NRA
An tÚdarás um Bóithre Náisiúnta
National Roads Authority

Project Appraisal Guidelines

Unit 20.1 Demographic and Economic Forecasting for the National Traffic Model

June 2011

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1.0	June 2011	New Guidance

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1. Background

1.1. The National Traffic Model (NTM) was constructed to assist the National Roads Authority (NRA) in the planning and appraisal of new road infrastructure. It is based on a forecast year of 2025. Predictions of population, job numbers and car ownership for that year form the basis of the model's trip generating and attraction functions

1.2. In 2001, the Transport Research Laboratory (TRL) undertook a study of travel on all public roads in Ireland and developed forecasts of traffic volumes covering the period 2002 to 2041. Considerable changes have occurred in the Irish economy since these forecasts were developed. Following a period of significant economic growth that was accompanied by very high levels of immigration, Ireland is now in economic recession and recorded negative net migration in 2009 for the first time since 1995. Negative net migration occurs when emigration exceeds immigration having a negative impact on the overall population. Thus, the underlying economic and demographic characteristics of the TRL forecasting are no longer tenable. With this in mind, and for the purposes of the NTM, a new set of traffic forecasts have been developed to take account of the changing economic and demographic characteristics of the country.

1.3. The development of future year traffic forecasts for the NTM needs to take account of the economic and demographic environment that has developed since 2008. Oil prices have also increased significantly over the period and the prospect is for further significant price rises, especially as the global economy recovers.

1.4. Concerns about climate change and sustainability have caused a significant policy shift in favour of sustainable transport policies. Smarter Travel – A Sustainable Future for Ireland aims at reversing unsustainable transport and travel patterns and reducing adverse health and environmental impacts. It recognises that economic growth prospects are now substantially reduced and the national population could reach 4.8m by 2020, rather than the previous projection of 5.1m.

1.5. Despite the reduced economic and demographic prospects, the Smarter Travel Policy is concerned that car numbers could reach 2.47m by 2020. Against this background, the Smarter Travel Policy aims to ensure that the total kilometres travelled by the car fleet in 2020 will not increase significantly from its 2008 level and that work-related commuting by car should reduce from 65 per cent to 45 per cent of all such trips.

1.6. The Policy recognises that achieving sustainable transport will require a suite of measures including sustainable land use and employment policies, fiscal measures to dis-incentivise unnecessary car travel and improvements in public transport. The cost of the Policy is estimated at €4.5bn and a phased approach to its implementation is envisaged, with significant progress being sought by 2015. The Policy document notes that funding the required measures will be a matter for Government in light of the prevailing economic and budgetary situation.

1.7. The NTM traffic forecasts take account of these new policies and prospects by:

- Incorporating reduced economic growth prospects [and higher oil prices];
- Adopting a central population forecast in line with the reduced Smarter Travel target of 4.8m by 2020;
- Recognising the impact of economic growth and saturation effects on car ownership and predicting a car fleet of 2.1m by 2020, thus almost halving the growth in car numbers envisaged in the Policy (medium scenario); and
- Providing a low scenario forecast that facilitates the testing of the robustness of projects to even more pessimistic assumptions.

1.8. The adoption of this approach means that the NTM traffic forecasts are realistic in the light of current policies and prospects. Nevertheless, they should be regarded as constituting a set of Baseline Forecasts that will need some revision, as the measures under the Smarter Travel Policy are successfully implemented.

Overview of Approach

1.9. Traffic demand varies according to a range of different factors, including the size of the population; the age distribution of the population; the rate of car ownership among the adult population; and economic activity both in terms of the movement of goods and the location of jobs. As such, it is necessary to develop a number of different forecasts that, when input to the NTM, will ultimately give rise to forecasts of future traffic demand. Figure 20.1.1 below gives a simple illustration of how the various forecasts work together.

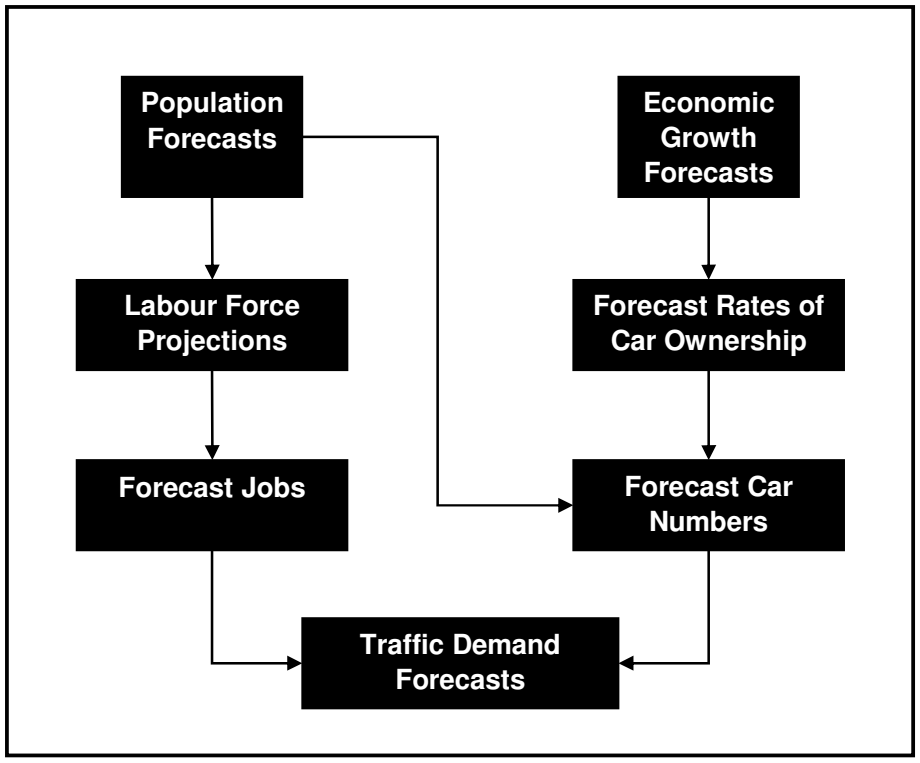

Figure 20.1.1: Overview of the Traffic Forecasting Process

1.10. As the figure indicates, the modelling process begins with the separate development of population and economic growth forecasts. The population forecasts are then

used to derive labour force projections, which take account of the future age distribution of the population as well as the expected rate of labour force participation. These labour force projections then take account of future employment rates, giving rise to forecast job numbers. The economic growth forecasts are used to develop future rates of car ownership among the adult population, taking account of an assumed saturation level. These car ownership rates are then applied to the adult population forecasts to derive forecasts of actual car numbers. These car numbers, together with the job forecasts, which give an indication of future traffic generators and attractors, are entered into the NTM to develop forecasts of future traffic demand.

1.11. Each set of forecasts is designed to produce output data at a number of different levels including national, regional, county, zone and DED. Furthermore, because the extent of economic and demographic change over the period to 2025 is uncertain, each set of forecasts includes low, medium and high scenario output data to take account of this uncertainty. The base year in each instance is 2006 as this is the most recent year for which definitive population and other demographic data are available.

2. Demographic Forecasts

National and Regional Population Forecasting

2.1. Population projections are based on the natural increase in the population and net migration. These in turn are dependent on anticipated fertility rates and the national and international economic environment.

2.2. In 2008, population projections based on the National and Regional Population Projections issued by the Department of Environment, Heritage and Local Government (DEHLG)[1] were employed in the National Traffic Model. The Department's projections were based on preliminary CSO census results but also accounted for the impact of the National Spatial Strategy on future population growth. The DEHLG made projections for 2011, 2016 and 2020[2]. Estimates for 2025 were obtained using a national population-forecasting model maintained by the consultants. Implicit in the DEHLG projections was large net migration in the region of 50,000 per annum up to 2011, falling to 37,500 per annum in the 2016-2020 period.

2.3. Recent economic developments will impact population growth going forward, particularly as they affect net migration. Current data suggest the number of immigrants, which was the main contributory factor in population growth in the past number of years, is falling and that net migration is recurring. This raises the issue of the extent to which existing National Traffic Model forecasts for 2025 needs to be complemented by conservative scenarios. The extent of the economic and

[1] Department of the Environment and Local Government, National and Regional Population Projections 2006-2020, February 2007. The Department's population projections are intended to support the Regional Planning Guidelines used as part of the implementation of the National Spatial Strategy (NSS).
[2] Department of the Environment and Local Government, National and Regional Population Projections 2006-2020, February 2007. The Department's population projections are intended to support the Regional Planning Guidelines used as part of the implementation of the National Spatial Strategy (NSS).

demographic change over the period to 2025 is subject to uncertainty. This suggests that a range of forecasts is required that take account of this uncertainty. This has traditionally been done by considering low, medium and high forecasts. This section of the report will outline the approach utilised in projecting a set of high, medium and low population forecasts.

Approach

2.4. The overall approach in projecting future population is illustrated in Figure 20.1.2. Firstly National Population is forecast for the high, medium and low scenarios. Subsequently, population projections are carried out for each of the NUTS 3 regions. The Regional Projections are broken down to Zones and from these projections the County and DED forecasts are extracted. A top down approach was adopted to ensure that the projections for the zones would be consistent with the regional and national projections. Thus, the zonal forecasts that form the basis of the model relate to regional and national population growth. These zonal projections can be aggregated to give county level projections and disaggregated to DED level projections.

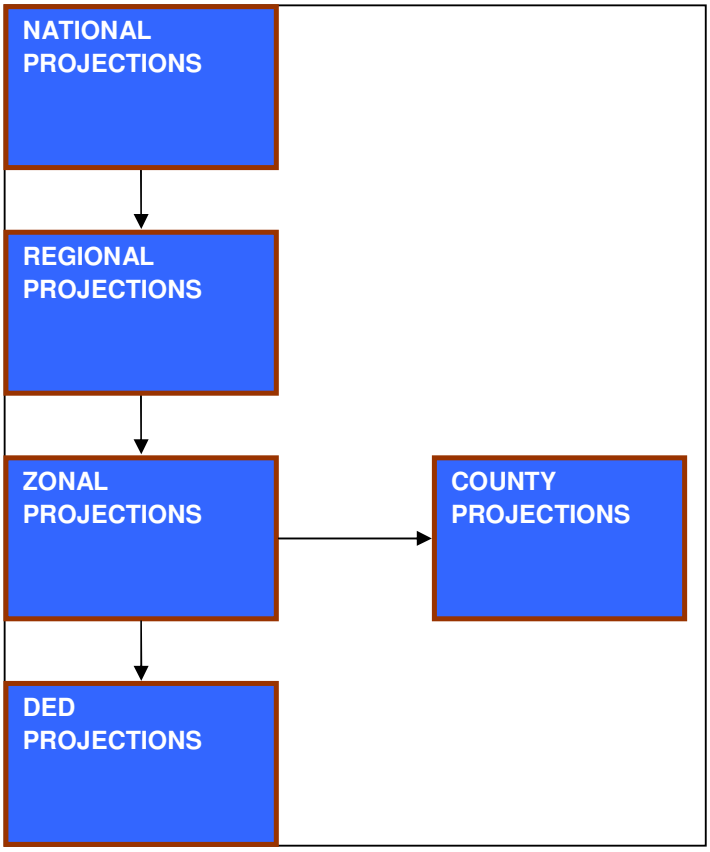

Figure 20.1.2 Approach to Preparation of Population Projections

National Population Forecasts

2.5. The National and Regional Population Projections issued by the Department of Environment, Heritage and Local Government (DEHLG) in 2007[3] were previously employed in the National Traffic Model. The Department's projections were based on preliminary CSO census results but also accounted for the impact of the National Spatial Strategy on future population growth. Two main assumptions were inherent in these projections. Firstly, the fertility rate was expected to decline up to 2011 and to stabilise thereafter; equivalent to the F2 assumption applied by the CSO at the time. Secondly, net immigration was assumed to total approximately 50,000 per annum up to 2011 before falling to 37,500 per annum in the 2016-2020 period. The DEHLG made projections for 2011, 2016 and 2020[4].

2.6. In order for the aforementioned projections to be accurately applied to the National Traffic Model, the projections were corrected to account for the final CSO census results and modified using linear interpolation to derive population estimates for 2010 and 2015. Estimates for 2025 were obtained using a national population-forecasting model maintained by AECOM. The decisions on population projections to be employed in the current model were taken after analysis of current official population projections discussed below.

Official Population Projections

2.7. In developing high, medium and low population projections consideration must be given to current official forecasts as it is desirable for current projections to be compatible with official forecasts as much as possible. In April 2008, the CSO published their national population projections for 2011-2041 based on the 2006 census[5]. On foot of this, they released the regional population projections for 2011-2026 in December 2008. In January 2009, the DEHLG issued the national and regional population projections for 2010-2022[6]. The revised figures by the DEHLG take account of the regional population projections by the CSO and update the Department's figures first issued in 2007. In addition, in May 2008, the ESRI Medium Term Review[7] outlined the demographic structure of the population up to 2020 enabling population estimates to be inferred for the period. At present, neither the CSO nor the DOE are expected to revise their national population projections. The CSO's next projections will be published following the 2011 Census.

Comparison of Population Projections

2.8. The official population projections are outlined in Table 2.1 below, which incorporate a range of assumptions regarding fertility and migration. The CSO proposes an F1 fertility rate which assumes fertility will remain at its 2006 level of 1.90 for the lifetime of the projections and an F2 fertility rate which proposes fertility will fall to 1.65 by

[3] Department of the Environment and Local Government, National and Regional Population Projections 2006-2020, February 2007. The Department's population projections are intended to support the Regional Planning Guidelines used as part of the implementation of the National Spatial Strategy (NSS).

[4] 2011, 2016, 2020 represent the years in which a review of the regional planning guidelines is anticipated.

[5] CSO Population and Labour Force Projections 2011-2041, April 2008

[6] Department of Environment Heritage and Local Government, National Population Projections and Regional Population Targets 2010-2022, January 2009.

[7] ESRI Medium Term Review 2008-2020 May 2008

2016 and remain stable thereafter. The DEHLG and the ESRI maintain the forecasts for the natural increase proposed by the CSO under F1.The CSO also proposes a series of migration assumptions. M1 assumes net immigration of over 60,000 per annum in the 2006-2011 period, moderating to over 30,000 per annum from 2021 onwards. M2 assumes net immigration of 50,000 per annum in the 2006-2011 period, before levelling off at 10,000 per annum from 2021 onwards and MO assumes zero net migration with inflows of 20,000 per annum being offset by equivalent annual outflows. The DEHLG assumption on net migration varies significantly from that of the CSO with net immigration of 20,000 in the 2008-2010 period and 17,500 in the 2017-2022 period. The ESRI assumes lower levels of net immigration at 10,000 per annum by 2010 before increasing to 15,000 by 2015 onwards.

2.9. As can be seen the AECOM projections previously employed are broadly in line with the figures for CSO F1M2 and DEHLG estimates over the short term. However, in the long term to 2025 the figures begin to deviate. The traditional CSO projection, F1M2 is approximately 60,000 greater than the AECOM projection for 2025. Some of this difference may be accounted for by the fact that the AECOM population forecasting model anticipated significant moderating of the population growth in the 2015-2025 period. However, the difference in the AECOM figure and the DEHLG projections are even starker with the DEHLG approximately 120,000 greater than the AECOM figure. The F1M0 and F2M0 projections are significantly lower than AECOM previous estimates, in the region of 700,000 and 800,000 respectively, the bulk of this difference stemming from the zero net migration assumed by the CSO. Both the CSO F1M2 and the DEHLG projections appear high given current developments in the economy particularly regarding net migration. However, these projections are largely compatible with the projections previously employed. The CSO F1M0 appears more plausible and these have been adopted by the Department of Transport as their medium population forecasts for use in Business Cases. The development of high, medium and low forecasts is discussed in the following sections.

Table 20.1.1 Population Projections 2006 - 2025 (CSO and DEHLG)

	DEHLG	CSO F1M2	CSO F2M0	CSO F1M0	ESRI	AECOM
2006	4,232,900	4,232,900	4,232,900	4,232,900	4,232,900	4,232,900
2010	4,584,900	4,594,980	4,376,980	4,384,100	4,532,529	4,572,811
2015	4,928,317	5,012,140	4,537,240	4,569,900	4,833,137	4,977,903
2020	5,299,560	5,378,120	4,662,780	4,732,340	5,172,402	5,339,139
2025	5,708,124	5,646,160	4,753,760	4,859,140		5,587,812

Source: AECOM, Department of Environment, Heritage & Local Government & CSO

High Population Projections

2.10. The F1M2 population projection issued by the CSO has been adopted as the High growth scenario. The F1M2 is largely consistent with the previous high forecasts employed and is also consistent with the overall methodology employed for the medium and low projections outlined below. The F1M2 projection assumes fertility rates remain at 2006 levels of 1.90 and net immigration of 50,000 per annum in the

2006-2011 period, before levelling off at 10,000 per annum from 2021 onwards. Other assumptions include mortality rates declining, with life expectancy at birth increasing from 76.7 years in 2005 to 86.5 in 2041 for males and an increase from 81.5 years in 2005 to 88.2 years in 2041 for women. In deciding on fertility rates the CSO concluded that the increased educational attainment and labour force participation of women would exert a downward pressure on fertility and average family size is projected to decrease further. It also noted that Irish fertility rates are still high compared to those of other European countries.

2.11. The model employed in projecting the population is outlined in Figure 20.1.3 below. The 2006 base population is disaggregated by age and sex. Once the population has aged one year, the survivorship ratios are applied at different age levels, giving a surviving population. The assumed inward and outward migration flows are broken down by age and sex based on patterns in the 2002-2006 period and added to the surviving population, resulting in the surviving population adjusted for migration. Age specific fertility rates are then applied to the female population, projecting the number of births. Birth are broken down by sex according to ratios experienced in recent years and the appropriate survivorship rates applied to male and female births, resulting in total projected population.

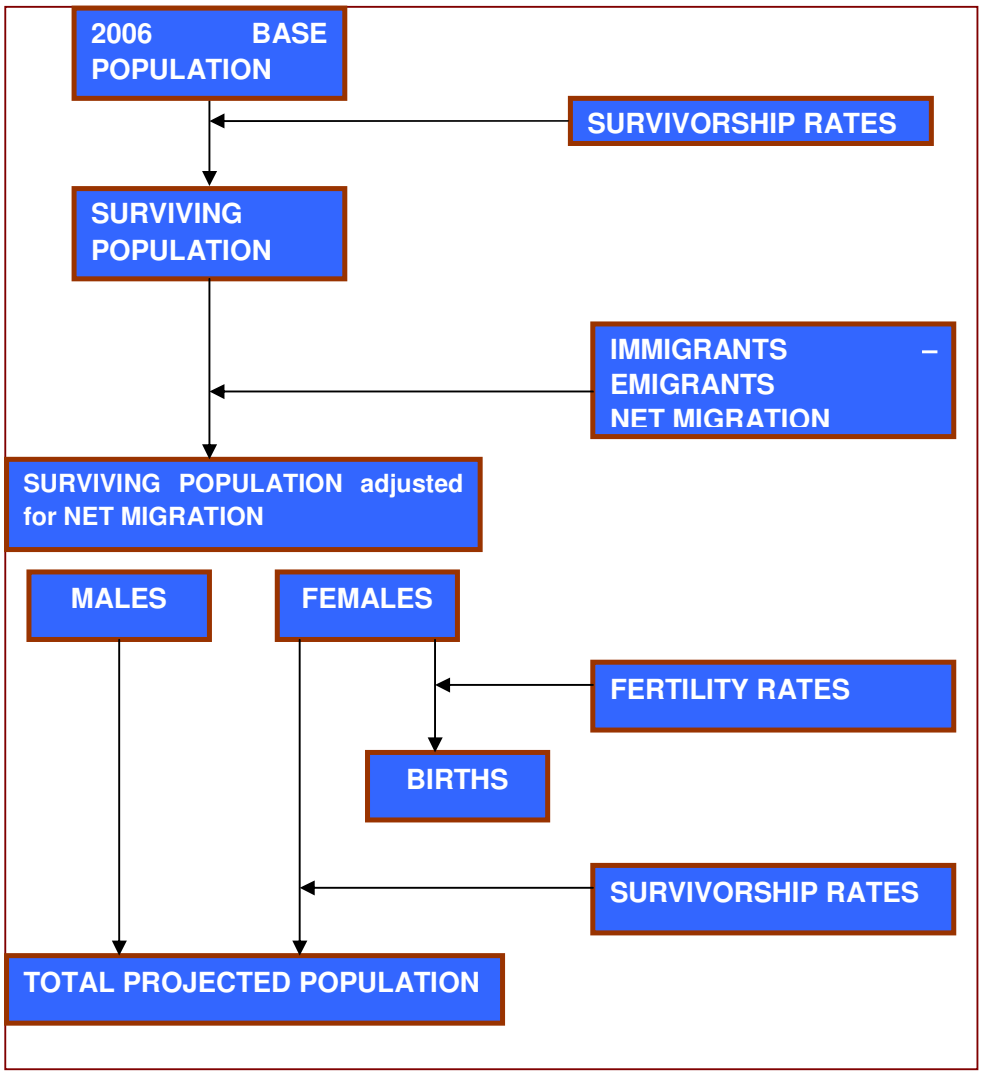

Figure 20.1.3 Population Projection Model

2.12. The High Population Projections are shown in Table 20.1.2 below.

Table 20.1.2: High Population Projections 2006 – 2025

	High
2006	4,232,929
2010	4,591,784
2015	5,011,233
2020	5,380,125
2025	5,649,728

Source: Population & Labour Force Projections 2011-2041 CSO

Medium Population Projections

2.13. The F1M0 population projection issued by the CSO has been adopted as the Medium growth scenario. The F1M0 projection assumes fertility rates remain at 2006 levels of 1.90 and zero net migration with inflows of 20,000 per annum being offset by equivalent annual outflows for the lifetime of the projections. Assumptions

regarding mortality and the methodology employed are equivalent to those for the High Projections. The Medium Population Projections are shown in Table 20.1.3 below.

Table 20.1.3: Medium Population Projections 2006 – 2025

	Medium
2006	4,232,929
2010	4,383,782
2015	4,571,520
2020	4,735,460
2025	4,861,661

Source: Population & Labour Force Projections 2011-2041 CSO

Low Population Projections

2.14. The Low Population Projections for the NTDM has been developed by the consultants utilising their Population Forecasting Model. The fertility and mortality assumptions utilised in the low projection were the same as those employed by the CSO in the Medium projection. However, the low projection incorporates significant out migration in the short term before moderating to lower levels in the long term to 2025. It is envisaged that net out migration will be at the level of 30,000 per annum for 2009-2011. These levels of net out migration are based on the assumption that a significant proportion of non nationals will leave the country as the economy declines. Following this substantial net out migration, the level of net out migration will diminish as the pool of possible emigrants' declines. From 2012 onwards, it is proposed to base the low forecast on an assumption of net out migration of 15,000 per annum up to 2020 and thereafter remain at zero net migration. Table 20.1.4 outlines AECOM proposed migration assumptions for the 2009-2025 period.

Table 20.1.4: Low Growth Migration Assumptions

	Net Migration
2009-2011	-30,000
2012-2020	-15,000
2021-2025	0

Source: AECOM

2.15. The methodology employed in the Low projections was the same methodology as outlined in Figure 20.1.2 above, as the population forecasting model maintained by the consultants essentially replicates the CSO model. The results of the Low Population Projection are given in Table 20.1.5 below.

Table 20.1.5: Low Population Projections 2006 – 2025

	Low
2006	4,232,929
2010	4,379,203
2015	4,497,596
2020	4,580,926
2025	4,670,410

Source: AECOM

Summary

2.16. The final population projections are presented in Table 20.1.6 below, detailing the high medium and low forecasts. The projections show that the AECOM Low projection in 2010 is a mere 4,500 less than the Medium Projection. The Medium projection is represented by the CSO F1M0 and based on 2006 does not account for the large levels of net inward immigration which occurred in the 2007-2008 period. Whilst the Low AECOM projection takes account of these inward migration levels and the subsequent outward migration forecasted, the effects of the large out migration are not seen until after 2010. However, by 2015 the Medium forecast is some 74,000 greater than the Low projections, rising to approximately 190,000 by 2025. The High projection is some 980,000 greater than the AECOM Low projections and some 788,000 greater than the AECOM Medium forecasts in 2025.

Table 20.1.6: Population Projections 2006 – 2025

	High	Medium	Low
2006	4,232,929	4,232,929	4,232,929
2010	4,591,784	4,383,782	4,379,203
2015	5,011,233	4,571,520	4,497,596
2020	5,380,125	4,735,460	4,580,926
2025	5,649,728	4,861,661	4,670,410

Source: AECOM & CSO

Regional Population Projections

High Regional Population Projections

2.17. The regional projections for the High forecast represented by the CSO F1M2 were published in December 2008. The regional projections assumed that the regional fertility and mortality trends and international migration to and from each region were consistent with those used at national level and published in April 2008. In addition two internal migration scenarios are used, “Recent” and “Traditional” The traditional scenario assumes the pattern of internal migration experienced in 1996 is applied from 2016 onwards with the difference between 2006 and 1996 distributed over the years 2006-2016. The recent scenario assumes the pattern of internal migration experienced in 2006 is applied up to 2026.

2.18. In deciding on which scenario to employ for the High Projection for the NTDM, trends in migration over the past number of years were examined. The 2006 census showed that Dublin experienced a net negative net migration flow whilst the long

term traditional pattern showed that Dublin and the Mid East experienced positive net migration flows while flows in all other regions were negative. In the current circumstance the traditional scenario for internal migration patterns was utilised. This was deemed appropriate since a return to economic growth is likely to centre on Dublin. The High Population Projections are illustrated in Table 20.1.7 below. The methodology employed in the Regional projections is the same methodology as outlined in Figure 20.1.2.

Table 20.1.7: High Regional Population Projections, 2010-2025

	2006	2010	2015	2020	2025
Border	469,839	506,264	543,237	571,214	589,304
Greater Dublin	1,183,384	1,274,997	1,404,736	1,537,756	1,640,590
Mid East	478,512	544,216	619,818	686,872	743,224
Midlands	251,973	277,449	300,402	314,046	320,392
Mid West	358,891	382,712	409,883	432,730	448,095
South East	460,944	499,655	539,318	569,146	588,428
South West	618,679	661,398	709,156	748,526	772,572
West	410,707	445,262	485,698	521,693	548,076

Source: CSO & AECOM

Medium Regional Population Projections

2.19. The regional projections for the Medium forecast represented by the CSO F1M0 were published in December 2008. Similar to the High regional projections it is assumed that the regional fertility and mortality trends and international migration to and from each region were consistent with those used at national level and published in April 2008. Again the traditional scenario for internal migration patterns was utilised since a return to economic growth is likely to centre on Dublin. The Medium Population Projections are illustrated in Table 20.1.8 below.

Table 20.1.8: Medium Regional Population Projections, 2010-2025

	2006	2010	2015	2020	2025
Border	469,839	487,884	504,516	514,935	521,639
Greater Dublin	1,183,384	1,193,771	1,234,153	1,288,521	1,334,665
Mid East	478,512	524,101	576,017	620,535	659,693
Midlands	251,973	267,322	279,346	284,124	285,032
Mid West	358,891	369,681	382,306	392,227	398,641
South East	460,944	483,462	505,313	519,843	529,334
South West	618,679	634,056	651,438	663,836	669,334
West	410,707	423,723	439,870	453,971	464,716

Source: CSO & AECOM

Low Regional Population Projections

2.20. The regional projections for the Low scenario were forecast by Regional Population Forecasting Model maintained by the consultants. In running the model for each region the fertility, mortality and international migration assumptions previously used for the national model are also applied for each region. In the current case the traditional pattern of internal migration was also used, in line with the medium

scenario. The regional model replicates the CSO model and thereby applies the same methodology. Table 20.1.9 outlines the projections for the Low scenario.

Table 20.1.9: Low Regional Population Projections, 2010-2025

	2006	2010	2015	2020	2025
Border	469,839	486,101	495,732	499,949	503,841
Greater Dublin	1,183,384	1,193,653	1,208,879	1,226,823	1,253,746
Mid East	478,512	521,631	565,383	603,462	641,639
Midlands	251,973	266,280	274,368	276,717	277,820
Mid West	358,891	366,699	373,220	377,127	380,392
South East	460,944	485,048	502,919	514,285	524,480
South West	618,679	629,548	635,768	636,726	636,431
West	410,707	426,454	437,358	444,662	452,300

Source: AECOM

Summary

2.21. The Regional population projections for 2025 under the three scenarios are outlined in Table 20.1.10 below. A similar pattern is seen across all regions with incremental population increases from the Low to High projections. The regional population projections do not tally to the National Figures due to rounding.

Table 20.1.10 Regional Population Projections 2006 & 2025

		High	Medium	Low
	2006	2025	2025	2025
Border	469,839	589,304	521,639	503,841
Dublin	1,183,384	1,640,590	1,334,665	1,253,746
Mid East	478,512	743,224	659,693	641,639
Midlands	251,973	320,392	285,032	277,820
Mid West	358,891	448,095	398,641	380,392
South East	460,944	588,428	529,334	524,480
South West	618,679	772,572	669,334	636,431
West	410,707	548,076	464,716	452,300
State	4,232,929	5,650,681	4,863,054	4,670,649

Source: AECOM, CSO & DEHLG

Zonal and DED Population Forecasts

Introduction

2.22. The National Traffic Model is based on zonal population projections, with each zone comprising a number of DEDs. As a result the high, medium and low growth scenarios need to be disaggregated down to zonal level. Population projections for each zone are derived from the regional population projections.

Zonal Population Projections

2.23. The methodology adopted to forecast the populations of individual zones within each region was based on the identification of factors particular to certain zones which were likely to support or hinder population growth. This approach took account of both the topographical features of each zone, and the likely level of future development as envisaged by local authorities in their local area plans.

2.24. The zones were coded according to their various features, and four groups or categories of zone were developed based on the number of positive or negative features found in each zone. The categories ranged in scale from the first, which was for zones that are expected to achieve low growth, to the fourth which was for zones that are expected to exhibit high growth:

1. Zones with negative features such as the presence of mountains or being located in an urban core;
2. Zones that had neither positive or negative features associated with them;
3. Zones with just one positive feature associated with them; and
4. Zones with more that one positive feature, such as being in the commuter orbit of a large city and having a national route pass through the zone.

2.25. A small number of zones had both positive and negative features, and these were allocated to the third category. This allocation was based on the observation that those zones which had both positive and negative features had tended to exhibit reasonably strong growth rates in the past. Thus it was concluded that the presence of a positive feature tended to dominate the presence of a negative feature.

2.26. Each zone is allocated a growth rate and a process of iteration results in the zonal projections matching the regional totals. Thus, the four categories were allocated a separate growth rate that was consistent with the category hierarchy and the regional population target. The zonal growth rates are estimated for each region separately and the future zonal distribution of population within each region is determined by the growth rates estimated.

DED Population Projections

In allocating zonal population to DED level a partial count was taken of recent trends in population growth levels. This was done in the following manner.

- The starting point of analysis was the belief that DED growth rates should reflect in part recent trends in population growth. When previous trends were fully reflected it was found a certain percentage of DEDs, which experienced strong growth patterns in 2002-2006 period, took an inordinately high share of zonal population growth.
- To avoid this outcome, the previous trends were only partially reflected in future growth. This process was applied all DEDs with the exception of one Zone comprising Airport and Turnapin. This Zone had exhibited extremely high growth rates in the 2002-2006 period such that that even recognising this trend only partially gave rise to unbelievably high projected growth rates

for Airport and the opposite for Turnapin. For that Zone, the DED growth rates were adjusted by assuming that both DEDs experience the growth rate for the zone as a whole.

- Given that the overall DED population was required to tally with the Zonal Population, each DED was adjusted by the projected Zonal Population so the aggregate population of the DEDs totalled to the Zonal Population Projections.

2.27. Given that there are approximately 3400 DED population projections at this level are not supplied in this document. However, a visual representation of the growth in population between 2006 and 2025 is given in Figures 20.1.4 and 20.1.5 below for the medium projection.

County Population Projections

2.28. Population projections at County level are built up from the Zonal population projections. The population totals for Counties, Zones and DEDs do not quite tally to the National or Regional totals. This is partly due to rounding and also due to fact that the Zonal DED and County projections are derived by utilising the de facto population at DED level. This differs from the National and Regional projections which utilise the usually resident population. At present the CSO do not provide data at DED level of usually resident population. Table 20.1.11 illustrates the County Projections for 2006 and 2025 under the three scenarios.

Table 20.1.11 County Projections 2006 & 2025

County	2006	2025 Low	2025 Medium	2025 High
Carlow	50,349	56,951	57,454	63,566
Dublin City	506,211	516,398	528,157	573,224
South Dublin	246,935	270,328	297,376	401,043
Fingal	239,992	266,186	296,234	408,969
Dún Laoghaire	194,038	204,852	217,174	262,611
Kildare	186,335	249,953	256,993	289,566
Kilkenny	87,558	99,229	100,118	110,926
Laoighis	67,059	74,063	76,024	85,677
Longford	34,391	37,516	38,379	42,564
Louth	111,267	119,856	124,361	141,527
Meath	162,831	218,679	224,863	253,478
Offaly	70,868	78,097	80,113	89,987
Westmeath	79,346	87,803	90,166	101,771
Wexford	131,749	151,206	152,697	170,888
Wicklow	126,194	168,781	173,492	195,284
Clare	110,950	119,489	126,962	148,150
Cork City	119,418	124,553	124,553	135,181
Cork County	361,877	371,092	397,728	470,941
Kerry	139,835	143,307	149,705	169,510
Limerick City	52,539	54,798	54,798	59,474
Limerick County	131,516	138,617	146,464	162,645
Tipperary North	66,023	69,752	72,790	80,494
Tipperary South	83,221	95,553	96,498	108,035
Waterford City	45,748	50,992	51,389	56,196
Waterford County	62,213	70,428	71,055	78,681
Galway City	72,414	80,046	82,329	97,694
Galway County	159,256	179,593	185,797	228,689
Leitrim	28,950	30,916	31,939	35,797
Mayo	123,839	134,006	137,017	157,010
Roscommon	58,768	62,586	63,613	69,447
Sligo	60,894	65,388	67,749	76,774
Cavan	64,003	68,403	70,684	79,254
Donegal	147,264	157,608	163,044	183,812
Monaghan	55,997	60,100	62,237	70,305
State	4,239,848	4,677,126	4,869,953	5,659,171

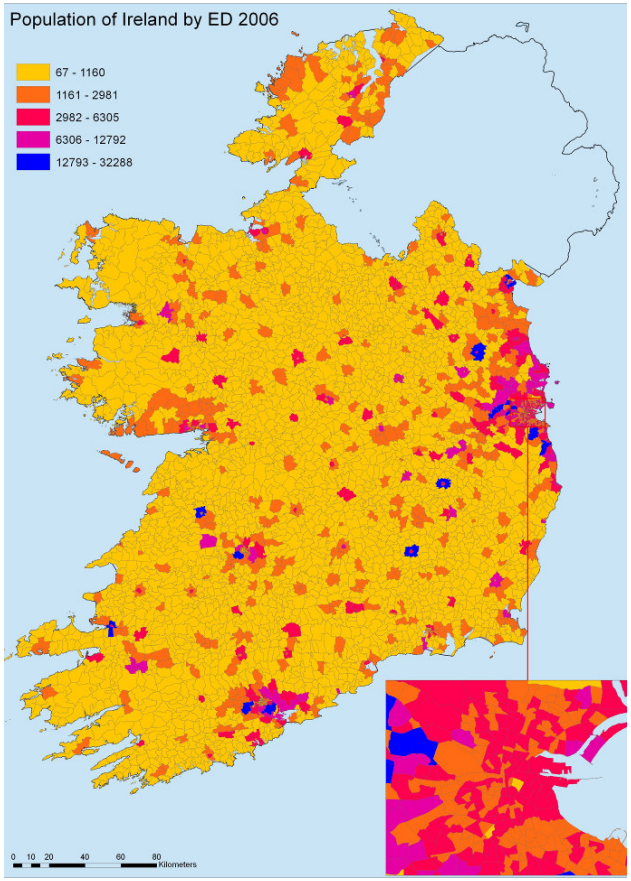

Figure 20.1.4: Population by DED 2006

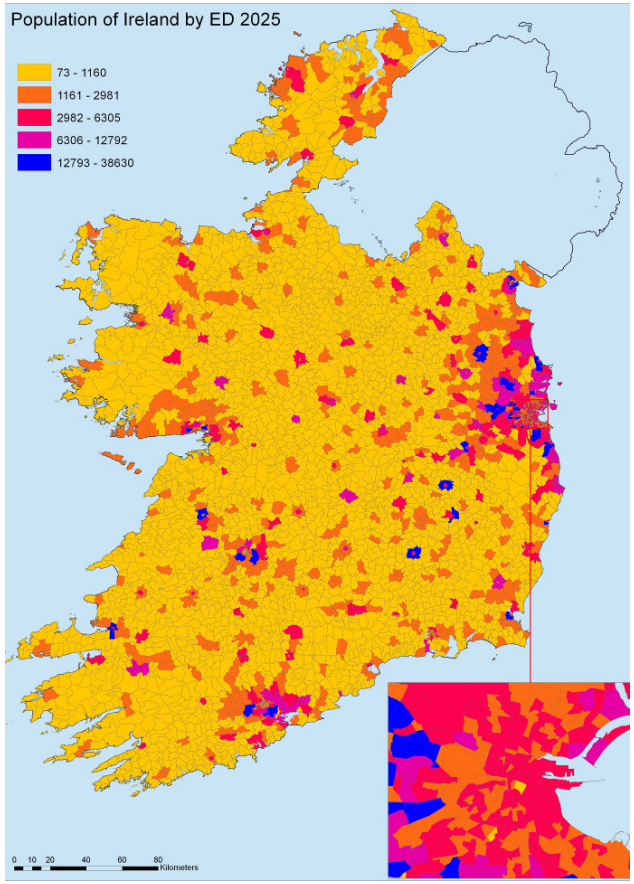

Figure 20.1.5: Population Projections by DED 2025 (Medium Growth)

Households

2.29. Projections of household numbers were developed at national and regional levels using the headship rate method. This involved an analysis of the population by age to identify the proportion of individuals at each age group that are the head of a household. These proportions were then applied to future age groups to get future household numbers and by implication average household sizes. Table 20.1.12 sets out the number of households and average household size forecast for each scenario at five-year intervals covering the period to 2025.

Table 20.1.12: Forecast National Household Numbers and Average Household Size, 2006 – 2025

	Low Scenario		Medium Scenario		High Scenario	
	Total	Average Size	Total	Average Size	Total	Average Size
2006	1,469,521	2.81	1,469,521	2.81	1,469,521	2.81
2015	1,672,139	2.62	1,681,167	2.64	1,826,167	2.67
2020	1,748,373	2.55	1,784,056	2.58	2,002,753	2.61
2025	1,826,581	2.48	1,878,566	2.51	2,148,788	2.55

Source: AECOM & CSO

2.30. The baseline population data at county level does not contain the level of detail on age groups and gender required for the headship rate method of forecasting. Thus a different approach was taken to developing the forecasts of households and average household size at county and DED level.

2.31. Census data on the population living in private households and average household size were used to derive a baseline of household numbers in each county. It was assumed that the proportion of the population in each county living in private households in 2006 would remain the same over the lifetime of the projections, so these proportions were applied to the population forecasts for each county to derive forecasts of the population that will be living in private households in each county.

2.32. To derive forecasts of actual household numbers, it was then necessary to derive forecasts of average household size, so the growth in average household size as forecast for each region was distributed across the counties located in each region according to the distribution of average household size recorded in Census 2006. The resultant projected average household sizes were then applied to the forecasts of the population that will be living in private households to derive forecasts of household numbers. Some minor adjustments were then made to bring these projections in line with the regional totals.

2.33. The DED household projections were derived using the same methodology but using the relevant county forecasts as a reference point for the DEDs contained therein.

3. Economic Forecasts

GNP Growth Forecasting

3.1. Forecasts of economic growth are a prerequisite to the development of car ownership forecasts, primarily because income is generally considered to be the most important variable in determining the demand for consumer goods. Thus, three sets of forecast GNP were developed one for each growth scenario. As Table 20.1.13 below indicates, all three scenarios reflect the recovery path for the Irish economy as set out by Department of Finance in the short-term. The low and medium scenarios are quite conservative assuming lower rates of growth in the medium-term with levels only strengthening slightly in the longer-term. The high scenario assumes a return to stronger levels of growth in the short-term with these levels moderating over time.

Table 20.1.13: Forecast Average Annual Growth in GNP (%), 2006 – 2025

	Forecast Average Annual Growth in GNP (%)		
	Low Scenario	Medium Scenario	High Scenario
2006 – 2010	-2.70	-2.70	-2.70
2010 – 2015	1.74	2.32	3.97
2015 – 2020	1.65	2.20	3.56
2020 – 2025	2.33	2.57	3.41

Source: AECOM

Labour Force & Employment Projections

3.2. The F1M0 and F1M2 labour force projections issued by the CSO relates to the High and Medium labour force projection. The Labour Force Projections Methodology employed for the low scenarios replicates the CSO's Labour Force Projection Methodology. This is presented in Figure 20.1.6 below. The labour force relates to the population 15 and over. The projected population is disaggregated by age and sex. Individuals in the 15 – 24 age groups are split between those in the education system and those outside it. Separate participation rates are applied for to these two groups for males and females. The female population over 25 is categorised by marital status and separate participation rates are projected to reflect the different participation and development profiles. Finally, the projected participation rates for males are applied to the population over 25 years, resulting in total projected labour force.

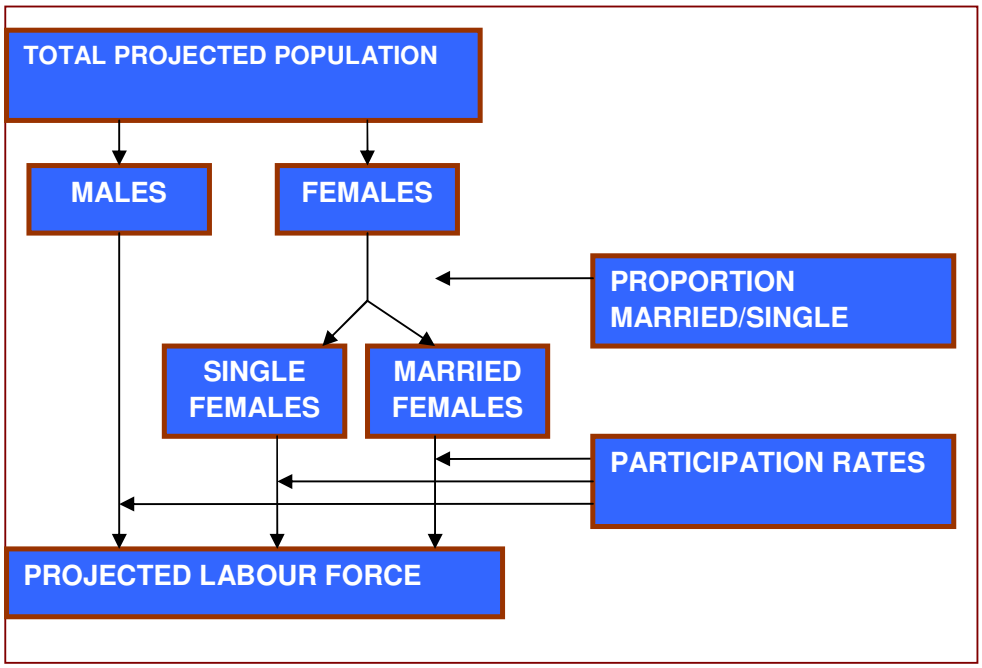

Figure 20.1.6 Approach to Preparation of Labour Force Projections

Assumptions

3.3. In developing the Labour Force Projections a number of assumptions were developed for future marriage rates, education participation rates and labour force participation rates. The sharp decline in marriage rates among women in the 25-34 age groups between 1996 and 2006 is assumed to continue but at more moderate levels. Marriage rates are also anticipated to decline for women in the 35-54 age groups and to remain broadly the same for women over 55 years. Participation in education is forecast to increase in line with recent times reflecting a greater emphasis on participation in third level education. The labour force projections for students largely reflect their involvement in part time work and are expected to increase over time. Participation rates for non students in the 15-24 age groups are assumed to remain similar to 2006 levels. Likewise participation rates for men 25-44 will remain unchanged while there is expected to be a slight upward trend for those over 45 reflecting a greater propensity to remain in the labour force. Further gains in participation are expected for married females aged 25-49 and single women. Moderate gains are anticipated for married women over 50.

3.4. The CSO Labour Force Projections are completed up to 2021. Consequently in order to be compatible with the National Traffic Model, the assumptions for 2021 were extended for the next 5 years to 2026. Interpolation is subsequently required for 2010, 2015, 2020 and 2025 projections. Employment numbers are derived from the Labour Force applying unemployment rates. Unemployment is assumed to peak in 2011 at 14 per cent and decline gradually thereafter to 5 per cent by 2025. The growth rate in the Employment Projections is equivalent to the growth in Job Numbers nationally and is used to inflate DED job numbers over the projection period.

Summary

3.5. The Labour Force Projections for the three scenarios are presented in Table 20.1.14 below. The projections show that the Low projection in 2010 is actually greater than the Medium Projection. This is due to the fact that there is a higher proportion of population of working age for 2010 under the low scenario. However, by 2015 the medium forecast is some 29,000 greater than the low projections, rising to approximately 114,000 by 2025. The High projection is some 600,000 greater than the Low projections and 490,000 greater than the Medium forecasts in 2025.

Table 20.1.14 Labour Force Projections 2006 -2025

	High	Medium	Low
2006	2,118,262	2,118,262	2,118,262
2010	2,329,503	2,188,271	2,205,367
2015	2,534,614	2,250,171	2,221,210
2020	2,687,869	2,299,779	2,217,181
2025	2,838,281	2,348,799	2,234,696

Forecasting Job Numbers

3.6. The National Traffic Model features journeys to work as part of its traffic generation function. Accordingly, information on employment and workplace location are important inputs. The forecast error relating to projections of the number and location of jobs in the future is large due to uncertainty regarding future economic conditions and changes to the structure of economic activity and employment. This report explains what steps have been taken in the forecasting of future jobs numbers.

Overall Approach

3.7. The overall approach in projecting job numbers is illustrated in Figure 20.1.7. Firstly National Labour Force Projections are forecast for the high, medium and low population projections outlined in National Regional County Zonal & DED Population Projections 2006-2025. Subsequently, unemployment rates are applied to these projections to yield Employment Projections. The growth rate in the Employment Projections is deemed equivalent to the growth in Job Numbers nationally. The growth rate in Job Numbers is used to inflate DED job numbers over the projection period. A top down approach was adopted to ensure that the projections for DEDs are consistent with national Jobs growth. Thus, the DED forecasts that form the basis of the model relate to national job numbers growth. This approach assumes that jobs growth will continue to be located in areas of current employment. While this may have implications at DED level, nationally the trend in jobs location is likely to remain broadly stable and only change gradually over time.

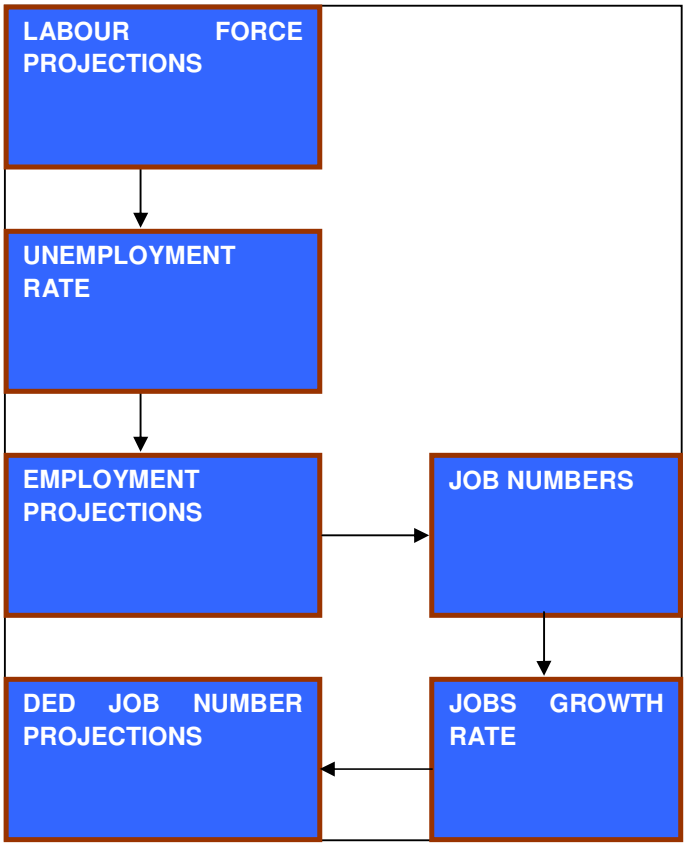

Figure 20.1.7 Approach to Preparation of Job Number Projections

Census of Journey to Work

3.8. The Census releases on the entire population contain data on where people live and their employment status. Accordingly, this provides data on the total number of workers in the economy and their resident location. Additional Census data contained in the POWCAR[8] database reports journey to work information for employed people, which provides information on actual workplace locations. Both the Census releases and the POWCAR database provide information at the DED level.

3.9. Not all workers that feature in the POWCAR database have reported a workplace DED to which they travel. In some cases the workplace location is simply not reported, and in others, workers do not report having a fixed workplace location. Other workers report that they work from home, so while they do have a workplace DED, they do not make a journey to work. A small proportion of workers report their workplace to be in Northern Ireland. In these cases the POWCAR database reports the county in which the workplace is located. In addition to those who work in the North, a relatively small number of individuals report that they work overseas.

3.10. The incomplete reporting of workplace locations means that additional assumptions are required to allocate workplace locations to those with incomplete responses. The proportion of respondents that left their workplace location blank is relatively evenly

[8] Place of Work Census of Anonymised Records

distributed across the country according to the workers' resident location. Accordingly, the responses of those who left the workplace location blank are assumed to have the same distribution as those who did complete the survey question. Consequently, the number of jobs represented by those who left their workplace location blank is allocated to the other locations reported in the survey.

3.11. The proportion of workers reporting no fixed workplace location is high at 11.5 per cent. It is likely that a large proportion of those workers work in the construction industry. Since the workplace location of these workers will continually change over time, it is not possible to accurately forecast the future location of these jobs. However, as a proxy the assumption that the location of jobs without fixed locations will largely be in areas where other economic activity takes place allows these jobs to be allocated to particular locations. Accordingly, the jobs of those workers reporting no fixed workplace location are allocated to the locations of those who do report their workplace location. While it is inevitable that some degree of error will occur as a consequence of this imperfect allocation of jobs, it is important that the significant proportion of jobs that do not have a fixed location are included in the workplace forecasts.

3.12. Jobs belonging to those workers who work from home are not included in the workplace location estimates as they do not involve a journey to work. Similarly, the small proportion of respondents that report working overseas is not included in the workplace location estimates.

3.13. The allocation of jobs across DED provides a baseline estimate of job numbers for each DED.

Assumptions

3.14. Forecasts of the DED distribution of jobs between 2010 and 2025 were derived from the 2006 distribution and forecasts of changes to the numbers employed nationally. It was assumed that the number of jobs located in each DED would increase in proportion to the increase in the national population employed. The increase in the numbers employed nationally was derived from the labour force and employment projections outlined above.

3.15. Using the increase in the numbers employed nationally to inflate the number of jobs in each period carries a number of implicit assumptions. The first is that jobs growth will continue to be located in areas of current employment. This is a significant assumption, as certain rural DEDs may have one significant employer and should this operation cease the job numbers for this DED in 2025 are unlikely to reflect the true state of employment. However, without such an assumption it would be necessary to forecast future trends of workplace location, which are very difficult to predict. The use of the numbers employed at national level is warranted given that the numbers employed at regional or county level may not reflect the jobs in that area since a vast number of people travel outside their region or county for work. This would be particularly evident in the Dublin and Mid East regions where a large proportion of the Mid East population are employed in Dublin. Consequently, the assumption that jobs growth at DED level grows in line with the numbers employed nationally is justified.

Figures 20.1.8 and 20.1.9 show job numbers in 2006 and 2025 respectively. It details the growth in job numbers at DED for the Medium population projection outlined in National Regional County Zonal & DED Population Projections 2006 - 2025.

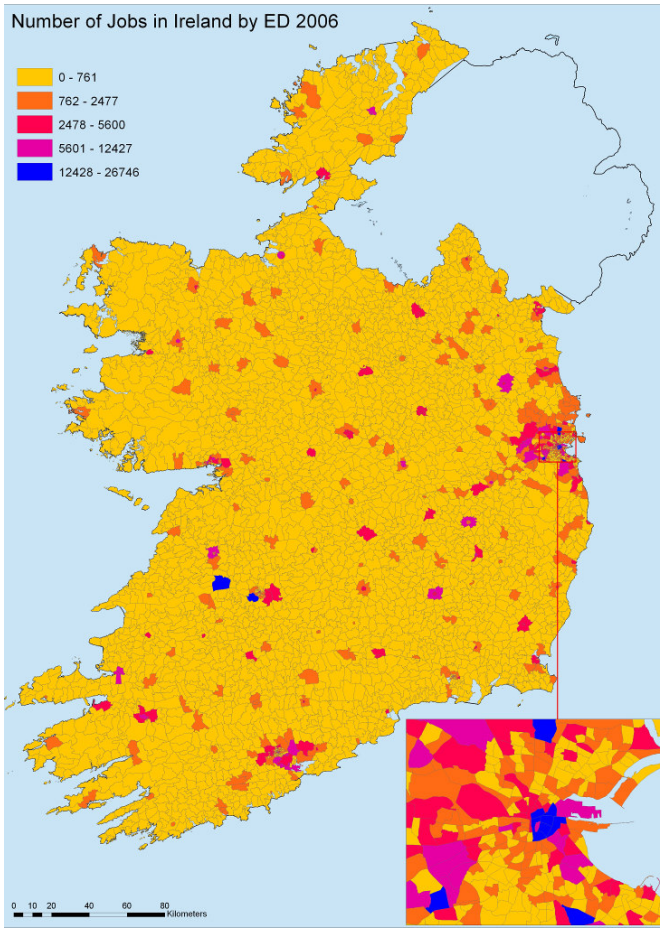

Figure 20.1.8: Number of Jobs by DED 2006

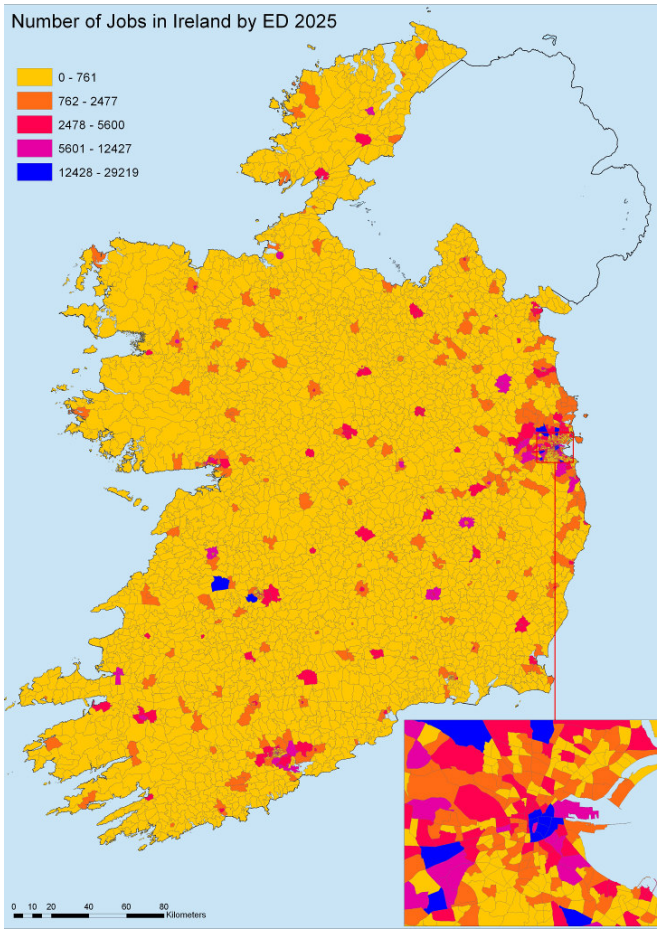

Figure 20.1.9: Number of Jobs by DED 2025 (Medium Growth)

4. Car Ownership Trends

Historical Trends and Influencing Factors in Car Ownership

Car Numbers and Car Ownership

4.1. Rates of car ownership are calculated by dividing the number of private cars for a given year by the adult population for the same year. For the purposes of this report, car ownership refers to the number of private cars per 1,000 adults. It should also be noted that the adult population is defined herein as members of the population aged 17 years or over, as this is the minimum legal age at which people can apply for a driving licence in Ireland.

4.2. The number of private cars registered in Ireland more that trebled between 1976 and 2006, increasing from 551,117 cars to 1,778,861 cars over the thirty-year period. This increase represents an average annual growth rate of 4.0 per cent.

4.3. Car ownership increased by an average of 2.5 per cent per annum over the same period, from 262.6 cars per 1,000 adults in 1976 to 545.6 cars per 1,000 adults in 2006.

4.4. The higher level of growth in actual car numbers compared to the growth in the car ownership is an indication of the effects that population growth has on car numbers. Over the same 30 year period, the population living in Ireland increased by an average of 1.5 per cent per annum.

4.5. Table 20.1.15 below sets out the number of private cars registered in Ireland and the car ownership rate for each year, from 1976 to 2006. It should be noted that the population data included in the table is based on CSO Census results which were interpolated to give population figures for the inter-censal years.

Table 20.1.15: Car Numbers and Rates of Car Ownership in Ireland, 1976-2006

Year	Population aged 17 years and over	No. Private Cars Registered*	Car Ownership per 1,000 Adults
1976	2,098,456	551,117	262.6
1977	2,133,194	572,692	268.5
1978	2,168,601	638,740	294.5
1979	2,204,694	682,958	309.8
1980	2,234,061	734,371	328.7
1981	2,263,914	774,594	342.1
1982	2,285,971	709,000	310.2
1983	2,308,300	718,555	311.3
1984	2,330,904	711,098	305.1
1985	2,353,788	709,546	301.4
1986	2,376,955	711,087	299.2
1987	2,391,059	736,595	308.1
1988	2,405,307	749,459	311.6
1989	2,419,699	773,396	319.6
1990	2,434,237	796,408	327.2
1991	2,448,923	836,583	341.6
1992	2,482,720	858,498	345.8
1993	2,517,022	891,027	354.0
1994	2,551,838	939,022	368.0
1995	2,587,177	990,384	382.8
1996	2,623,047	1,057,383	403.1
1997	2,677,207	1,134,429	423.7
1998	2,732,603	1,196,901	438.0
1999	2,789,268	1,269,245	455.0
2000	2,847,235	1,319,250	463.3
2001	2,906,537	1,384,704	476.4
2002	2,967,211	1,447,908	488.0
2003	3,037,674	1,507,106	496.1
2004	3,110,010	1,582,833	508.9
2005	3,184,275	1,662,157	522.0
2006	3,260,530	1,778,861	545.6

Source: AECOM

*Note: Data on private cars in each county was collated from the Department of Transport's *Irish Bulletin of Vehicle and Driver Statistics* for the years 1976-2006.

Trends in Car Numbers and Car Ownership and the Effects of Other Variables

4.6. It has already been mentioned that actual car numbers are affected both by changes in the rate of car ownership, and by changes in the population.

4.7. Car ownership is also affected by different variables, but perhaps the most significant one is economic growth, as this drives personal income, which is an essential determinant of the demand for consumer goods.[9] Table 20.1.16 below sets out 5-

[9] For the purposes of this report, economic growth refers to growth in GNP as opposed to GDP. GDP is usually higher than GNP due to profit repatriation by large multinational corporations. Using GNP over

year growth rates in the adult population, in car numbers, in car ownership, and in the economy, between 1976 and 2006.

Table 20.1.16: Periodical Growth Rates in Population, Car Numbers, Car Ownership, and the Economy (1976-2006)

Period	Growth in the Adult Population (%)	Growth in Car Numbers (%)	Growth in Car Ownership (%)	Growth in GNP per Person (%)
1976-1981	7.9	40.5	30.3	20.8
1981-1986	5.0	-8.2	-12.6	-1.7
1986-1991	3.0	17.6	14.2	20.0
1991-1996	7.1	26.4	18.0	30.8
1996-2001	10.8	31.0	18.2	46.3
2001-2006	12.2	28.5	14.5	25.8

Source: AECOM

4.8. Car numbers grew significantly between 1976 and 1981. Some of this growth would be more apparent than real owing to the fact that car tax was substantively abolished in 1978, affecting the degree of tax evasion with the result that more private cars were registered.

4.9. Car numbers then fell between 1981 and 1986, but again some of this decline might be attributed to the reintroduction in 1982 of car tax and the affect that this might have had on the degree of tax evasion. The economic downturn of the early 1980s brought about high levels of emigration, impacting on population growth. This, combined with the apparent fall in car numbers, resulted in a fall in car ownership levels of 12.6 per cent over the five-year period, but again it should be emphasised that this reduction is more apparent than real.

4.10. As the economy picked up, particularly in light of the Celtic tiger years, so too did car ownership. However, as Table 20.1.16 indicates, growth in car ownership in the years to 2006 had started to slow even though economic growth remained strong, suggesting that the market for cars in Ireland is starting to mature. It is inevitable that the car market, like most markets for durable goods, will eventually become saturated when all consumers who are going to acquire a car have done so. As car ownership approaches this saturation level, growth in car ownership levels will start to slow before beginning to level out.

Car Ownership in Ireland in a European Context

4.11. For comparative purposes, the most recent data available on car ownership in other EU member states relates to 2005. It should be noted that the car ownership data presented in Table 4.3 below relates to the number of cars per 1,000 people aged 15 years and over, owing to the nature of the population data available.

GDP assumes that money earned in Ireland but repatriated elsewhere will not influence consumption patterns in Ireland.

4.12. Average car ownership for the twenty-five EU member states as a whole stood at 527.4 in 2005, indicating that Ireland was just 3.3 per cent below the EU average. The average for the former fifteen member states was 573.8, with Ireland lagging by 11.1 per cent. As car ownership levels in Ireland approach the EU average, growth in car ownership is expected to slow.

Table 20.1.17: Car Ownership per 1,000 People aged 15+ in each EU Member State, 2005

Ranking	Country	Car Ownership per 1,000 People aged 15+
1	Luxembourg	818.7
2	Italy	690.3
3	Germany	653.4
4	Malta	642.0
5	Austria	603.8
6	France	598.9
7	Cyprus	586.5
8	United Kingdom	575.9
9	Belgium	568.7
10	Finland	562.5
11	Sweden	559.4
12	Slovenia	552.1
13	Spain	550.3
14	Netherlands	533.7
15	Lithuania	512.4
16	*Ireland*	*510.0*
17	Portugal	472.6
18	Greece	461.3
19	Czech Republic	455.2
20	Denmark	447.2
21	Estonia	433.3
22	Poland	388.0
23	Latvia	377.6
24	Hungary	339.0
25	Slovakia	292.1

Source: Eurostat 2005

Previous Car Ownership Forecasting Approaches

4.13. A number of forecasts of future car ownership rates in Ireland have been developed over recent decades. The different approaches adopted in three previous reports are summarised below. The three reports are:

- Future Traffic Forecasts 2002-2040 (NRA, 2003);
- Forecasts of Vehicle Numbers and Traffic Volumes (Dept. Environment, 1994); and,
- Car Ownership Forecasts 1995-2005 (An Foras Forbartha, 1984).

TRL Future Traffic Forecasts, 2002-2040

4.14. Most recently, TRL developed forecasts for the National Roads Authority (NRA) for growth in car traffic for the period 2002-2040[10]. The method employed was based on that adopted in the An Foras Forbartha (AFF) Car Ownership Forecasts 1995-2005, which is summarised separately below. The NRA car ownership forecasts effectively updated the AFF work by taking account of more recent historic trends in the number of registered cars, the adult population, and GNP, and revised forecast values for the adult population and GNP.

4.15. The actual forecast methodology employed took account of a time trend and economic growth, as well as the market saturation level, which was assumed to be 80 cars per 100 adults. The methodology involved the regression on the linear form of the following equation:

$$\textit{Cars per 100 Adults} = \frac{SaturationLevel}{1+\exp[\alpha.year+\beta.(GNPperAdult)+\gamma]}$$

4.16. This regression analysis enabled the calculation of values for α, β and γ which produced the most accurate fit to the historic values for car ownership per 100 adults, the year, GNP and the adult population over the historic period for which data was available.

4.17. Forecasts of GNP per adult were then inputted to the equation to produce forecast car ownership per 100 adults in future years. Forecast car ownership was then multiplied by the forecast adult population to derive forecast car numbers as set out in Table 20.1.18 below. TRL's forecast for the number of cars in 2006 was 1,661,655, which compares to the actual number of private cars (1,778,861) recorded in the Department of Transport's Irish Bulletin of Vehicle and Driver Statistics for that year.

Table 20.1.18: Forecast Numbers of Registered Cars, 2006-2041

Year	Forecast Car Numbers
2006	1,661,655
2011	1,876,168
2016	2,028,235
2021	2,160,704
2026	2,262,455
2031	2,334,765
2036	2,389,788
2041	2,433,164

Source: TRL, 2003.

[10] Future Traffic Forecasts, 2002-2040. National Roads Authority, 2003.

Dept. of the Environment Forecasts of Vehicle Numbers and Traffic Volumes

4.18. In 1994, DKM Economic Consultants developed forecasts of car ownership for the Department of the Environment, covering the period 1996-2011[11]. The models adopted by the consultants reflected standard approaches to car ownership modelling in that they reflected an early period of rapid growth, followed by a slowing growth rate, and the eventual approach to a saturation ownership rate which would never be exceeded.

4.19. Three functions were tested using a number of different explanatory variables. The functions tested were the Logistic function, the Log Reciprocal function and the Gompertz function. The explanatory variables used included a simple time trend, a series on real GNP (per adult), a series on real domestic demand (per adult), and a real fixed cost of car ownership series.

4.20. The Logistic function describes a situation where the annual increases in car ownership are low initially, but gradually accelerate until they reach half the saturation level. At this point they begin to decline and eventual cease when the saturation level is reached. The function is as follows:

$$V_t = \frac{S}{1 + b_0 e^{b_1 X_t}}$$

Where: V_t = car ownership
S = saturation level
b_0, b_1 = parameters
X_t = an explanatory variable

4.21. The Log Reciprocal function also describes a situation where the annual growth in car ownership is low initially, but gradually accelerates until it reaches the saturation level. The function is as follows:

$$V_t = e^{b_0} + \frac{b_1}{X_t^{-b_2}}$$

Where: V_t = car ownership
e^{b_0} = saturation level
b_0, b_1 = parameters
X_t = an explanatory variable

4.22. The Gompertz function then, describes a situation similar to the Logistic function in that car ownership grows rapidly, but the rate of growth declines very quickly and the saturation level is reached more slowly. The maximum growth rate is reached at the point when car ownership is equal to S/e, where S is the saturation level and e is the

[11] Forecasts of Vehicle Numbers and Traffic Volumes, DKM Economic Consultants. Department of the Environment, 1994.

base of the natural log. This occurs earlier than in the case of the Logistic function. The Gompertz function is as follows:

$$V_t = \frac{S}{e^{e^{Lnb_0 + Lnb_1 X_t}}}$$

Where: V_t = car ownership
S = saturation level
b_0, b_1 = parameters
X_t = an explanatory variable

4.23. Using saturation levels of 75, 80 and 85 cars per 100 adults[12], the consultants found that the best results were obtained using the Logistic function or the Gompertz function, with real domestic demand as the explanatory variable.

4.24. The final estimates were derived using a saturation level of 80 and an annual domestic demand (per capita) rate of 4 per cent. The resultant forecast rates of car ownership were then adjusted to correct the effects of autocorrelation, before being multiplied by forecasts of the adult population to derive forecast car numbers as set out in Table 20.1.19 below.

Table 20.1.19: Forecast Numbers of Registered Cars, 1996-2011

	Logistical Function	Gompertz Function
1996	987,500	977,500
2001	1,255,500	1,218,900
2006	1,547,900	1,476,000
2011	1,759,000	1,675,300

Source: DKM Economic Consultants

Car Ownership Forecasts, 1995-2005

4.25. In 1984, An Foras Forbartha developed Car Ownership Forecasts for the period 1995-2005.[13] The approach used began with the development of a trend model that would test both the Logistic function and the Gompertz function to determine which gave more accurate estimates. Both functions would take account of an imposed saturation level, as set out below.

Logistic function: $$Y = \frac{S}{1 + a_o e^{-a_1 T}}$$

Where Y = car ownership
S = saturation point
a_0, a_1 = coefficients whose values are to be estimated
T = time

[12] For the purposes of their report, DKM Economic Consultants defined the adult population as those aged between 20 and 74 years.
[13] Car Ownership Forecasts 1995-2005, B. P. Feeney. An Foras Forbartha, 1984.

Gompertz function: $Y = Se^{-b_0 b_1^T}$

Where
- Y = car ownership
- S = saturation point
- b_0, b_1 = coefficients whose values are to be estimated
- T = time

4.26. Feeney began by transforming each of the functional equations into linear form to enable the estimation of coefficient values that could then be used to derive values for the original functions.

The equation for the logistic function became:

$$Log_e(\frac{S-Y}{Y}) = Log_e a_0 - a_1 T$$

And the equation for the Gompertz function became:

$$Log_e{}^2 \frac{S}{Y} = Log_e b_0 + T Log_e b_1$$

4.27. Saturation levels were set at 350, 400 and 450 cars per 1,000 people, based on an evaluation of the proportion of the population which would be physically capable and legally entitled to drive, and an assessment of car ownership levels in more developed countries. Using actual annual data for car ownership over the period 1952-1979, the transformed equations were run using each of the three saturation levels.

4.28. The derived coefficient values were used to establish values for the original Logistic and Gompertz functions. The functions were then used to establish predicted car ownership values, which could be compared to actual values to determine the best fit. In this instance, the Gompertz model tended to underpredict recent values so Feeney decided to use the Logistic functional form to further develop a causal model that would take account of the various factors that might influence car ownership.

4.29. The development of the causal model involved the statistical testing of a number of different independent variables and their relationships with levels of car ownership. These variables included income (GNP), car prices, petrol prices, and the need for transport for journeys to work. GNP was found to be highly significant and car prices were found to be significant. However, when the equations were corrected for autocorrelation, car prices became statistically insignificant, so GNP was adopted as the sole independent variable.

4.30. High, medium and low forecasts for GNP, that predicted little growth in the short term and a return to moderate growth in the long term, were then used to forecast levels of car ownership. The 'high' GNP forecasts were associated with a saturation level of 450 cars per 1,000 people, the 'medium' GNP forecasts with a level of 400, and the 'low' GNP forecasts with a level of 350, giving high, medium and low level forecasts

of car ownership. These levels of car ownership were then applied to forecast population figures to derive forecast car numbers as set out in Table 20.1.20 below.

Table 20.1.20: Forecast Numbers of Registered Cars, 1995-2005

Year	Low Scenario	Medium Scenario	High Scenario
1995	1,106,000	1,172,000	1,309,000
1996	1,136,000	1,213,000	1,363,000
1997	1,166,000	1,254,000	1,417,000
1998	1,195,000	1,295,000	1,470,000
1999	1,224,000	1,335,000	1,521,000
2000	1,253,000	1,374,000	1,572,000
2001	1,281,000	1,413,000	1,621,000
2002	1,309,000	1,452,000	1,668,000
2003	1,336,000	1,489,000	1,713,000
2004	1,363,000	1,525,000	1,757,000
2005	1,390,000	1,561,000	1,798,000

Source: An Foras Forbartha

Summary and Conclusions

4.31. The forecasting processes exhibited above all share a number of common features. In each case, projections of car ownership and population figures are forecast separately and then combined to produce forecast car numbers. Furthermore, car ownership projections are based on time series econometric analysis, either employing GNP per capita or a time trend, and the functions employed are largely the Gompertz or the Logistic. When the 'per 1,000 adults' specification is used to describe rates of car ownership, the saturation levels vary between 750 and 850.

4.32. Overall, the process has a fairly good track record. TRL's forecasts, carried out in 2003, predicted car numbers of 1,661,655 in 2006. DKM's forecasts, carried out in 1995, predicted car numbers of 1,547,900 for the same year. Both of these forecasts are reasonably close to the actual number of private cars registered that year, which amounted to 1,778,861. Similarly, An Foras Forbartha's medium scenario forecasts, carried out in 1984, predicted car numbers of 1,561,000 in 2005, which again compares to the actual number of cars registered that year, namely 1,662,157.

4.33. In light of the above, a broadly similar approach has been adopted for this study.

Developing a National Car Ownership Model

4.34. This section describes the methodology employed to develop the national car ownership forecasting model. The influencing factors that were identified for use in the car ownership forecasting model are discussed first. The approach taken to identifying the most appropriate function for the model is then described. Finally, the practical application of the model is set out and the results are presented.

Factors Impacting on Car Ownership

4.35. Historic data relating to car ownership over the thirty-year period between 1976-2006 were collated at county level and national level to enable the statistical testing of the relationship between car ownership and income, and that between car ownership and population density. Income is generally considered to be the most important variable in determining the demand for consumer goods. The hypothesis that car ownership might be effected by population density was based on the assumption that people living in more rural areas, or in areas with under-developed transport links are more likely to own cars.

4.36. Although the statistical test of the relationship between car ownership and population density at DED level gave a highly significant result, the effect of population density became very diluted when the same test was carried out at county and national levels.

4.37. The relationship between car ownership and income, on the other hand, was shown to be significant at both county and national level, so it was decided to relate projected car ownership to forecast GNP per Person.

Low, Medium and High Scenarios

4.38. Three levels of forecast GNP were used in the model; one for low economic growth, one for medium growth and one for high growth. Table 20.1.21 below indicates the various forecast average annual growth rates in GNP for each of the different scenarios.

Table 20.1.21: Forecast Average Annual Growth in GNP, 2006 – 2025

	Forecast Average Annual Growth in GNP (%)		
	Low Scenario	Medium Scenario	High Scenario
2006 – 2010	-2.70	-2.70	-2.70
2010 – 2015	1.74	2.32	3.97
2015 – 2020	1.65	2.20	3.56
2020 – 2025	2.33	2.57	3.41

Source: AECOM

Setting a Saturation Level

4.39. Where long term forecasting of car ownership is concerned, it is prudent to incorporate a saturation level at which growth in car ownership will cease, to avoid over-prediction.

4.40. As already mentioned, car ownership rates as referred to in this report are per 1,000 head of the adult population, defined herein as those aged seventeen years and older. In the national model, the saturation point for car ownership among the adult population was set at 850 cars per 1,000 adults. This was to allow for the proportion of the adult population that will never own a car for one of a number of reasons that might include: a lack of need if they live and work in an urban centre with good public transport links, a personal environmental decision, disability, or old age.

Identifying the Preferred Model

4.41. Two causal forecasting models were tested to see which gave the best fit, the Logistic model and the Gompertz model. Both models assume an initial period of gradual annual growth that accelerates for a time, before slowing as car ownership approaches a saturation level. As such, both models also assume that the development of car ownership over time may be represented by an S-shaped curve. However, the maximum annual growth rate, and therefore the point of inflexion, occurs sooner in the Gompertz model than in the Logistic model.

4.42. Each model was tested using historical annual car ownership data over the period 1976-2006. In both cases car ownership was regressed onto GNP per capita with a saturation level of 850 cars per 1,000 adults, using the following formulae:

Logistic model: $$Log_e(\frac{S-Y}{Y}) = Log_e a - bX$$

Where
- Y = car ownership
- S = saturation point
- a, b = coefficients whose values are to be estimated
- X = GNP per Capita

Gompertz model: $$Log_e{}^2 \frac{S}{Y} = Log_e a + XLog_e b$$

Where
- Y = car ownership
- S = saturation point
- a, b = coefficients whose values are to be estimated
- X = GNP per Capita

4.43. The resultant values for predicted car ownership over the same period were compared to actual values using a best-fit test, which indicated that in this instance, the Gompertz model gave more accurate results[14].

Application of the Gompertz Model

4.44. The application of the Gompertz model as defined above began with the creation of a new dependent variable using the following function:

$$Log_e{}^2 \frac{S}{Y}$$

where S is the saturation point (850) and Y is annual car ownership.

4.45. A regression analysis of this new dependent variable on GNP per Capita was then carried out. The Durbin-Watson test statistic, when employed during a regression

[14] In conducting this test, the predicted values were transposed back into the X, Y space.

analysis, tests the extent to which the residuals from an ordinary least-squares regression may or may not be autocorrelated. The Durbin-Watson statistic in this instance indicated positive autocorrelation, which needed to be corrected.

4.46. The autocorrelation correction process involved the regression of the residuals (Ut) on the residuals lagged by one year (Ut-1). The resultant coefficient was then used to adjust the original dependent variable and independent variable (GNP per Capita), before the regression analysis was re-run, to produce the 'a' and 'b' coefficients indicated in Table 20.1.22 below. This 'a' coefficient was then also adjusted using the coefficient of the regression of Ut on Ut-1.

Table 20.1.22: Regression Coefficients of adjusted Variable on adjusted GNP per Capita

	Coefficients	'a' coefficient adjusted
a	0.223818	0.565854
b	-3.76592E-05	-3.76592E-05

Source: AECOM

4.47. The coefficients were put into the following formula to forecast the predicted variables necessary to calculate future rates of car ownership:

$$\hat{y} = a + bZ$$

where $\hat{y}$ is the predicted variable and Z is forecast GNP per Capita.

4.48. The predicted variables were then converted back to car ownership rates using the following formula:

$$S/(Exp^{2}\hat{y})$$

National Projected Car Ownership

4.49. This model was run three times, once for each of the different economic growth scenarios (high, medium and low). In each instance, GNP per Capita was derived using a different dataset of forecast population.[15]

4.50. In all scenarios, GNP per person is predicted to fall in the shorter term, with growth returning after 2010 and increasing at varying rates over time. In relation to growth in the adult population, the low scenario predicts an initial slowdown before a return to current levels. In the medium scenario, it is predicted to remain fairly steady at current levels. In the high scenario, although overall forecast growth in the adult population is higher than in the other two scenarios, it is predicted to slow gradually over time.

[15] The GNP growth rates were applied as set out in Table 4.8. It should be noted however, that the rate of population growth for the high scenario is such that it slightly dilutes growth in income (in the shorter term) when *GNP per Capita* is calculated for the high scenario.

4.51. Table 20.1.23 below sets out the resultant forecast car ownership rates for the three scenarios over the period 2006-2025. The forecast car ownership rates were applied to the various population forecasts to derive actual car number forecasts for the same period. These are also presented in Table 20.1.23.

4.52. The actual rate of car ownership in Ireland in 2006 was 545.6 cars per 1,000 adults. The forecasting model suggests that under the low scenario car ownership is set to reach 609.9 cars per 1,000 adults in 2025, under the medium it is set to reach 618.7 cars per 1,000 adults, and under the high scenario it is set to reach 624.7 cars per 1,000 adults in the same year.

4.53. When these car ownership rates are applied to each of the population forecasts, car numbers are forecast to increase from an actual figure of 1.8 million cars in 2006 to 2.3 million cars in 2025 using the low growth scenario, 2.4 million using the medium growth scenario, and 2.8 million using the high growth scenario.

Table 20.1.23: Forecast Car Ownership Rates and Car Numbers at National Level, 2006-2025*

Year	Low Scenario		Medium Scenario		High Scenario	
	Car Ownership	Car Numbers	Car Ownership	Car Numbers	Car Ownership	Car Numbers
2006	545.6	1,778,861	545.6	1,778,861	545.6	1,778,861
2010	532.8	1,792,875	531.7	1,791,129	509.9	1,808,578
2015	553.3	1,907,404	556.7	1,952,443	546.0	2,106,583
2020	575.6	2,039,943	582.6	2,134,293	582.3	2,413,791
2025	609.9	2,256,934	618.7	2,368,791	624.7	2,739,690

Source: AECOM

*Note: Car Ownership and Car Numbers data for 2006 are actual data.

Car Ownership at County Level

Introduction

4.54. This section considers car ownership at county level in Ireland. It begins by looking at car numbers and cars per head of adult population in each county, comparing the various historical trends. It then summarises the approach adopted in a previous car ownership forecasting report. The county forecasting model adopted for this paper is then discussed, and the 2025 projections for county car ownership under the three different economic growth scenarios are presented.

Historical Trends in County Car Ownership

4.55. Table 20.1.24 sets out car numbers and rates of car ownership in each county for the years 1976 and 2006.

4.56. In terms of car numbers, Leitrim had the fewest cars in 1976 (4,378), followed by Longford (5,537) and Carlow (6,892). Dublin had the greatest amount with 158,923 cars. In 2006, there had not been any significant change in these positions, with Dublin having the highest number of cars (470,952) and Leitrim having the fewest (12,337), followed by Longford (13,807). However, the impact that varying population

trends have on car numbers has already been noted, so when car numbers for each county are related to population data to derive rates of car ownership, quite different trends emerge. It becomes apparent that Mayo had the lowest rate of car ownership in 1976 (207.6 cars per 1,000 adults) followed by Donegal (216.5). Tipperary North had the highest rate at 350.3, followed by Meath (313.2), Kildare (299.8), and Carlow (295.9). In 2006, Tipperary North continued to have the highest rate (627.5), followed by Carlow (616.7), Wexford (609.6), and Tipperary South (594.1). Louth had the lowest rate of car ownership in 2006 at 483.8, followed by Monaghan (498.7).

4.57. Despite the fact that Tipperary North had the highest rate of car ownership in both 1976 and 2006, the county experienced the lowest rate of growth over the period as a whole: 79.1 per cent, or an average of 2.0 per cent per annum. The highest rate of growth was experienced in Mayo, where car ownership increased by 157.1 per cent over the thirty-year period, or by an average of 3.2 per cent per annum. This compares to growth in the country as a whole of 107.8 per cent, or by an annual average of 2.5 per cent.

Table 20.1.24: Car Numbers and Car Ownership by County, 1976 & 2006

	Car Numbers			Car Ownership		
	1976	2006	Growth (%)	1976	2006	Growth (%)
Carlow	6,892	23,668	243.4	295.9	616.7	108.4
Cavan	9,460	25,606	170.7	263.9	535.5	102.9
Clare	13,076	49,405	277.8	243.4	589.4	142.2
Cork	70,176	219,109	212.2	282.1	590.0	109.1
Dublin	158,923	470,952	196.3	260.8	500.6	91.9
Donegal	16,634	55,036	230.9	216.5	503.9	132.7
Galway	24,072	93,861	289.9	227.2	522.9	130.1
Kerry	18,658	61,014	227.0	235.7	561.3	138.1
Kildare	16,010	79,539	396.8	299.8	574.6	91.6
Kilkenny	12,281	37,101	202.1	286.0	561.9	96.4
Laois	8,763	27,066	208.9	284.4	541.7	90.5
Leitrim	4,378	12,337	181.8	222.8	555.1	149.2
Limerick	25,147	78,920	213.8	258.5	551.5	113.3
Longford	5,537	13,807	149.4	281.8	532.8	89.1
Louth	13,350	40,449	203.0	256.5	483.8	88.6
Mayo	15,716	50,533	221.5	207.6	533.7	157.1
Meath	16,234	70,413	333.7	313.2	585.4	86.9
Monaghan	8,252	21,134	156.1	255.1	498.7	95.5
Offaly	8,831	28,852	226.7	254.8	546.8	114.6
Roscommon	9,163	25,626	179.7	249.6	568.3	127.7
Sligo	8,679	26,084	200.5	241.8	552.3	128.4
Tipp. Nth	12,999	31,454	142.0	350.3	627.5	79.1
Tipp. Sth	13,368	37,550	180.9	284.8	594.1	108.6
Waterford	14,423	48,824	238.5	268.3	592.3	120.8
Westmeath	9,970	33,852	239.5	271.7	570.5	109.9
Wexford	16,847	60,186	257.3	284.9	609.6	114.0
Wicklow	13,278	56,483	325.4	270.4	591.6	118.8

Ireland	551,117	1,778,861	222.8	262.6	545.6	107.8

Source: AECOM

*Note: Data on private cars in each county was collated from the Department of Transport's *Irish Bulletin of Vehicle and Driver Statistics* for the years 1976 & 2006.

Changes in the Rank Order of Counties by Car Ownership

4.58. Table 20.1.25 ranks the counties in order of their level of car ownership, starting with the highest, at five-yearly intervals over the ten-year period, 1996-2006.

Table 20.1.25: Counties ranked in order of Car Ownership at five-year intervals, 1996-2006

	1996	2001	2006
1.	Tipperary North	Tipperary North	Tipperary North
2.	Meath	Carlow	Carlow
3.	Carlow	Wexford	Wexford
4.	Tipperary South	Tipperary South	Tipperary South
5.	Kildare	Cork	Waterford
6.	Wexford	Clare	Wicklow
7.	Cork	Kildare	Cork
8.	Clare	Meath	Clare
9.	Longford	Kilkenny	Meath
10.	Wicklow	Roscommon	Kildare
11.	Kilkenny	Waterford	Westmeath
12.	Westmeath	Westmeath	Roscommon
13.	Laois	Wicklow	Kilkenny
14.	Kerry	Kerry	Kerry
15.	Roscommon	Laois	Leitrim
16.	Cavan	Longford	Sligo
17.	Limerick	Leitrim	Limerick
18.	Sligo	Limerick	Offaly
19.	Waterford	Offaly	Laois
20.	Offaly	Sligo	Cavan
21.	Leitrim	Cavan	Mayo
22.	Monaghan	Mayo	Longford
23.	Galway	Dublin	Galway
24.	Mayo	Galway	Donegal
25.	Dublin	Monaghan	Dublin
26.	Louth	Louth	Monaghan
27.	Donegal	Donegal	Louth

Source: AECOM

4.59. If the ranking for each year is considered in terms of three groups of nine counties, there is not a substantial amount of movement between the groups. The exceptions to this are Longford and Waterford. Longford moved from the first group (ranked 9th) in 1996 to the third group (ranked 22nd) in 2006. The reverse happened with Waterford which was in the third group (ranked 19th) in 1996 but moved up to the first group (ranked 5th) in 2006. Other than that, only six counties (Kildare, Wicklow, Laois, Cavan, Offaly and Leitrim) moved from one grouping into another immediately

above or below it. The remaining nineteen counties stayed in the same groupings over the ten-year period.

4.60. Overall, the ratio between the highest and lowest levels of car ownership has remained static at 1.3:1.0 since 1981.

Previous County Car Ownership Forecasting Approaches

Car Number Projections by County for 1985-1995

4.61. Car ownership forecasting was previously carried out at county level by An Foras Forbartha (AFF), in Car Number Projections by County for 1985-1995[16]. The AFF model was developed using the Logistic function as set out below:

$$V_t = \frac{a}{1 + be^{-ct}}$$

Where:

V_t	=	vehicles per 100 persons in period t
t	=	time
a, b, c	=	positive numerical coefficients
e	=	the base of the natural logarithm

4.62. A time series of actual car ownership data for each county over the period 1951-1971, as well as three different saturation levels for each county, were incorporated into the model.

4.63. To set the saturation levels, regression analyses were used to determine the effects of income and population density on car ownership and saturation levels. It was determined that income disparities across different counties accounted for the speed at which saturation levels were approached, but not the saturation levels themselves. The analysis of population density on the other hand found that it accounted for differences in car ownership rates of between 3 and 4 cars per 100 people, with a higher density resulting in a lower rate of car ownership. The model, as it was developed, assumed that at saturation level, the differences in population density would be greater between counties, resulting in a spread in car ownership of up to 5 or 6 cars per 100 people. With this in mind, the counties were put into five different groups according to projected levels of urbanisation in 1995 as set out in Table 20.1.26 below.

[16] Car Number Projections by County for 1985-1995 by C. McCarthy. An Foras Forbartha, 1974.

Table 20.1.26: County Groupings determined by An Foras Forbartha

Group	Projected Level of Urbanisation in 1995 (%)	Counties included:
1	90-100	Dublin
2	60-90	Cork, Limerick, Louth, Waterford
3	50-60	Carlow, Clare, Galway, Kildare, Tipperary, Westmeath, Wexford, Wicklow
4	30-50	Kerry, Kilkenny, Laois, Longford, Meath, Offaly, Sligo
5	0.30	Cavan, Donegal, Leitrim, Mayo, Monaghan, Roscommon

Source: Car Number Projections by County for 1985/1995. McCarthy, 1974

4.64. Three saturation levels were then set for each group of counties. For Group 2, they were set at 36, 40 and 44 cars per hundred people. The levels for Group 1 were scaled 3 points below these levels, and the levels for Groups 3, 4 and 5 were scaled respectively by 1, 2 and 3 points above. The resultant 9 saturation levels are set out in Table 20.1.27 below.

Table 20.1.27: Saturation Levels employed by An Foras Forbartha

Group	Saturation Level 1	Saturation Level 2	Saturation Level 3
1	33	37	41
2	36	40	44
3	37	41	45
4	38	42	46
5	39	43	47

Source: Car Number Projections by County for 1985/1995. McCarthy, 1974

4.65. Using the Logistic function and the time series of car ownership data mentioned above, three estimates of projected car ownership were made using the different saturation levels set for each county. The car ownership projections were then applied to three sets of population forecasts for each county, resulting in nine projections of car numbers for each county.

Developing a Forecasting Model

4.66. The model adopted to forecast car ownership at county level for this paper was in keeping with the national model to ensure that the projections for the counties were consistent with the national projections. Thus the Gompertz model was used, incorporating income as an independent variable as well as a number of pre-defined saturation levels.

4.67. As mentioned above, the relationship between car ownership and population density was tested statistically and, although at DED level it gave a highly significant result, the effect of population density became diluted when the same test was carried out at county level. For this reason, it was not incorporated into the model for developing county forecasts.

Saturation Levels

4.68. It was decided to adopt different saturation levels for each county to reflect the current variations in car ownership and growth in car ownership between counties. An analysis of car ownership at county level, as summarised in above, indicated that if counties are broken down into three groups according to their car ownership ranking, there has not been a great deal of movement between the groups over the last decade. The groups as they stood in 2006 were adjusted slightly to reflect any fluctuations that had occurred in preceding years and the results are summarised in Table 20.1.28.

Table 20.1.28: Car Ownership Ranking Groups

Group 1	Group 2	Group 3
Tipperary North	Waterford	Laois
Carlow	Wicklow	Cavan
Wexford	Westmeath	Mayo
Tipperary South	Roscommon	Longford
Cork	Kilkenny	Galway
Clare	Kerry	Donegal
Meath	Leitrim	Dublin
Kildare	Sligo	Monaghan
	Limerick	Louth
	Offaly	

4.69. Three saturation levels were then set, to reflect the national saturation level of 850 cars per 1,000 adults. They were 900 cars per 1,000 adults for Group 1, 850 for Group 2, and 775 for Group 3.

Income and Car Ownership

4.70. Again to reflect the national model, a time series of car ownership data for each county over the period 1976-2006 was used, and income data for the same period was incorporated as the independent variable.

4.71. The most recent data available on income per person at county level relates to 2005 and the available historical data does not provide a time series that is long enough to be in keeping with the data on car ownership. Furthermore, the historical data that is available is only available in nominal terms as opposed to real terms. The income data that is available was analysed to measure the levels of disparity that arise between the counties. Although some variations do exist, it was found that they are not at a significant level. With this in mind, it was decided to use the same low-, medium- and high-scenario time series data on GNP per Person as was used in the national model. This also served to keep the county projections in line with the national projections.

Projected County Car Ownership

4.72. Using the methodology previously, the Gompertz model was employed, incorporating the relevant time series data and saturation levels for each county, to forecast projected car ownership levels.

4.73. As with the national forecasts, the resultant projected car ownership rates were then applied to county population forecasts to derive three scenarios of projected car numbers for each county. The low growth scenario county population forecasts were taken from the AECOM population growth model[17]. The medium- and high-growth scenario county population forecasts were derived from the M0F1 and the M2F1 scenarios of the Regional Population Projections produced by the CSO[18]. The resultant forecast rates of car ownership and forecast car numbers for each county are presented in Tables 20.1.29 and 20.1.30 below.

Table 20.1.29: Forecast Car Ownership (Cars per 1,000 Adults) by County, 2006 & 2025*

County	2006	Forecast Car Ownership 2025		
	(Actual)	(Low)	(Medium)	(High)
Carlow	616.7	691.7	704.8	717.0
Cavan	535.5	592.0	600.5	607.5
Clare	589.4	654.8	663.2	672.8
Cork	590.0	662.5	671.5	679.3
Donegal	503.9	547.8	557.6	568.2
Dublin	500.6	564.4	573.3	573.0
Galway	522.9	577.8	588.2	592.1
Kerry	561.3	628.5	637.8	648.4
Kildare	574.6	637.4	647.8	657.3
Kilkenny	561.9	617.3	628.5	638.0
Laois	541.7	610.1	618.5	624.1
Leitrim	555.1	618.2	629.1	640.9
Limerick	551.5	626.4	634.8	647.2
Longford	532.8	594.8	603.3	610.2
Louth	483.8	539.4	548.2	555.9
Mayo	533.7	589.0	599.4	609.4
Meath	585.4	631.1	640.9	649.3
Monaghan	498.7	547.7	555.9	562.5
Offaly	546.8	591.9	602.1	612.0
Roscommon	568.3	637.7	648.1	659.9
Sligo	552.3	613.2	623.6	633.7
Tipperary North	627.5	714.0	722.6	733.6
Tipperary South	594.1	624.6	636.7	646.9
Waterford	592.3	661.3	674.3	687.6
Westmeath	570.5	628.3	638.0	645.8
Wexford	609.6	667.3	680.6	692.4

[17] *Population Projections at National, Regional, County, Zonal and DED Levels (2006-2025).* AECOM, February 2010.
[18] *Regional Population Projections, 2011-2026.* CSO, December 2008.

Wicklow	591.6	650.3	660.9	670.9

Source: AECOM
*Note: Data for 2006 are actual data

4.74. Tipperary North is forecast to retain the highest rate of car ownership under all three economic growth scenarios. Under the low scenario, it is forecast to reach 714.0 cars per 1,000 adults in 2025. Under the medium and high scenarios it is forecast to reach 722.6 and 733.6 cars per 1,000 adults respectively. At the other end of the scale, Louth is forecast to retain the lowest level, reaching just 539.4 cars per 1,000 adults in 2025 under the low scenario, which is lower than the actual rate of car ownership recorded in 2006 for the country as a whole (545.6). Under the medium and high scenarios car ownership in Louth is forecast to reach 548.2 and 555.9 cars per 1,000 adults in 2025, respectively.

Table 20.1.30: Forecast Car Numbers by County, 2006 & 2025*

County	2006	Forecast Car Numbers 2025		
	(Actual)	(Low)	(Medium)	(High)
Carlow	23,668	30,900	34,839	35,445
Cavan	25,606	32,004	33,400	37,388
Clare	49,405	62,013	66,273	77,474
Cork	219,109	262,719	277,438	320,488
Donegal	55,036	68,228	71,531	81,096
Dublin	470,952	575,000	619,414	748,865
Galway	93,861	119,338	122,019	149,507
Kerry	61,014	72,054	75,531	85,557
Kildare	79,539	121,524	126,025	142,339
Kilkenny	37,101	48,052	49,460	55,039
Laois	27,066	35,073	36,375	41,034
Leitrim	12,337	15,104	15,809	17,816
Limerick	78,920	96,016	100,567	111,730
Longford	13,807	17,321	17,909	19,929
Louth	40,449	51,097	53,643	61,090
Mayo	50,533	62,795	63,539	74,027
Meath	70,413	105,262	109,095	123,080
Monaghan	21,134	26,015	27,222	30,709
Offaly	28,852	35,881	37,312	42,263
Roscommon	25,626	31,750	31,899	35,456
Sligo	26,084	31,685	33,240	37,778
Tipperary North	31,454	39,470	41,397	45,897
Tipperary South	37,550	46,816	48,293	54,349
Waterford	48,824	62,985	64,896	72,125
Westmeath	33,852	42,821	44,501	50,436
Wexford	60,186	79,153	81,693	92,022
Wicklow	56,483	83,726	86,805	97,968

Source: AECOM
*Note: Data for 2006 are actual data

4.75. In terms of actual car numbers, Dublin is forecast to have the highest number of cars in 2025 under all three scenarios (575,000; 619,414; and 748,865), followed by Cork (262,719; 277,438; and 320,488). This is not surprising considering the effect that

population has on car numbers. Leitrim is forecast to have the fewest cars in 2025 under each of the scenarios (15,104; 15,809; and 17,816) followed by Longford (17,321; 17,909; and 19,929).

4.76. In terms of growth in car numbers, Kildare and Meath are expected to have the highest rates of growth in car numbers under all three economic growth scenarios. Under the low growth scenario, car numbers in Kildare are forecast to increase by 52.8 per cent between 2006 and 2025. They are forecast to increase by 58.4 per cent over the same period under the medium scenario, and by 79.0 per cent under the high scenario. Similarly, car numbers in Meath are forecast to increase by 49.5 per cent between 2006 and 2025 under the low growth scenario, by 54.9 per cent under the medium scenario, and by 74.8 per cent under the high scenario over the same period.

Car Ownership at DED and Zone Levels

Introduction

4.77. This section outlines the methodology employed to derive estimates of car ownership and car numbers at both DED and zone level. Owing to the size of the datasheets (there are over 3,400 DEDs in Ireland), the projections are not included here.

DED Projections

4.78. As there are no definitive data on car numbers at DED level, it was necessary to establish a set of base data from which forecasts could be made. The numbers of cars owned at DED level in 2006 were estimated using the number of cars reported to be available to each household in Census 2006. These data include both taxed and untaxed vehicles, and taxis as well as private cars. As a consequence, the county totals were larger than the Department of Transport's actual data which were used for the national and county forecasting models. To overcome this problem and prevent the base data on car ownership rates at DED level from being over-inflated, an adjustment was made. The estimated car numbers for each DED were aggregated for each county and these totals were compared to the Department of Transport's county data. The DED estimates were then re-based to reflect the relevant county totals.

4.79. Forecast rates of car ownership for each DED were simply calculated by inflating the estimated 2006 rates of car ownership by the various forecast growth rates in car ownership for the counties in which the DEDs are located. This calculation was carried out for each of the three economic growth scenarios.

4.80. The forecast numbers of cars were then derived by applying these projected rates of car ownership to forecast population data at DED level. The DED population data used was derived from the same sources as those used for the county forecasts.

4.81. It should be noted that in a number of instances, the rate of car ownership at DED level is forecast to exceed the saturation levels discussed in previous sections. This is because of the level of detail that emerges in an analysis at DED level. It is to be expected that people living in a rural DED, with little or no public transport links are

more likely to own a car. It has already been mentioned previously that a statistical test of the relationship between car ownership and population density was found to be highly significant at DED level. Similarly, the relationship between car ownership and income was found to be highly significant at every level, from DED right up to the country as a whole. Thus it is quite possible that a DED that is primarily populated with affluent people will also have a high rate of car ownership, as there is a potential for some members of the local population to own more than one car.

4.82. The rate of car ownership is forecast to exceed 1,000 cars per 1,000 adults by 2025 in just one instance under each of the three growth scenarios. Saggart (DED reference 3027), which is located on the outskirts of South Dublin, close to the Kildare border, had a recorded population of 2,020 people in 2006, of which 1,524 were estimated to be 17 years or older. The number of cars estimated for the DED in 2006 was 1,500, meaning that car ownership is already very high in the area. When these data are input to the low growth forecasting model, car ownership is projected to reach 1,008.6 cars per 1,000 adults by 2015, increasing to 1,109.9 by 2025. The medium growth model forecasts car ownership in the DED to reach 1,016.4 cars per 1,000 adults by 2015, increasing to 1,127.4 by 2025. The high growth model forecasts car ownership in Saggart to reach similar levels to those forecast under the medium growth model.

Zonal Projections

4.83. The forecasts for car ownership at zonal level fall out of the DED projections. The numbers of cars forecast for each DED within a particular zone were aggregated, as were the projected population data. These car number forecasts and projected adult population figures for each zone were then used to derive projected rates of car ownership.

4.84. Although some zones are forecast to attain rates of car ownership in excess of the saturation levels discussed, none of the growth models project car ownership of 1,000 cars or more per 1,000 adults for any zone. Zone 830 is forecast to have the highest rate of car ownership under each scenario (941.3 cars per 1,000 adults under the low growth scenario; 955.6 under the medium growth scenario; and, 953.2 under the high growth scenario). This zone is located on the outskirts of South Dublin and comprises just three DEDs, one of which is Saggart (DED reference 3027). The other two DEDs are Ballinascorney (DED reference 3001) and Rathcoole (DED reference 3021).

5. Fuel Prices and Traffic Demand

5.1. Another determinant of future traffic is the cost of travel, of which the largest variable component is the cost of transport fuels. A model of fuel demand was developed to provide an insight into the sensitivity of the NTM traffic volume outputs to such prices.

5.2. Existing traffic data do not have the precision required for statistical modelling of price effects. Thus, to determine the sensitivity of traffic volumes to fuel prices in an Irish context, the model developed relies on estimates of the sensitivity of fuel demand to such prices.

5.3. Estimates of fuel demand can be subject to errors arising from "fuel tourism", requiring the model to take account of this factor. Estimates of fuel tourism suggest that:

- Official data for 2008 overestimate petrol consumption in the ROI by 9.6 per cent and diesel consumption by 24.9 per cent.
- Only 90.2 per cent of reported petrol consumption and only 80.1 per cent of reported diesel consumption in the ROI were actually consumed locally in 2008. The balance is represented by fuel tourism.
- Relative price differentials between the ROI and NI are the main determinants of both the direction and scale of cross border fuel movements. For example, in 2002, petrol prices in the UK were on average 44 per cent higher than in the ROI, coinciding with the peak in fuel tourism.

5.4. Two econometric models were used to estimate price and income elasticities. In the static demand model, the quantity of fuel consumed was estimated to be a linear function of real petrol prices and real personal consumer expenditure. In the dynamic model, the function was extended to incorporate a lagged dependent variable – the quantity of fuel consumed in the prior time period – thus enabling long run elasticities to be calculated.

5.5. Regressions were then run against a number of different measures of the quantity of fuel demanded. For petrol, the most statistically reliable results were obtained from a time series adjusted for fuel tourism, running from 1989 to 2008. For petrol and diesel combined, the best results were obtained with officially reported data extending back to 1965. This enabled short and long run price and income elasticities to be calculated for Ireland. These are summarised in Table 20.1.31 together with a synopsis of price and income elasticities for all fuels derived from an international meta analysis.

Table 20.1.31: Summary of Price and Income Elasticities of Demand

Country	Fuel	Duration	Price	Income
Ireland	Petrol	Short Run	-0.14	0.48
		Long Run	-0.20	0.71
Ireland	All Fuel	Short Run	-0.05	0.30
		Long Run	-0.19	1.20
International	All Fuel	Short Run	-0.25	0.47
		Long Run	-0.77	0.93

5.6. Some of the key findings can be stated as follows:

- The demand for petrol in Ireland was found to be very inelastic with respect to price, with the short run measure estimated at -0.14 and the long run at -0.20. The price elasticity of demand for petrol and diesel combined is found to be even lower. By comparison, international measures of price elasticity for all fuels average -0.25 in the short run and -0.77 in the long run.

- Income elasticities of demand in Ireland are much higher than price elasticities and are therefore more in line with international experience. The elasticity of petrol demand with respect to income levels, for example, is estimated at 0.48 in the short run and 0.71 in the long run. The international income elasticities for all fuels are estimated at 0.47 in the short run and 0.93 in the long run.

5.7. Essentially, the elasticity of fuel demand with respect to fuel prices is very low in Ireland, particularly for the short term response. For petrol price elasticity, which relates wholly to car travel, the results are -0.14 for the short run and -0.20 for the long run. These values are low by comparison with average international experience, particularly for the long run, while remaining within the range of international results. A priori reasoning, as confirmed by the international data, suggests that the petrol price elasticity for traffic volumes would be appreciably lower, typically by some 40 per cent. This would result in petrol price elasticity for traffic volumes of approximately -0.08 and -0.12 for short and long run respectively. At these levels, a 50 per cent increase in petrol prices would reduce traffic volumes by some 6 per cent, once long run adjustments have been worked through.

5.8. The traffic projections emanating from the NTM do not take account of the impact of fuel prices. However, the results of this fuel demand model suggest that even very large changes in fuel prices are unlikely to invalidate the projections emanating from the NTM.