Investigating the Potential Impact of Transport Changes on the London Economy

Report

GLA Economics

October 2005

Investigating the Potential Impact of Transport Changes on the London Economy
Report

Project No: 98431
October 2005

Newcombe House
45 Notting Hill Gate
London, W11 3PB
Telephone: 020 7309 7000
Fax: 020 7309 0906
Email : London@cbuchanan.co.uk

Prepared by:	Approved by:
P Buchanan	P Buchanan

Status: 1st draft Issue no: 1 Date: October 2005

document4

Contents

Page

1. Introduction

1.1.1 A growing economy means growing transport demand. Improved transport connections benefit the economy. This paper takes a first step towards modelling the dynamics of this interaction between transport demand and the economy within London. It is intended to provoke discussion of both the effects of this interaction and the best approach to modelling them.

1.1.2 We consider the consequences of a policy change on:

- The total level of demand;
- The pattern of demand across zones and modes;
- Employment and its distribution across zones; and
- Output of the London economy.

1.1.3 The real world is hugely complex, with millions of people making decisions based on varying and constantly changing information and preferences. A model cannot hope to capture this complexity in all its detail. The purpose of modelling is to abstract from this complexity whilst retaining and capturing the key elements of the real world. By building a picture of the major underlying dynamics we can see how the consequences of change might evolve over time.

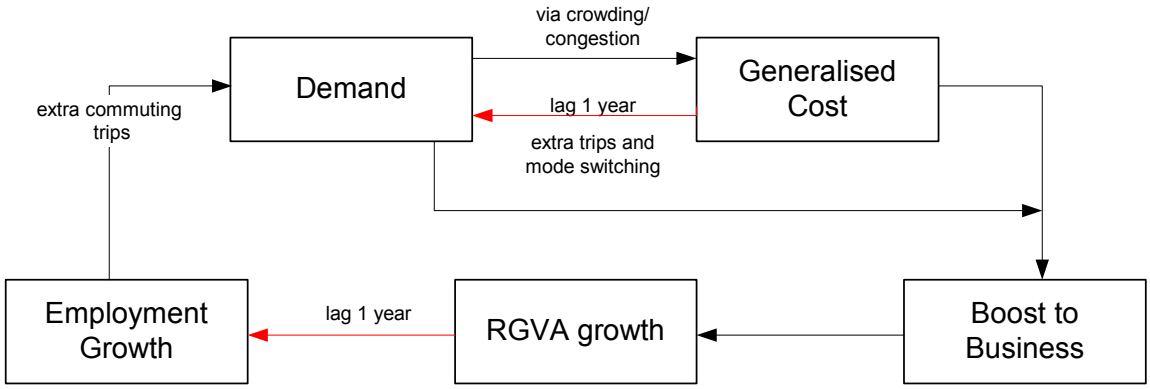
1.1.4 With this in mind we have attempted to keep the model as simple and transparent as possible. We hope that for any policy change the chain of knock on effects within the model can be understood and the corresponding lessons for the possible effects on the London economy made clear. As mentioned above, one goal of the project has been to open up a discussion. Keeping the workings of the model as transparent as possible invites input, criticism and discussion of our approach to modelling the key elements in the interaction between the economy and the transport system.

2. Approach

2.1 The simple model

2.1.1 To start the investigation we proposed the following relationships between demand for trips, generalised costs of trips and the levels of business and employment growth.

FIGURE 1: THE SIMPLE MODEL



2.1.2 Generalised cost is a measure of the total cost of a trip for the passenger. It includes monetary costs reflecting fares, parking costs and petrol costs, and time costs valuing the length of the journey, crowding on the route, and penalties for infrequent or unreliable routes. Output is measured in RGVA (Real Gross Value Added).

2.1.3 Demand and generalised cost both depend on each other. As the number of people travelling increases, the crowding and congestion within the system increase. This increases the generalised cost of trips made. As the generalised cost increases less people are willing to travel by that mode, and people either stop making the journey or change onto a different mode of transport, changing the level of demand. The full effects of this change take time to occur, since people are generally slow to change habits.

2.1.4 While these links have been widely explored in transport models the next link to employment is more experimental. Firstly, the benefit to travellers of a change in generalised cost is calculated. This is given by:

$$\text{Boost} = \text{previous passengers} \times \text{absolute change in generalised cost} + 0.5 \times \text{new passengers} \times \text{absolute change in generalised cost}$$

2.1.5 The benefit reflects the surplus/loss to consumers based on their willingness to pay. This method of valuing the welfare effects of a price change is a standard technique in economics.

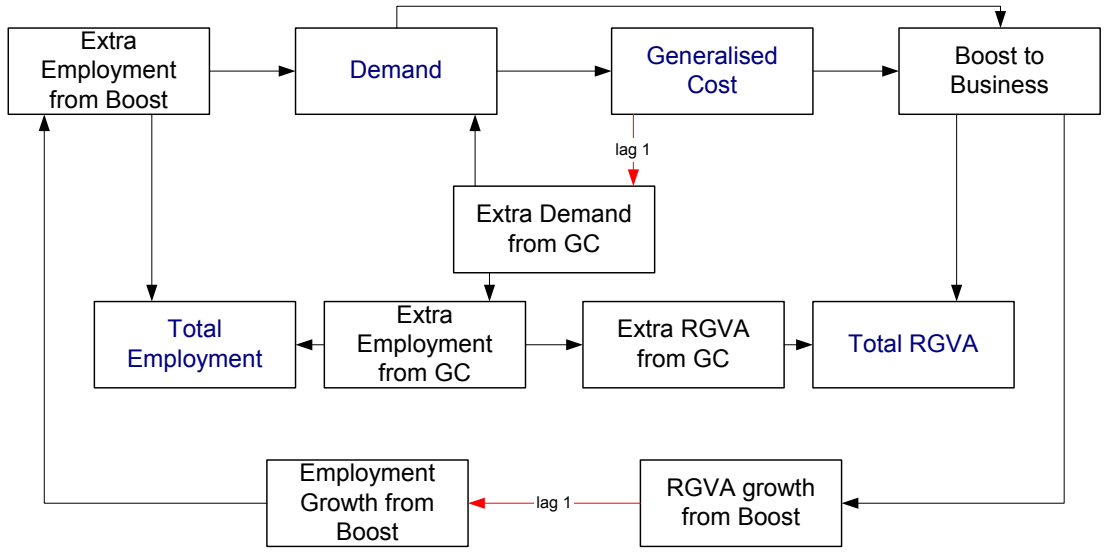
2.1.6 Secondly, we assume a proportion of this benefit/loss is absorbed by businesses. These factors vary by trip purpose and are given in Appendix E. The 'Boost' referred to in the equation above is multiplied by the relevant proportion to give the 'Boost to Business'.

2.1.7 This boost contributes to output growth in the period and, after a year, to additional employment growth. This follows the strong link between the amount of cash in an employer's pocket and the number of people they wish to employ. Employment growth leads to a growth in commuting trips, which completes the circle.

2.2 The simple model - commuters

2.2.1 For commuting trips we need to add a few more links between the boxes. The direct link from generalised cost to demand reflects a supply side effect – individuals deciding whether or not they are willing to travel. The loop via boost, output and employment from generalised cost to demand captures the demand side – employers able to hire more people following their cash saving. Both of these links affect employment levels in distinct ways and both need to be counted. So when generalised cost changes commuting demand we correspondingly change employment and RGVA.

FIGURE 2: THE SIMPLE MODEL FOR COMMUTERS



2.3 Stability Conditions

2.3.1 Since the model is simple it is possible to analyse the conditions required for stable, and realistic, solutions. It is also possible to find which assumptions are key for driving the results.

2.3.2 We can expect that the boost to business from any transport change will never be a large proportion of total output since average earnings are much higher than average transport costs.

2.3.3 The critical links in the models are therefore those between demand and generalised cost. For these to be stable we need the product of the two elasticities to be between –1 and 0. In real terms, if the total number of people travelling jumps causing a rise in crowding levels then the number of people who stop travelling as a result must be less than the size of the initial jump.

2.3.4 For example if this condition were violated for buses this would lead to people flocking to the buses only to be put off by crowding and leave. The sight of the empty buses would then attract more people back than had originally left which would then cause an even greater crowding problem than existed previously. This process would continue getting more and more extreme which is unrealistic.

2.3.5 This stability condition is therefore a reflection of what happens in the world rather than an artificial construction of the model.

2.3.6 The additional commuting link from generalised cost directly to employment ends in the total employment and total RGVA boxes. These convert between percentage growths and absolute growths but do not directly drive any changes. Therefore these should not cause instability.

2.4 The full model

2.4.1 For the model to capture the main effects of transport policies we need it to include several journey purposes, modes of travel and origins and destinations within London. We tried to keep these groups as simple as possible while retaining enough information to be interesting to policy makers. The dimensions are:

- **Purposes**: Commute; Business (trips during work hours paid for by company); and other.
- **Modes**: Car; Bus; and Rail (including Underground and Docklands Light Railway).
- **Zones**: Central, Inner and Outer London and External.

2.4.2 The external zone is included to keep the contribution to total demand levels but we will not attempt to change employment in the zone at all.

2.4.3 Slow modes, eg walking and cycling, and motorcycles have been excluded at this stage for simplification, although they clearly have a very important role within any transport strategy.

2.4.4 Again to keep the model simple, we only consider am peak trips (07:00 to 10:00) on weekdays. We use annualisation factors to convert from am peak demand to annual demand in the business impacts equations. If we were to model other periods the split by mode and purpose of demand and the elasticities would be different.

2.4.5 It is useful to think of the full model as a set of simple models that run parallel to each other but interact in three key places:

1. Trips can change mode in the link from generalised cost to demand.

2. The total number of trips across purposes affects the total crowding and changes the time costs for all purposes.

3. The boost to business is calculated according to the destination of the trip, corresponding to the employment end. Employment grows most in the zones that benefit the most, and therefore the growth in commuting demand is dependent on all cost savings to that zone.

2.4.6 Note that if the stability conditions hold for the simple models they will also hold for the full model.

2.5 Detailed description of links

2.5.1 Table 1 lists the links within the model, the mechanism by which they work and the data source we have used to estimate the parameters.

TABLE 1: MECHANISMS FOR LINKS AND CORRESPONDING DATA SOURCES

Link	Mechanism	Data Sources
Demand → Generalised Cost	1) Elasticity to find change in time costs for each trip. 2) New time cost added to monetary costs divided by value of time by purpose to find new Generalised Cost.	1) SPAM/ estimation 2) SPAM
Generalised Cost → Extra Demand*	1) Elasticity to find total change in demand for each trip 2) Redistribution factors are used to choose where this demand comes from – a proportion is created and proportions are taken from each of the other modes	1) SPAM/ estimation 2) Estimated
Demand (D) and Generalised Cost (GC) → Boost	Boost $_t$ = $(D_{t-1} + ½*(D_t-D_{t-1})) * A * (GC_t – GC_{t-1})* V * P$: 1) A =Annualisation factors by mode and purpose 2) V=Value of time by purpose 3) P=Proportion of benefit transferred to business by purpose Summed to give boost by trip destination	1) CB 2) CB 3) Assumption
Boost →RGVA growth B	Boost converted to percentage of previous RGVA (for "Total Inner" and "Outer")	
RGVA growthB → Employment GrowthB	1) Linear coefficient to get total employment growth 2) RGVA "Total Inner" distributed to our "Central" and "Inner" zones by distribution of boost	1) GLA Forecasts of productivity growth 2) Calculated
Employment GrowthB → Extra CommuteB	1) Extra employment by zone converted to extra commute trips by ratio commuters/employment (assumes that those newly employed by businesses will have similar travel characteristics to current employees) 2) Distributed by previous distribution of trips for each destination (assumes people are still likely to live in the same areas despite transport changes)	1) Initial ratio of demand to employment 2) Calculated
Extra Demand* → Extra Employment*	One new job for each new commuting trip by destination (assumes that all the people who start commuting due to savings in cost are captured by this model and that people who do not commute in the morning peak are unaffected by transport changes).	Assumed
Extra Employment* → Extra RGVA*	Multiplied by RGVA per job in London (assumes that those who loose a job drop out the London job market entirely)	Office for National Statistics

A trip refers to a choice of mode, purpose, origin and destination. B is used to denote 'from boost' while * denotes 'directly from generalised cost change'.

3. Values and Data

3.1 Data Sources

3.1.1 The data for this project have been taken from the Strategic Policy Analysis Model (SPAM) from Transport for London, the Office for National Statistics (ONS) and estimated from results of similar studies. We have included all of the data used in the model in the appendices for this report and have flagged up the main issues surrounding them below.

3.2 SPAM

3.2.1 We hoped to use the SPAM model to provide the base demand and generalised costs, and the elasticities in both directions between them. SPAM uses 13 zones, four in each of Inner, Outer and External London and one for the Central zone. It covers two purposes 'work' for commuting trips and 'non-work' for everything else including business. It models ten modes including bus, car, rail, underground and Docklands Light Railway. We were supplied with two sets of runs. The first featured increases of 20% in initial demand for each of rail, bus and car trips separately and the second a 20% increase in initial monetary costs for each of the modes. These were initially sent in late July 2005 but the model and base data were revised and new runs received as this draft was being produced.

3.3 SPAM – base values

3.3.1 To convert into our zones and modes we summed SPAM's base demand and averaged its generalised costs. To match our purposes we then assumed that monetary costs for business travellers would match those of commuters and those of our 'other' would match those of SPAM's 'non-work'. We split the demand for 'non-work' into 'business' and 'other' using the ratio, by trip destination and mode, of business to leisure in the most recent London Area Transport Survey (LATS) data.

3.3.2 The base demand data are shown in Appendix A and summarised below, and although slightly changed in the revision, appear suitable for our model.

TABLE 2: TOTAL BASE DEMAND FOR ALL MODES AND PURPOSES IN THOUSANDS PER WEEKDAY MORNING PEAK BY ORIGIN (ROWS) AND DESTINATION (COLUMNS)

Base	Central	Inner	Outer	External	Total
Central	49.14	42.54	14.68	8.10	114.46
Inner	284.89	529.96	160.02	49.99	1024.86
Outer	299.59	259.09	1,270.07	174.79	2003.54
External	189.05	77.62	209.99	0.18	476.84
Total	822.67	909.21	1654.76	233.06	3619.7

3.3.3 The base costs are given in sections. Firstly there is a time cost by mode, origin and destination. This includes a time to make the journey weighted by the crowding levels in each zone and penalties for access times, waiting, and unreliability. Secondly there are monetary costs. For public transport these reflect fares while for cars they are broken down into parking and other costs. To help judge the likely effect on generalised cost of policy changes we will need more detail about the magnitude of each of these components.

3.3.4 We were initially concerned over the base costs provided to us since:

1. Parking costs were not included in the monetary costs output by SPAM (although they were part of the generalised cost)

2. Bus costs were higher than rail costs for all trips excluding those to/from external and those from inner to inner.

3.3.5 Further explanations from SPAM resolved the first of these and the revision to the data resolved the second.

3.4 SPAM – elasticities

3.4.1 We then proceeded to derive elasticities for the links between demand and generalised cost. Representing these links as elasticities is, of course, a simplification. It does, however, have the benefit of allowing a transparency to the results from the model. We calculated the changes in demand and generalised cost for each of the scenarios and then found our elasticities: change in demand for each percentage change in generalised cost; and change in time costs following percentage change in demand.

3.4.2 The elasticities generated from the first release of SPAM data contained some patterns which gave us some concerns. We queried these with the SPAM modellers.

3.4.3 In order to continue the project, Bridget Rosewell and Paul Buchanan suggested a set of alternative elasticities to use as a working assumption. These are given in Appendices B and C. We have tried to keep these as simple as possible. The stability condition is met for all trips and they match what we believe to be the broad pattern of behaviour of journey makers in London. We strongly welcome input over the suitability of these figures and suggestions for other possible sources for them.

3.4.4 We are in the process of analysing the elasticities implied by the data received from SPAM in early October. These are shown in Appendix G.

3.5 Other data

3.5.1 The base data for Employment and RGVA were acquired from the Office for National Statistics (ONS). The link from RGVA growth to employment growth was estimated using the GLA's forecast for productivity growth over ten years.

3.5.2 To model redistribution of demand across modes we have used an unorthodox route. The intention was again to make the assumptions more explicit and make the results more transparent, while again keeping the complexity to a minimum. The full set of factors is in Appendix D. Table 3 below gives the factors for commuting trip moving from car. Central, Inner, Outer and eXternal (CIOX) zones give the origin, down the rows, and destination, across the columns, of the trip. An example of how the factors are applied is given underneath.

TABLE 3: REDISTRIBUTION FACTORS FOR COMMUTING TRIPS FROM CAR

New	C	I	O	X
C	5	5	5	10
I	5	5	15	20
O	5	**15**	20	20
X	10	20	20	30

To bus	C	I	O	X
C	25	25	15	5
I	25	20	15	10
O	15	**15**	15	15
X	5	10	10	10

To rail	C	I	O	X
C	70	70	80	85
I	70	75	70	70
O	80	**70**	65	65
X	85	70	70	60

3.5.3 For example, if the elasticity from generalised cost to demand generates 100 new commuting car trips from Outer London to Inner London we read off the three bold numbers from the tables. These tell us that 15 are entirely new trips, 15 are taken from bus and 70 are taken from rail. The distributions reflect the main competitors for transport in the different zones and the likelihood passengers will start or stop making the journey. These factors would also be applied to a fall in demand. For example, if the elasticity led to a fall in demand of 100 trips, 15 trips would be lost, 15 trips would move to bus and 70 to rail.

3.5.4 In this method increases in cost for each mode drive passengers away and towards other modes every period. The corresponding change to distribution of mode reflects both the magnitude of a change in generalised cost and the assumed change of mode they will make.

4. Results

4.1 Introduction

4.1.1 The appendices carry the results for six scenarios:

1. Increasing car money costs including parking by 20%
2. Increasing bus fares by 20%
3. Increasing rail fares by 20%
4. Increasing car money costs by £2
5. Increasing bus fares by £2
6. Increasing rail fares by £2

4.1.2 The first thing to note when studying the results is the magnitude of the change in generalised cost caused by the policy change. For cars, monetary costs form the lion's share of the total costs, with parking costs dominating. For rail and buses however, monetary costs are small compared to time costs. The results include a table giving the size of the change in generalised cost for commuters. This is very similar to the split for 'other' travellers while for business travellers time costs rank much higher than money and so the change in generalised cost will be different.

4.1.3 The distribution of initial demand is the next driving factor to consider. The number of people travelling by rail or underground is highest in the heart of London, while for cars and buses it is higher further out. This distribution indicates where the effects of prices will be felt by businesses.

4.1.4 The mode redistribution factors should be considered when looking at the changes in demand by mode. Leisure travellers are the most likely to make or stop making trips and commuters are the least likely. Most car and bus users switch to rail rather than to each other while rail users switch mostly to bus. These trends are skewed towards car as we move out of London.

4.1.5 Finally while gauging the magnitude of the changes it is useful to look back to the elasticities between generalised cost and demand. These indicate the magnitude of the initial change.

4.2 Summary of results for +20% monetary costs scenarios

4.2.1 Results compare values at the inception of the policy change and values 10 years later. The results are summarised in Table 4.

4.2.2 The appendices carry the full details of these scenarios and also results for scenarios with £2 added to monetary costs for each mode in turn.

4.2.3 Increasing monetary costs for cars by 20% increased the overall generalised cost for cars by between 9% and 18%. It caused a total loss in demand for transport of over 19,000 trips in the morning peak of which 13,600 were leisure passengers, 5,000 were commuters and only 500 business travellers. 80,000 car trips were lost leading to an increase of nearly 46,000 rail trips and 15,000 bus trips. 7,600 jobs were lost, mainly in outer London. Total annual RGVA in London decreased by £550m of which £304m was lost from Outer.

4.2.4 Increasing rail fares by 20% increased the generalised cost for rail by between only 2% and 6%. The corresponding change in demand was also much smaller at 3,700 trips per morning. Again trips were mainly lost from the leisure market. The loss in rail passengers in the morning peak was 19,700 of which 11,000 moved to car and 4,800 to bus. Employment changed by 2,000 jobs of which over half were in central London. 86% of the total annual RGVA loss of £158.5m was lost in central and inner London.

4.2.5 The bus fare increase of 20% had the smallest overall impact with generalised cost increases less than 1.5%. Total morning peak demand fell by 2,700 with 1,900 lost leisure trips, and 720 lost commuters. The loss of 10,900 bus trips caused increases of 3,300 car trips and 4,900 rail trips. Only 780 jobs were lost across London with 450 in outer, 200 in inner and 130 in central London. Annual RGVA in outer London decreased by £23m and in central and inner London by £18m.

TABLE 4: SUMMARY OF RESULTS FROM 3 SCENARIOS

		Monetary Costs + 20% for		
		Car	Bus	Rail
Generalised Cost Change		+ 9 to 18%	less than 1.5%	+ 2 to 6%
Demand Change (000s trips per am peak)	**Total**	**-19.2**	**-2.7**	**-3.7**
	Leisure	-13.6	-2.0	-2.2
	Commute	-5.1	-0.7	-1.4
	Business	-0.5	0.0	-0.1
	Car Trips	-80.2	3.3	11.2
	Bus Trips	15.1	-11.0	4.9
	Rail Trips	45.9	4.9	-19.8
Employment Change (000s jobs)	**Total**	**-7.6**	**-0.8**	**-2.0**
	Central	-1.2	-0.1	-1.1
	Inner	-1.9	-0.2	-0.6
	Outer	-4.5	-0.5	-0.4
RGVA Change (£M per annum)	**Total**	**-1,103.0**	**-81.8**	**-317.1**
	Central	-247.8	-17.6	-135.6
	Inner	-303.7	-23.3	-22.9
	Outer	-551.5	-40.9	-158.5

5. Taking the Model Forward

5.1.1 Some elements that are not yet included in the model, but which we believe are important and would wish to address in order to extend this work are:

- **Agglomeration Impacts**
  Productivity rises when there is a high concentration of business in one area. There are big economic advantages therefore to facilitating higher density employment areas. This model does not at present explicitly value this benefit.

- **Origin and Destination Switching**
  Currently within the model people only have the option of changing the mode by which they make their journey or of stopping making it altogether. In reality people also have the option of switching where they live, work and where they make their other journeys. More work could be done to model this, although data on this type of behaviour probably does not exist.

- **Non-Linearities**
  The relationships between Generalised Cost and Demand, and back from Demand to Generalised Cost are both likely to be non-linear. For crowding, impacts are only felt as a service or road approaches capacity and rapidly increase in severity. The elasticities within this model are all linear, but further work could be done to build in an estimated relationship that takes non-linearity into account.

- **Exogenous growths of employment**
  The economy is constantly changing independent of the transport network. Building in exogenous output and employment growth would allow us to use the links between transport and economics that we have developed to say something about how congestion and transport costs are likely to evolve as the economy grows. This could be achieved by the addition of an exogenous RGVA growth each year, in line with GLA assumptions.

- **Extra zones**
  Although we wish to keep the complexity to a minimum it would be possible to extend the model to cover more zones, possibly by splitting the 'outer' zone into four separate zones. This would be important if we wished to find the benefit of, say, improving the railways operating in one corridor of London.

6. Conclusions

6.1 Model Overview

6.1.1 The purpose of this project has been to explore the links between the economy and transport. The model produced is capable of showing the impact of policy changes on transport demand split by four zones, three purposes and three modes and on output, employment and the distribution of employment within the zones.

6.1.2 The model is very much intended to be a first step in thinking about how to model the key links that enable policy makers to understand the effects of policy changes. As such we welcome any input or criticism from other parties as a contribution to taking our understanding of how to model these types of interactions clearly and coherently.

6.1.3 The key inputs to the model are

- Elasticities of demand to generalised cost;
- Elasticities of generalised cost to demand;
- Mode redistribution factors;
- Base values of demand and generalised cost;
- Level of output and employment.

6.1.4 The final results show the impacts from both individuals choosing different travel behaviour and businesses absorbing costs. We hope that this will form the basis of a discussion on what are the key impacts of transport on the economy.

Appendices

Please note that throughout the Appendices in tables of origins and destinations, rows refer to origins of trips and columns to destinations.

Appendix A – Base Data

Appendix B – Demand Elasticities with respect to Generalised Cost

Appendix C – Time Elasticities with respect to Demand

Appendix D – Redistribution Factors

Appendix E – Other Inputs

Appendix F – Results

Appendix G – Elasticities derived from SPAM

Appendix A – Base Data

Sources: SPAM 04/10/05
LATS survey data for split between Business and Other

TABLE A1: DAILY AM PEAK TRIPS FOR CARS

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	3,683	4,729	2,387	873	14,690	18,164	3,694	373	9,096	2,882	362	247
Inner	22,794	71,738	31,408	11,317	18,197	182,900	46,087	5,167	11,267	29,018	4,512	3,421
Outer	17,869	66,678	272,344	60,007	9,097	57,192	608,081	41,398	5,632	9,074	59,535	27,411
Ext	9,610	17,028	106,069	0	3,327	11,079	65,233	0	2,060	1,758	6,387	0

TABLE A2: DAILY AM PEAK TRIPS FOR BUS

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	5,022	2,289	140	0	3,352	3,245	114	0	794	183	5	0
Inner	44,737	45,832	9,034	0	12,009	83,193	8,887	0	2,844	4,687	393	0
Outer	1,847	7,936	83,761	7,124	394	5,430	142,117	7,113	93	306	6,292	889
Ext	0	46	7,304	0	0	0	4,984	0	0	0	221	0

TABLE A3: DAILY AM PEAK TRIPS FOR RAIL

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	6,837	4,312	4,404	3,140	3,304	4,835	2,867	1,823	2,360	1,901	710	1,641
Inner	130,773	46,518	31,488	15,997	24,657	47,424	22,611	7,414	17,612	18,645	5,603	6,672
Outer	213,533	64,926	43,755	13,756	29,825	34,127	43,422	8,998	21,304	13,417	10,759	8,098
Ext	141,945	29,493	10,921	0	18,731	13,075	7,107	0	13,379	5,141	1,761	0

TABLE A4: AVERAGE TIME COSTS FOR CARS (HOURS) – INCLUDES PENALTIES FOR CONGESTION

	Central	Inner	Outer	Ext
Central	0.35	0.59	1.18	2.46
Inner	0.69	0.73	1.08	2.49
Outer	1.35	1.22	1.31	1.96
Ext	2.67	2.63	2.14	1.66

TABLE A5: AVERAGE TIME COSTS FOR BUS (HOURS) - INCLUDES PENALTIES FOR INFREQUENCY, INTERCHANGE AND UNRELIABILITY

	Central	Inner	Outer	Ext
Central	1.38	2.20	3.71	6.62
Inner	2.12	2.23	3.16	6.36
Outer	3.21	2.97	3.27	5.40
Ext	6.11	6.06	5.52	6.00

TABLE A6: AVERAGE TIME COSTS FOR RAIL (HOURS) - INCLUDES PENALTIES FOR INFREQUENCY, INTERCHANGE AND UNRELIABILITY

	Central	Inner	Outer	Ext
Central	1.11	1.71	2.26	2.73
Inner	1.73	1.78	2.18	2.75
Outer	2.28	2.17	2.34	2.55
Ext	2.69	2.70	2.53	2.67

TABLE A7: AVERAGE VARIABLE MONEY COSTS FOR CAR (£)

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	0.61	1.19	2.94	7.35	0.41	0.88	2.29	6.26	0.61	1.19	2.94	7.35
Inner	1.46	1.57	2.85	7.44	0.98	1.12	2.19	6.35	1.46	1.57	2.85	7.44
Outer	3.56	3.07	3.21	6.21	2.51	2.26	2.60	5.40	3.56	3.07	3.21	6.21
Ext	8.80	8.23	6.72	6.91	7.12	6.80	5.76	6.03	8.80	8.23	6.72	6.91

TABLE A8: AVERAGE PARKING MONEY COSTS FOR CAR (£) – INCLUDES A TIME COST FOR SEARCHING

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	12.37	4.06	2.43	1.86	8.74	1.98	1.34	1.78	12.37	4.06	2.43	1.86
Inner	12.37	4.06	2.43	1.86	8.74	1.98	1.34	1.78	12.37	4.06	2.43	1.86
Outer	12.37	4.06	2.43	1.86	8.74	1.98	1.34	1.78	12.37	4.06	2.43	1.86
Ext	12.37	4.06	2.43	1.86	8.74	1.98	1.34	1.78	12.37	4.06	2.43	1.86

TABLE A9: TOTAL MONEY COSTS FOR CAR (£)

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	12.98	5.25	5.37	9.22	9.15	2.86	3.63	8.04	12.98	5.25	5.37	9.22
Inner	13.83	5.63	5.28	9.30	9.72	3.10	3.53	8.13	13.83	5.63	5.28	9.30
Outer	15.92	7.13	5.64	8.07	11.25	4.24	3.94	7.19	15.92	7.13	5.64	8.07
Ext	21.16	12.29	9.15	8.77	15.86	8.78	7.10	7.81	21.16	12.29	9.15	8.77

TABLE A10: TOTAL MONEY COSTS FOR BUS (£)

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	0.58	0.68	1.16	1.16	0.60	0.70	1.20	1.20	0.58	0.68	1.16	1.16
Inner	0.68	0.51	1.16	1.16	0.70	0.53	1.20	1.20	0.68	0.51	1.16	1.16
Outer	1.16	1.16	0.99	1.16	1.20	1.20	1.02	1.20	1.16	1.16	0.99	1.16
Ext	1.16	1.16	1.16	0.99	1.20	1.20	1.20	1.02	1.16	1.16	1.16	0.99

TABLE A11: TOTAL MONEY COSTS FOR RAIL (£)

	Commute				Other				Business			
	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	0.87	1.09	1.65	4.60	0.90	1.13	1.71	4.76	0.87	1.09	1.65	4.60
Inner	1.09	0.97	1.44	5.09	1.13	1.01	1.49	5.27	1.09	0.97	1.44	5.09
Outer	1.65	1.44	1.31	5.37	1.71	1.49	1.35	5.55	1.65	1.44	1.31	5.37
Ext	4.60	5.09	5.37	6.45	4.76	5.27	5.55	6.67	4.60	5.09	5.37	6.45

Appendix B – Demand Elasticities to Generalised Cost

Source: Estimated

TABLE B1: ELASTICITIES OF DEMAND TO GENERALISED COST FOR CARS

Car	Central	Inner	Outer	Ext
Central	-1.00	-0.50	-0.50	0.00
Inner	-1.00	-0.50	-0.50	0.00
Outer	-1.00	-0.50	-0.50	0.00
Ext	-1.00	-0.50	-0.50	0.00

TABLE B2: ELASTICITIES OF DEMAND TO GENERALISED COST FOR BUS

Bus	Central	Inner	Outer	Ext
Central	-1.20	-1.75	-3.00	0.00
Inner	-1.75	-1.75	-2.50	0.00
Outer	-3.00	-2.50	-1.75	-5.00
Ext	0.00	-5.00	-5.00	-2.50

TABLE B3: ELASTICITIES OF DEMAND TO GENERALISED COST FOR RAIL

	Central	Inner	Outer	Ext
Central	-1.13	-1.00	-1.00	-1.00
Inner	-0.82	-1.00	-1.00	-1.00
Outer	-0.23	-1.00	-1.00	-1.00
Ext	-0.21	-1.00	-1.00	-1.00

Appendix C – Time Elasticities with respect to Demand

Source: Estimated

TABLE C1: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR CAR

	Central	Inner	Outer	Ext
Central	0.30	0.20	0.10	0.00
Inner	0.40	0.30	0.20	0.10
Outer	0.50	0.40	0.30	0.20
Ext	0.60	0.40	0.20	0.00

TABLE C2: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR BUS

	Central	Inner	Outer	Ext
Central	0.00	0.00	0.00	0.00
Inner	0.00	0.00	0.00	0.00
Outer	0.00	0.00	0.00	0.00
Ext	0.00	0.00	0.00	0.00

TABLE C3: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR RAIL

	Central	Inner	Outer	Ext
Central	0.20	0.15	0.10	0.05
Inner	0.15	0.11	0.07	0.03
Outer	0.10	0.07	0.04	0.02
Ext	0.05	0.03	0.02	0.00

Appendix D – Redistribution Factors

Source: Estimated

Commute

TABLE D1: REDISTRIBUTION FACTORS FOR COMMUTERS SWITCHING FROM CAR

New	Central	Inner	Outer	External
Central	5	5	5	10
Inner	5	5	15	20
Outer	5	15	20	20
External	10	20	20	30

To bus	Central	Inner	Outer	External
Central	25	25	15	5
Inner	25	20	15	10
Outer	15	15	15	15
External	5	10	10	10

To rail	Central	Inner	Outer	External
Central	70	70	80	85
Inner	70	75	70	70
Outer	80	70	65	65
External	85	70	70	60

TABLE D2: REDISTRIBUTION FACTORS FOR COMMUTERS SWITCHING FROM BUS

To car	Central	Inner	Outer	External
Central	5	5	10	25
Inner	5	10	20	40
Outer	10	20	40	40
External	25	25	40	60

New	Central	Inner	Outer	External
Central	5	5	5	10
Inner	5	5	15	20
Outer	5	15	20	20
External	5	20	20	30

To rail	Central	Inner	Outer	External
Central	90	90	85	65
Inner	90	85	65	40
Outer	85	65	40	40
External	70	55	40	10

TABLE D3: REDISTRIBUTION FACTORS FOR COMMUTERS SWITCHING FROM RAIL

To car	Central	Inner	Outer	External
Central	30	40	60	80
Inner	40	60	65	80
Outer	50	65	75	80
External	60	70	80	85

To bus	Central	Inner	Outer	External
Central	60	50	30	10
Inner	50	30	25	10
Outer	35	25	15	10
External	25	20	10	5

New	Central	Inner	Outer	External
Central	10	10	10	10
Inner	10	10	10	10
Outer	15	10	10	10
External	15	10	10	10

Business

TABLE D4: REDISTRIBUTION FACTORS FOR BUSINESS TRIPS SWITCHING FROM CAR

New	Central	Inner	Outer	External
Central	15	15	15	15
Inner	15	15	15	25
Outer	15	15	40	50
External	15	25	50	75

To bus	Central	Inner	Outer	External
Central	30	20	10	10
Inner	20	20	20	10
Outer	10	20	20	10
External	10	10	10	5

To rail	Central	Inner	Outer	External
Central	55	65	75	75
Inner	65	65	65	65
Outer	75	65	40	40
External	75	65	40	20

TABLE D5: REDISTRIBUTION FACTORS FOR BUSINESS TRIPS SWITCHING FROM BUS

To car	Central	Inner	Outer	External
Central	5	5	10	20
Inner	5	10	25	30
Outer	10	25	30	40
External	20	30	40	60

New	Central	Inner	Outer	External
Central	15	15	15	15
Inner	15	15	15	20
Outer	15	15	20	25
External	15	20	25	25

To rail	Central	Inner	Outer	External
Central	80	80	75	65
Inner	80	75	60	50
Outer	75	60	50	35
External	65	50	35	15

TABLE D6: REDISTRIBUTION FACTORS FOR BUSINESS TRIPS SWITCHING FROM RAIL

To car	Central	Inner	Outer	External
Central	40	50	50	60
Inner	50	60	60	60
Outer	50	60	60	80
External	60	60	80	85

To bus	Central	Inner	Outer	External
Central	35	25	30	25
Inner	25	20	25	25
Outer	30	25	25	5
External	25	25	5	0

New	Central	Inner	Outer	External
Central	25	25	20	15
Inner	25	20	15	15
Outer	20	15	15	15
External	15	15	15	15

Other

TABLE D7: REDISTRIBUTION FACTORS FOR OTHER TRIPS SWITCHING FROM CAR

New	Central	Inner	Outer	External
Central	20	25	30	30
Inner	25	30	30	30
Outer	30	30	30	30
External	30	30	30	30

To bus	Central	Inner	Outer	External
Central	30	30	15	10
Inner	30	30	20	15
Outer	15	20	15	15
External	5	15	15	10

To rail	Central	Inner	Outer	External
Central	50	45	55	60
Inner	45	40	50	55
Outer	55	50	55	55
External	65	55	55	60

TABLE D8: REDISTRIBUTION FACTORS FOR OTHER TRIPS SWITCHING FROM BUS

To car	Central	Inner	Outer	External
Central	20	20	10	10
Inner	15	30	40	50
Outer	10	30	40	55
External	10	30	55	65

New	Central	Inner	Outer	External
Central	30	30	30	30
Inner	30	30	30	30
Outer	30	30	30	30
External	30	30	30	30

To rail	Central	Inner	Outer	External
Central	50	50	60	60
Inner	55	40	30	20
Outer	60	40	30	15
External	60	40	15	5

TABLE D9: REDISTRIBUTION FACTORS FOR OTHER TRIPS SWITCHING FROM RAIL

To car	Central	Inner	Outer	External
Central	20	25	40	60
Inner	20	30	40	60
Outer	20	40	50	60
External	20	50	60	70

To bus	Central	Inner	Outer	External
Central	50	45	30	10
Inner	50	40	30	10
Outer	50	30	20	10
External	50	20	10	0

New	Central	Inner	Outer	External
Central	30	30	30	30
Inner	30	30	30	30
Outer	30	30	30	30
External	30	30	30	30

Appendix E – Other Inputs

TABLE E1: ANNUALISATION FACTORS - FROM WEEKLY AM TRIPS TO TOTAL YEARLY DEMAND

	Business	Commute	Other
Car	213	144	294
Bus	168	118	301
Rail	187	145	250

Source: Estimated

TABLE E2: PROPORTION OF BENEFIT PASSED ON TO BUSINESS

Business	Commute	Other
100%	25%	5%

Source: Estimated

TABLE E3: VALUES OF TIME (£ PER HOUR)

Business	Commute	Other
£ 36.50	£ 5.04	£ 4.46

Source: Rail manual

TABLE E4: BUSINESS TRIPS AS A PROPORTION OF ALL NON-COMMUTING TRIPS BY DESTINATION

	Central	Inner	Outer	External
Car	38%	14%	9%	40%
Rail	42%	28%	20%	47%
Bus	19%	5%	4%	11%

Source: LATS

TABLE E5: RGVA BY ZONE (£M)

	Central + Inner	Outer
Initial RGVA (£m)	106180	63856

Source: ONS

TABLE E6: OUTPUT PER HEAD, EMPLOYMENT IN LONDON, EXPECTED LINEAR COEFFICIENT FOR LINK FROM OUTPUT TO EMPLOYMENT IN FUTURE

Output per head London	£ 35,818.51
Employment London	3906411
Coefficient	0.32

Source: ONS

Appendix F – Results

Scenario 1 Monetary costs including parking for car increased by 20%

TABLE S1.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR CAR COMMUTER

	Central	Inner	Outer	Ext
Central	18%	13%	9%	9%
Inner	16%	12%	10%	9%
Outer	14%	11%	9%	9%
Ext	12%	10%	9%	10%

TABLE S1.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,600.47	-19.23

TABLE S1.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	317.96	-0.47
Commute	1,675.46	1,670.37	-5.09
Other	1,625.80	1,612.13	-13.66

TABLE S1.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	1,875.70	-80.24
bus	502.68	517.78	15.10
rail	1,161.08	1,206.99	45.91

TABLE S1.5: TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	48.42	42.27	14.63	8.10
Inner	283.60	526.34	159.12	49.99
Outer	299.18	258.17	1,261.22	174.79
External	188.89	77.37	208.20	0.18

Change	Central	Inner	Outer	External
Central	-0.72	-0.27	-0.05	0.00
Inner	-1.29	-3.61	-0.90	0.00
Outer	-0.42	-0.92	-8.85	0.00
External	-0.16	-0.25	-1.78	0.00

TABLE S1.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,898.77	-7.65

TABLE S1.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,494.80	-1.23
Inner	903.45	901.57	-1.88
Outer	1,506.93	1,502.40	-4.53

TABLE S1.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	106,180.00	105,932.22	-247.78
Outer	63,856.00	63,552.29	-303.71
Total	170,036.00	169,484.51	-551.49

Scenario 2 Bus fares increased by 20%

TABLE S2.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR BUS COMMUTER

	Central	Inner	Outer	Ext
Central	2%	1%	1%	1%
Inner	1%	1%	1%	1%
Outer	1%	1%	1%	1%
Ext	1%	1%	1%	1%

TABLE S2.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,616.97	-2.72

TABLE S2.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	318.41	-0.02
Commute	1,675.46	1,674.74	-0.72
Other	1,625.80	1,623.82	-1.98

TABLE S2.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	1,959.28	3.34
bus	502.68	491.72	-10.96
rail	1,161.08	1,165.98	4.90

TABLE S2.5: TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	49.11	42.51	14.68	8.10
Inner	284.69	529.34	159.85	49.99
Outer	299.58	259.00	1,268.78	174.63
External	189.05	77.62	209.85	0.18

Change	Central	Inner	Outer	External
Central	-0.03	-0.03	0.00	0.00
Inner	-0.20	-0.61	-0.17	0.00
Outer	-0.01	-0.09	-1.28	-0.16
External	0.00	0.00	-0.13	0.00

TABLE S2.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,905.63	-0.78

TABLE S2.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,495.89	-0.13
Inner	903.45	903.26	-0.20
Outer	1,506.93	1,506.48	-0.45

TABLE S2.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	106,180.00	106,162.38	-17.62
Outer	63,856.00	63,832.72	-23.28
Total	170,036.00	169,995.10	-40.90

Scenario 3 Rail fares increased by 20%

TABLE S3.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR RAIL COMMUTER

	Central	Inner	Outer	Ext
Central	3%	2%	3%	5%
Inner	2%	2%	2%	5%
Outer	3%	2%	2%	6%
Ext	5%	5%	6%	6%

TABLE S3.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,615.95	-3.74

TABLE S3.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	318.34	-0.10
Commute	1,675.46	1,674.02	-1.44
Other	1,625.80	1,623.59	-2.21

TABLE S3.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	1,967.09	11.16
bus	502.68	507.55	4.87
rail	1,161.08	1,141.31	-19.77

TABLE S3.5: TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	49.09	42.50	14.64	8.04
Inner	284.47	529.54	159.77	49.77
Outer	299.38	258.65	1,269.66	174.53
External	188.79	77.19	209.77	0.18

Change	Central	Inner	Outer	External
Central	-0.05	-0.04	-0.04	-0.05
Inner	-0.42	-0.42	-0.26	-0.22
Outer	-0.21	-0.43	-0.40	-0.27
External	-0.27	-0.43	-0.22	0.00

TABLE S3.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,904.39	-2.02

TABLE S3.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,494.96	-1.07
Inner	903.45	902.85	-0.60
Outer	1,506.93	1,506.58	-0.35

TABLE S3.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	106,180.00	106,044.39	-135.61
Outer	63,856.00	63,833.07	-22.93
Total	170,036.00	169,877.46	-158.54

Scenario 4 Car costs increased by £2

TABLE S4.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR CAR COMMUTER

	Central	Inner	Outer	Ext
Central	14%	24%	18%	9%
Inner	12%	21%	19%	9%
Outer	9%	15%	16%	11%
Ext	6%	8%	10%	12%

TABLE S4.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,577.64	-42.06

TABLE S4.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	317.88	-0.55
Commute	1,675.46	1,667.92	-7.55
Other	1,625.80	1,591.84	-33.96

TABLE S4.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	1,798.73	-157.21
bus	502.68	532.95	30.27
rail	1,161.08	1,245.96	84.88

TABLE S4.5: TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	48.42	41.63	14.54	8.10
Inner	283.71	519.54	157.75	49.99
Outer	299.26	257.08	1,248.56	174.79
External	188.96	77.36	207.77	0.18

Change	Central	Inner	Outer	External
Central	-0.72	-0.91	-0.14	0.00
Inner	-1.18	-10.41	-2.28	0.00
Outer	-0.33	-2.01	-21.50	0.00
External	-0.09	-0.26	-2.22	0.00

TABLE S4.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,895.11	-11.30

TABLE S4.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,495.18	-0.85
Inner	903.45	900.31	-3.14
Outer	1,506.93	1,499.62	-7.31

TABLE S4.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	106,180.00	105,870.80	-309.20
Outer	63,856.00	63,354.55	-501.45
Total	170,036.00	169,225.35	-810.65

Scenario 5 Bus fares increased by £2

TABLE S5.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR BUS COMMUTER

	Central	Inner	Outer	Ext
Central	27%	17%	10%	6%
Inner	18%	17%	12%	6%
Outer	12%	12%	11%	7%
Ext	6%	6%	7%	6%

TABLE S5.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,586.57	-33.13

TABLE S5.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	318.10	-0.34
Commute	1,675.46	1,666.49	-8.97
Other	1,625.80	1,601.98	-23.82

TABLE S5.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	1,998.65	42.72
bus	502.68	370.29	-132.39
rail	1,161.08	1,217.62	56.54

TABLE S5.5: TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	48.62	42.14	14.67	8.10
Inner	281.97	518.17	158.55	49.99
Outer	299.50	258.33	1,257.40	173.43
External	189.05	77.61	208.86	0.18

Change	Central	Inner	Outer	External
Central	-0.52	-0.40	-0.02	0.00
Inner	-2.92	-11.79	-1.47	0.00
Outer	-0.09	-0.75	-12.67	-1.36
External	-0.01	-0.01	-1.12	0.00

TABLE S5.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,896.46	-9.95

TABLE S5.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,494.04	-1.99
Inner	903.45	899.88	-3.57
Outer	1,506.93	1,502.55	-4.39

TABLE S5.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	106,180.00	105,887.44	-292.56
Outer	63,856.00	63,630.39	-225.61
Total	170,036.00	169,517.83	-518.17

Scenario 6 Rail fares increased by £2

TABLE S6.1: AVERAGE PERCENTAGE INCREASE IN GENERALISED COSTS, FOR RAIL COMMUTER

	Central	Inner	Outer	Ext
Central	31%	21%	15%	11%
Inner	20%	20%	16%	11%
Outer	15%	16%	15%	11%
Ext	11%	11%	11%	10%

TABLE S6.2: TOTAL DEMAND CHANGE (000S TRIPS PER AM PEAK)

Base	Final	Change
3,619.70	3,598.33	-21.37

TABLE S6.3: TOTAL DEMAND CHANGE BY PURPOSE (000S TRIPS PER AM PEAK)

	Base	Final	Change
Business	318.43	317.89	-0.54
Commute	1,675.46	1,667.49	-7.97
Other	1,625.80	1,612.94	-12.85

TABLE S6.4: TOTAL DEMAND CHANGE BY MODE (000S TRIPS PER AM PEAK)

	Base	Final	Change
car	1,955.94	2,018.05	62.11
bus	502.68	529.45	26.77
rail	1,161.08	1,050.83	-110.25

TABLE S6.5 TOTAL DEMAND CHANGE BY ORIGIN AND DESTINATION (000S TRIPS PER AM PEAK)

Origin	Destination			
Base	Central	Inner	Outer	External
Central	49.14	42.54	14.68	8.10
Inner	284.89	529.96	160.02	49.99
Outer	299.59	259.09	1,270.07	174.79
External	189.05	77.62	209.99	0.18

Final	Central	Inner	Outer	External
Central	48.54	42.13	14.44	7.98
Inner	280.96	525.69	158.25	49.56
Outer	298.33	256.10	1,267.04	174.30
External	188.45	76.78	209.58	0.18

Change	Central	Inner	Outer	External
Central	-0.60	-0.41	-0.24	-0.12
Inner	-3.93	-4.26	-1.77	-0.43
Outer	-1.26	-2.99	-3.02	-0.49
External	-0.60	-0.84	-0.40	0.00

TABLE S6.6: TOTAL EMPLOYMENT CHANGE (000S JOBS)

Base	Final	Change
3,906.41	3,895.23	-11.19

TABLE S6.7: TOTAL EMPLOYMENT CHANGE BY ZONE (000S JOBS)

	Base	Final	Change
Central	1,496.03	1,490.16	-5.87
Inner	903.45	900.13	-3.32
Outer	1,506.93	1,504.94	-2.00

TABLE S6.8: LONDON RGVA PER ANNUM (£M)

	Base	Final	Change
Inner	170,036.00	169,237.33	-798.67
Outer	170,036.00	169,237.33	-798.67
Total	170,036.00	169,237.33	-798.67

Appendix G – Elasticities derived from SPAM

Source: SPAM 04/10/05

TABLE G1: ELASTICITY OF DEMAND WITH RESPECT TO GENERALISED COST FOR CARS

	work				non work			
Car	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	-1.42	-0.44	-0.75	-1.73	-0.76	-0.31	-0.66	-2.93
Inner	-1.62	-0.34	-0.42	-1.07	-1.28	-0.35	-0.40	-1.70
Outer	-2.46	-0.49	-0.17	-0.27	-2.28	-0.52	-0.23	-0.45
Ext	-3.61	-1.30	-0.17	0.00	-4.11	-1.66	-0.27	0.00

TABLE G2: ELASTICITY OF DEMAND WITH RESPECT TO GENERALISED COST FOR BUS

	work				non work			
Bus	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	-1.18	-1.78	-3.57	0.00	-1.56	-2.35	-4.34	0.00
Inner	-1.67	-1.84	-2.86	0.00	-2.16	-2.33	-3.43	0.00
Outer	-3.33	-3.25	-1.90	-5.29	-3.99	-3.83	-2.21	-5.87
Ext	0.00	-7.56	-7.80	-2.76	0.00	0.00	-8.16	-3.17

TABLE G3: ELASTICITY OF DEMAND WITH RESPECT TO GENERALISED COST FOR RAIL

	work				non work			
Rail	Central	Inner	Outer	Ext	Central	Inner	Outer	Ext
Central	-1.22	-1.22	-0.70	-0.66	-1.08	-1.19	-0.80	-0.40
Inner	-0.79	-1.20	-0.95	-1.12	-0.90	-1.05	-0.91	-0.82
Outer	-0.18	-0.90	-1.21	-2.22	-0.37	-0.83	-1.08	-2.09
Ext	-0.18	-0.83	-2.62	-0.67	-0.37	-0.85	-2.45	-0.47

TABLE G4: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR CAR

Car	Central	Inner	Outer	Ext
Central	0.34	0.37	0.44	0.93
Inner	0.43	0.36	0.38	0.56
Outer	0.60	0.41	0.39	0.41
Ext	1.56	0.58	0.41	0.00

TABLE G5: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR BUS

Bus	Central	Inner	Outer	Ext
Central	0.15	0.22	1.80	0.00
Inner	0.25	0.17	0.28	0.00
Outer	0.97	0.36	0.21	0.14
Ext	0.00	0.00	0.26	0.13

TABLE G6: ELASTICITY OF TIME COSTS WITH RESPECT TO DEMAND FOR RAIL

Rail	Central	Inner	Outer	Ext
Central	0.03	0.05	0.09	0.06
Inner	0.04	0.04	0.07	0.05
Outer	0.06	0.06	0.07	0.04
Ext	0.04	0.04	0.04	0.04