ie Scotland, in total) by:

- the household formation/transition/dissolution rates and the rates of migration to and from Scotland, as defined in 10.1;
- the numbers of persons per household, controlled by inputs to ME12; and
- the non-household population defined in 5.6 (which is assumed constant in location and numbers).

17.3.3 The tables below show the rates of formation, transition and dissolution, respectively for the periods of 2001-2006 and 2007-2032. These rates are input in various blocks of the MT12<><>.INP files.

Households generating formation	Formation rate: 2001-6	Formation rate: 2007-32	New households generated by this formation
Single parent + children	0.097972	0.106464	Young Single
Single parent + children	0.019575	0.021272	Older single
Young couple no children	0.001885	0.003195	Young Single
Older couple no children	0.000050	0.003281	Older single
Couple + children	0.012184	0.016746	Young Single
Couple + children	0.000001	0	3 Adults no children
3 Adults no children	0.054907	0.051021	Young Single
3 Adults + children	0.145226	0.118112	Young Single

Table 17-10 Formation rates 2002 – 2006 and 2007-32

Source for 2002-6: previous analysis of BHPS and other data, adjusted to match reported observed changes (Scotland totals). Source for 2007-32: 2001-6 values (above), further adjusted to match reported scenario (Scotland totals)

Households undergoing transition	Transition rate: 2002-6	Transition rate: 2007-32	Households type after this transition
Young Single	0.148281	0.150489	Older single
Young Single	0.106735	0.078273	Single parent + children
Young Single	0.016400	0.000994	Young couple no children
Older single	0.166796	0.169734	Retired single
Older single	0.008531	0.000954	Older couple no children
Retired single	0.035855	0.048593	Couple retired
Single parent + children	0.078396	0.085191	Older single
Single parent + children	0.066871	0.042743	Couple + children

Households undergoing transition	Transition rate: 2002-6	Transition rate: 2007-32	Households type after this transition
Young couple no children	0.001885	0.003195	Young Single
Young couple no children	0.005231	0.039637	Couple + children
Young couple no children	0.002020	0.011835	Older couple no children
Older couple no children	0.000050	0.003281	Older single
Older couple no children	0.000129	0.000029	Couple retired
Couple + children	0.005271	0.003381	Single parent + children
Couple + children	0.003616	0.007677	Older couple no children
Couple + children	0.003381	0.000029	3 Adults no children
Couple + children	0.035676	0.041971	3 Adults + children
Couple retired	0.050066	0.050066	Retired single
3 Adults no children	0.031423	0.030613	Older couple no children
3 Adults no children	0.001532	0.000008	Couple retired
3 Adults + children	0.070222	0.087604	Couple + children
3 Adults + children	0.038641	0.000955	3 Adults no children

Table 17-11 Transition rates 2002 – 2006 and 2007-32

Source, 2002-6: previous analysis of BHPS and other data, adjusted to match reported observed changes (Scotland totals). Source, 2007-32: 2001-6 values (above), further adjusted to match reported scenario (Scotland totals)

Household type	Dissolutions	Departures	Arrival/Departure
Young Single	0.017210	0.087766	2.260597
Older single	0.015819	0.058511	1.032154
Retired single	0.085921	0.043883	0.905921
Single parent + children	0.031242	0.009417	0.408905
Young couple no children	0.000000	0.006519	1.896978
Older couple no children	0.000000	0.099671	0.801132
Couple + children	0.012975	0.002468	0.624183
Couple retired	0.000000	0.022954	0.902999
3 Adults no children	0.000000	0.002361	1.492292
3 Adults + children	0.000000	0.032995	0.388424

Table 17-12 Dissolution, departure and arrival/departure rates 2001 – 2006

Source: previous analysis of BHPS and other data, adjusted to match reported observed changes (Scotland totals)

Household type	Dissolutions	Departures	Arrival/Departure
Young Single	0.001804	0.010000	10.256860
Older single	0.008242	0.010000	1.201121
Retired single	0.098659	0.004255	0.000000
Single parent + children	0.019970	0.018139	0.000000
Young couple no children	0.000000	0.010000	5.247053
Older couple no children	0.000000	0.022593	0.000000
Couple + children	0.015264	0.004036	0.000000
Couple retired	0.000000	0.001238	0.000000
3 Adults no children	0.000000	0.010000	1.427019
3 Adults + children	0.000000	0.031710	0.000000

Table 17-13 Dissolution, departure and arrival/departure rates 2007 – 2032

Source: 2001-6 values (above), further adjusted to match reported scenario (Scotland totals)

17.3.4 The rates of additional mobility are shown below. These do not affect the overall demographic scenario, but are included here since they applied by the MT12 program in conjunction with the formation, transition, dissolution etc rates that do define the scenario.

Activity	Household type	Additional mobility rate
1	Single adult younger (16-44), manual	0.0400
2	Single adult younger (16-44), non-manual	0.1000
7	Single adult parent (16-74, with children), manual	0.1000
8	Single adult parent (16-74, with children), non-manual	0.1133
9	2 adults household younger (both 16-44), at least one non-retired, no children, manual	0.1000
10	2 adults household younger (both 16-44), at least one non-retired, no children, non-manual	0.2318
11	2 adults household older (one or both 45+), at least one non-retired, no children, manual	0.1000
12	2 adults household older (one or both 45+), at least one non-retired, no children, non-manual	0.2318
13	2 adults household with children, manual	0.1326
14	2 adults household with children, non-manual	0.1326

Table 17-14 Additional mobility rates

Source: estimated so that the proportion of households of each type mobile in one year matches data on household mobility by type from the Survey of English Housing.

Note: for household types not shown the rate of additional mobility is zero, ie they are mobile only if newly-formed, newly-transitioned from another household type, or newly-migrated.

17.4 Other scenario variables

17.4.1 Income growth is defined as the proportional increase in income per household in each year. This is normally specified in the UP1_<><>.INP file which is used in program UP1 to prepared the ML12<><>.INP files read by ML12 and MC12 (see

12.2.5 above). The growth factor is applied both to the minimum income per household and the marginal income per worker.

17.4.2 The household income growth rates applied in the present scenario are shown below. These apply to all household types, ie it is assumed that the relative incomes of different households types will remain constant so long as their numbers of persons in work remain constant.

Model years	Growth factor
2002-2007	1.02
2008-2012	1.01482
2013-2017	1.01786

Model years	Growth factor
2018-2022	1.01902
2023-2027	1.01639
2028-2032	1.01853

Table 17-15 Household income growth scenario

Source: estimated so that the household growth (by type of household) given by the demographic scenario, combined with the employment growth scenario, will produce the growth in total consumer demand required as part of the economic scenario.

Note: "2013-2017" means that this factor is applied in each of the modelled one-year periods from the 2012-2013 period to the 2016-2017 period inclusive.

18 POLICY INPUTS

18.1 Introduction

18.1.1 The planning policy (PLAN<year><test>.POL) files provide inputs for each floorspace type on:

- permissible development;
- exogenous development, either in terms of growth factors or in terms of the quantity of floor space to build in each zone in each year; and
- vacated and demolished floorspace.

18.1.2 Permissible development can be for any forecast year and is immediately available to the modelled development process, in addition to any quantity of permissible development brought forward from the previous year. If permissible development (whether newly input or brought forward) is not taken up in any one year it is carried forward to the following year – the "permission" to develop does not expire.

18.1.3 For housing, both permissible development and exogenous development are (from Reference Case KR onwards) input as one or other of two development types: either

- higher density developments (as are likely to be predominate in Edinburgh and Glasgow) which are likely to be occupied by single or couple households without children
- other housing developments in general.

18.1.4 For all other floorspace types, permissible development and exogenous development are simply defined by floorspace type.

18.1.5 The exogenous development inputs are also used to input data on development completed in each year since the base year up to and including 2008. Permissible development is input so that the development model can forecast completions from 2009 onwards.

18.1.6 Demolitions recorded between 2001 and 2007, and those that were programmed for the period beyond 2007 have been entered. In all instances a two stage process is used for demolition floorspace. In the first year the floorspace to be demolished is vacated. This ensures that there is no activity using the floorspace. Then, in the second year the floorspace is demolished. Within TELMoS:07 it is assumed that, unless stated to the contrary by the local planning authority, an amount of permissible floorspace equal to that demolished is made available for development.

18.2 The information supplied

18.2.1 The table below summarises the nature of the information provided by each of the local planning authorities. The 32 local planning authorities can be grouped into those who:

- provided new planning policy inputs - there were 18 local authorities within this category;
- had recently updated the planning policy inputs for specific applications of the TELMoS:05 model. These included updates associated with the Lothian Development Plan project, the Glasgow City Plan 2 project and the South Lanarkshire Local Plan. In these circumstances the recent TELMoS05 data was used. There were nine local authorities within this category; and
- didn't supply information. In this instance we have used previously submitted data or information published on the local authority websites. There were five local authorities (the four described above plus Moray who provided links to the documents on their website).

18.2.2 In addition, use was made of completion data (for the period 2001-2006) that had been collected as part of previous data collections, and information published on the Scottish Neighbourhood Statistics website on the number of dwellings within each Datazone.

18.2.3 No information was received from either of the National Park Authorities.

Table 18-1 Sources of Planning Policy Inputs

Planning authority	Planning Policy Inputs	Consultation Note Response
Aberdeenshire	Information received from local planning authority	No response
City of Aberdeen	Information received from local planning authority	Additional information supplied following consultation note
Angus	Information received from local planning authority	No response
Argyll & Bute	Information received from local planning authority	No response
Clackmannanshire	Information based upon that supplied for Lothian Development Plan project in autumn 2007	No response
Dumfries & Galloway	No information received. Planning policy inputs based on data received in 2006	Further clarification sought on the data inputs
City of Dundee	Information received from local planning authority	Amendments made to the inputs in the light of comments received
East Ayrshire	Information received from Ayrshire Structure Plan team	Acknowledgement of Consultation Report by Ayrshire Structure Plan team
East Dunbartonshire	Information received from Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
East Lothian	Information based upon that supplied for Lothian Development Plan project in autumn 2007	No response
East Renfrewshire	Information received from Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
City of Edinburgh	Information based upon that supplied for Lothian Development Plan project in autumn 2007	Amendments made to the inputs in the light of comments received

Planning authority	Planning Policy Inputs	Consultation Note Response
Eilean Siar	No information received. Planning policy inputs based upon published planning documents on Eilean Siar websites	No response
Falkirk	Information received from local planning authority	Confirmation and explanation of planning inputs received from the local planning authority
Fife	Information received from local planning authority	No response
City of Glasgow	Information received from Glasgow City Council for the Glasgow City Plan 2 project and from Glasgow and Clyde Valley Structure Plan team	Amendments made to the inputs in the light of comments received from Glasgow City Council. Confirmation of the Business inputs by GCVSP team
Highland	Information received from local planning authority	No response, though clarification previously received to a query on which sites were to be included within the various A96 scenarios
Inverclyde	Information received from Inverclyde Council and the Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
Midlothian	Information based upon that supplied for Lothian Development Plan project in autumn 2007	
Moray	Sources of information supplied by the local planning authority	No response.
North Ayrshire	Information received from Ayrshire Structure Plan team	Acknowledgement of Consultation Report by Ayrshire Structure Plan team
North Lanarkshire	Information received from Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
Orkney Islands	No information received, information taken from published documents on the Orkney website	Comments received
Perth & Kinross	Information received from local planning authority	Clarification sought on the relative scale of permissions
Renfrewshire	Information received from Renfrewshire Council and the Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
Scottish Borders	Information based upon that supplied for Lothian Development Plan project	Clarification sought on the inputs and implications of omissions in the inputs
Shetland Islands	Informed by the local planning authority that the information was not collected (or available). Information taken from published documents on the Shetland website	Comments received
South Ayrshire	Information received from Ayrshire Structure Plan team	Acknowledgement of Consultation Report by Ayrshire Structure Plan team
South Lanarkshire	Information from the South Lanarkshire Local Plan project (in 2007) and data received from Glasgow and Clyde Valley Structure Plan team	Confirmation of the Business inputs by GCVSP team
Stirling	Information received from local planning authority	Amendments to the information in the light of comments received
West Dunbartonshire	Information received from West Dunbartonshire Council and the Glasgow and Clyde Valley Structure Plan team	Amendments to the information in the light of comments received from West Dunbartonshire. Confirmation of the Business inputs by GCVSP team
West Lothian	Information based upon that supplied for Lothian Development Plan project in autumn 2007	No response

18.2.4 The separate Report on the Assembly of Planning Policy Inputs (August 2008) provides a detailed description of the information received. The key points are:

- Residential information: 20 of the 32 local authorities have been able to provide some information on residential planning inputs through to 2022-2026. Three (Eilean Siar, Moray and Stirling have only provided data until 2011);
- Retail information: 11 of the 32 authorities have been able to provide data through to 2022-2026. 14 authorities have not supplied any post-2011 data;
- Office information: 17 of the 32 authorities have been able to provide data through to 2022-2026. Two authorities (Scottish Borders and East Lothian have provided no information on this land use; this may reflect the limited building programmes for offices within these areas rather than any omission); and
- Industry information: 17 of the 32 authorities have been able to provide data through to 2022-2026. Argyll and Bute is the only authority where there are no planning policy inputs post 2011.