**“An economic analysis for the elasticity of demand for energy in Northern Ireland”**

**by**

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# Executive Summary

One of the key signalling mechanisms to consumers (whether industrial, commercial or domestic) to reduce their CO2 emissions is price.

By providing consumers with a financial incentive to reduce their demand for carbon intensive fuels, price signals can drive the uptake of energy efficiency and lower carbon energy either by reducing their demand or by choosing renewable energy over more intensive CO2 sourced energy or both.

Economic theory says that as energy prices rise, the quantity of energy demanded will fall, holding all other factors constant. Own-price elasticities are typically in the negative range, which indicates that demand falls as prices increase or, conversely, that demand increases as prices fall. As income increases, the quantity of energy demanded will rise, holding all other factors constant. Income elasticities are typically in the range of 0 to 1.

The analysis finds that overall price elasticities are relatively low, a 10% rise in all fuel prices will result in a 2.1% fall in demand in the short-run and a fall in demand of 1.8% in the long-run.

Some sectors are much more responsive to price changes, in the case of the non-domestic (i.e. commercial & industrial) demand for electricity a 10% rise in all fuel prices will result in a 3.3% fall in demand in the short-run and a 2.9% in the long-run[[1]](#footnote-1).

Income elasticities are within the range expected, with the long-run income elasticity of demand for both non-domestic and domestic electricity being of the order of 0.26 – 0.28, these suggest that a 10% rise in real income will lead to a 2.7% or 2.8% increase in electricity demand. This is reassuring and suggests that rising levels of prosperity in Northern Ireland may not cause as serious problems with CO2 emissions as may have been feared.

Given the assumption of a 1% annual rise in real GDP in Northern Ireland, the level of annual real price change to reduce total electricity demand by 25% (e.g. parallel to the reduction sought in the draft Programme for Government of a 25% reduction in the carbon footprint of Northern Ireland by 2025) is of the order of 6%. Assuming higher levels of economic growth in Northern Ireland will increase this required real price increase.

Thus, if CO2 emissions are to be reduced via demand side mechanisms, then the implication of this analysis is that the impact would be greater if applied to the non-domestic electricity sector. Given that Northern Ireland has significantly less energy-intensive industry than Great Britain, a reduction in energy demand here would require a larger proportion of the business community to be targeted than would be the case in Great Britain for an equivalent reduction in demand.

The impression one gets from this analysis is that any action taken to impact on the carbon footprint of Northern Ireland, and hence climate change, would need to be a joined-up approach between NIAUR, government departments and other relevant agencies.

# Introduction

One of the key signalling mechanisms to consumers (whether industrial, commercial or domestic) to reduce their CO2 emissions is price.

Pricing in the full environmental cost of carbon (through a market mechanism via carbon levies or via taxes) sends price signals that can act to reduce the demand by consumers for CO2 intensive energy, thus leading to reductions in CO2 levels to meet targets. The relevant economic theory suggests that consumers will reduce the CO2 emissions from their energy usage up until the point where the marginal cost of abatement is equal to the carbon price.

By providing consumers with a financial incentive to reduce their demand for carbon intensive fuels, price signals can drive the uptake of energy efficiency and lower carbon energy either by reducing their demand or by choosing renewable energy over more intensive CO2 sourced energy or both.

This paper focuses on how energy consumers in Northern Ireland would respond to price signals by examining their elasticity of demand for energy.

# Literature Survey

The focus here is on studies in the United Kingdom, Northern Ireland and the Republic of Ireland so that factors of differing taxation, structural and cultural factors do not need to be taken into account.

The last substantive study of energy demand in Northern Ireland was Smyth (1996). This study focussed on two areas of interest to us here. Firstly, total energy demand where Smyth found a short-run price elasticity demand of -0.02, a long-run price elasticity of demand of -0.07, a short-run income elasticity of demand of 0.47 and a long-run income elasticity of demand of 0.73. Secondly domestic energy demand finding a short-run price elasticity demand of -0.12, a long-run price elasticity of demand of -0.01, a short-run income elasticity of demand of 1.06 and a long-run income elasticity of demand of 0.52.

Turning to our neighbours, the Republic of Ireland and Great Britain, more recent estimates of the elasticities of demand are available.

Bergin, FitzGerald and Kearney (2002) find that the long-term income elasticity of domestic demand for electricity in the Republic of Ireland is 1.12 whilst the long-term price elasticity is -0.24. Whilst their price elasticity of demand element is believable, the authors of this paper have qualms about the magnitude of their income elasticity of demand estimate as it suggests a 10% increase in real income leads to a 11.2% increase in electricity consumption.

Dulecka & Kaufmann (2004) find that the long-term income elasticity of domestic demand for electricity in the Republic of Ireland is 0.3896 (which is statistically significant at the 99.99% level) . However, they find that the price elasticity of domestic electricity demand is not statistically significant which they posit thus:

“… the insignificance of the price coefficient may be explained by two related factors. Firstly, in developed countries electricity has become a basic need for households so that the price elasticity of electricity demand is small, i.e. big price movements would be required to affect demand patterns significantly. This leads to our second factor, as big price movements have not taken place in the observed period (i.e. electricity price was not the prime policy variable), the price variable is not a determinant of electricity demand. This result is also in line with the previous analysis in Engle et al. (1989), where prices were not significant in determining long-run electricity demand in the UK.”

Both income and price were insignificant in their short-run model of domestic electricity demand.

A summary of overall energy demand elasticity estimates for the UK in Oxera (2006) suggests a consensus of a short-run income elasticity of about 0.03, a long-run income elasticity of between 0.02 and 0.07, a short-run price elasticity of about -0.3, a long-run elasticity of between -0.2 and -0.6.

A summary of recent Northern Ireland, UK and Republic of Ireland estimates for energy elasticities of demand is overleaf.

**Table 1 A summary of UK & Republic of Ireland elasticity of demand estimates**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Authors | Country | short-run price elasticity of demand | long-run price elasticity of demand | short-run income elasticity of demand | long-run income elasticity of demand |
| Smyth (1996) | Northern Ireland Total Energy Demand | -0.02 | -0.07 | 0.47 | 0.74 |
| Smyth (1996) | Northern Ireland Domestic Energy Demand | -0.12 | -0.18 | 1.06 | 0.52 |
| Bergin et al (2002) | Republic of Ireland domestic demand for electricity |  | -0.24 |  | 1.12 |
| Dulecka et al (2004) | Republic of Ireland domestic demand for electricity |  |  |  | 0.39 |
| Hunt and Witt (1995) | UK Total (annual - cointegration) |  | -0.29 |  | 0.23 |
| Clements & Madlener (1999) | UK domestic energy (quarterly - cointegration) |  |  |  | 0.36 |
| Oxera (2006) | UK Total  | -0.3 | -0.2 to -0.6 | 0.03 | 0.02 to 0.07 |

These estimates would suggest that an elasticity estimate of about -0.2 to -0.4 for both short-run and long-run price is anticipated on the basis of the UK and Republic or Ireland estimates.

Both the short-run and long-run income elasticity are more open to question as the UK estimates are considerable at variance with those for the Republic (by at least a magnitude of 5-fold).

The importance of obtaining sensible consistent estimates of elasticity, from a sustainability perspective, is that the magnitude of the elasticity has important policy implications. The 2 recent long-run income elasticity of demand estimates for the Republic differ to such an extent that one suggests a 10% rise in real income will increase domestic energy demand by 3.9% while the other suggests an increase in domestic energy demand of 11.2%. The same authors suggest that the real price rise required to counteract this increase in demand is of the order of 47%.[[2]](#footnote-2)

# The methodology of the model and data sources

**Methodology**

In each case, we will initially be estimating the relevant energy demand with respect to the real price of that type of energy, real income, the real price of other energy types and any relevant dummy variables to adjust for one-off shocks.

This very general regression model is estimated and which is then reduced by the elimination of those variables which are not statistically significant, bearing in mind the economic criteria which underlie the model.

Then we make using a cointegration methodology to analyse first the short-run and then the long-run.

**Data Sources**

Consumption and Income data has been primarily obtained from the Northern Ireland Annual Abstract of Statistics (1970 to 2007) supplemented by data obtained directly from both Phoenix[[3]](#footnote-3) and Viridian[[4]](#footnote-4). Price data has been mainly obtained from the Digest of United Kingdom Energy Statistics (1970 to 2007) again supplemented by data obtained directly from both Phoenix and Viridian[[5]](#footnote-5).

# Results – Northern Ireland

## Total Non-Transport Energy Demand (Northern Ireland)

**Table 2 – Elasticity estimates for Total Non-Transport Energy Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.2121 | 96.54% |
| Short-Run Income elasticity | Not significant |
| Long-Run Price elasticity | -0.1775 | 88.12% |
| Long-Run Income elasticity | Not significant |

The short-run model has an R2 of 0.4616 whilst the long-run model has an R2of 0.4548.

These relatively low R2 values are attributed by the authors to there being a number of other factors at work over the period from 1970 onwards – these include significant changes in the Northern Ireland economy in terms of the type of industry in operation.

One important point to be made here elating to the lack of significance of real income is that real income and real energy price seems to be highly correlated (a regression between them has an R2 of 0.61).

Although income was not statistically significant for this model, a quadratic time trend was.

The price elasticity of demand estimates suggest that a 5% rise in real price will result in just over a 1% fall in total non-transport energy demand in the short-run while a 6% rise would be required to have the same effect in the long-run.

The model estimates demand in the post-2000 period within acceptable confidence intervals.

##  Total Electricity Demand (Northern Ireland)

**Table 3 – Elasticity estimates for Total Electricity Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.3047 | 99.99% |
| Short-Run Income elasticity |  0.4645 | 99.99% |
| Long-Run Price elasticity  | -0.3157 | 99.99% |
| Long-Run Income elasticity |  0.2784 | 99.99% |

R2 = 0.99 (short-run), 0.99 (long-run)

This is a much better model than the previous one with the key variables being statistically significant and in line with expectations. There is also a much better explanatory performance (99% of variation in electricity demand is explained by the variables of interest in both the short and the long run)

The price elasticity of demand estimates suggest that a 3.3% rise in real price will result in just over a 1% fall in total electricity demand in the short-run while a 3.2% rise would be required to have the same effect in the long-run.

The income elasticity of demand estimates suggest that a 2.16% rise in real income will result in just over a 1% rise in total electricity demand in the short-run while a 3.6% rise would be required to have the same effect in the long-run.

The model estimates the total demand for electricity in recent years within acceptable confidence intervals.

##  Non-Domestic Electricity Demand (Northern Ireland)

**Table 4 – Elasticity estimates for Non-Domestic Electricity Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.3278 | 99.99% |
| Short-Run Income elasticity |  0.6013 | 99.99% |
| Long-Run Price elasticity | -0.2922 | 99.99% |
| Long-Run Income elasticity |  0.2837 | 99.99% |

R2 = 0.98 (short-run), 0.98 (long-run)

All of the key variables are statistically significant and in line with expectations. There is a good explanatory performance (98% of variation in electricity demand is explained by the variables of interest in both the short and the long run)

The price elasticity of demand estimates suggest that a 3.1% rise in real price will result in just over a 1% fall in total electricity demand in the short-run while a 3.43% rise would be required to have the same effect in the long-run.

The income elasticity of demand estimates suggest that a 1.67% rise in real income will result in just over a 1% rise in total electricity demand in the short-run while a 3.53% rise would be required to have the same effect in the long-run.

The model overestimates the non-domestic demand for electricity in recent years but within acceptable confidence intervals.

## Domestic Electricity Demand (Northern Ireland)

**Table 5 – Elasticity estimates for Domestic Electricity Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.2089 | 99.99% |
| Short-Run Income elasticity |  0.2597 | 99.99% |
| Short-Run cross-price elasticity (oil) | -0.0678 | 99.61% |
| Long-Run Price elasticity | -0.2314 | 99.99% |
| Long-Run Income elasticity |  0.2677 | 99.99% |
| Long-Run cross-price elasticity (oil) | -0.0532 | 97.36% |

R2 = 0.98(short-run), 0.98 (long-run)

All of the key variables are statistically significant and there is a good explanatory performance (98% of variation in domestic electricity demand is explained by the variables of interest in both the short and the long run)

The price elasticity of demand estimates suggest that a 4.8% rise in real price will result in just over a 1% fall in total electricity demand in the short-run while a 4.33% rise would be required to have the same effect in the long-run.

The income elasticity of demand estimates suggest that a 3.86% rise in real income will result in just over a 1% rise in total electricity demand in the short-run while a 3.74% rise would be required to have the same effect in the long-run.

As we might have expected, the non-domestic elasticity estimates have higher magnitudes than the domestic estimates. This is most probably due to the non-domestic sector having a more prompt response to price stimuli.

One interesting difference with this model is that the variable for the real price of one of the other fuels (namely oil) was statistically significant. The cross-price elasticity of demand estimates suggest that a 14.75% rise in the real price of oil will result in just over a 1% fall in total electricity demand in the short-run while a 18.8% rise would be required to have the same effect in the long-run. The authors wonder if this is masking some other effect as the sign does seem to be contrary to expectations.

The model does seem to underestimate recent domestic electricity demand but within acceptable confidence intervals.

## Domestic Oil Demand (Northern Ireland)

**Table 6 – Elasticity estimates for Domestic Oil Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.1902 | 95.44% |
| Short-Run cross-price elasticity (electricity) |  1.0362 | 99.98% |
| Long-Run Price elasticity | -0.1612 | 88.28% |
| Long-Run cross-price elasticity (electricity) |  0.9911 | 99.96% |

R2 = 0.99(short-run), 0.99 (long-run)

The price and cross-price (with respect to electricity) variables are statistically significant. There is a good explanatory performance (99% of the variation in domestic oil demand is explained by the variables of interest in both the short and the long run)

The price elasticity of demand estimates are in line with expectations and suggest that a 5.26% rise in real price will result in just over a 1% fall in domestic oil demand in the short-run while a 6.21% rise would be required to have the same effect in the long-run. The relatively small magnitude of these effects we would interpret as being due to many oil users having limited access to alternatives – e.g. outside the Phoenix Gas areas, supply choice is constrained to electricity, oil or coal; of these electricity tends to be more expensive and coal is a messier fuel.

The income elasticity of demand variable was not statistically significant.

It was again the case with this model that the variable for the real price of one of the other fuels (namely electricity) was statistically significant. The cross-price elasticity of demand estimates suggest that a 1.04% rise in the real price of electricity will result in just over a 1% fall in total oil demand in the short-run while a 1% rise would be required to have the same effect in the long-run. The authors again wonder if this is masking some other effect as the sign does seem contrary to expectations.

## Domestic Coal Demand (Northern Ireland)

**Table 7 – Elasticity estimates for Domestic Coal Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run Price elasticity | -0.3883 | 93.13% |
| Long-Run Price elasticity | -0.4491 | 99.23% |

R2 = 0.79(short-run), 0.81 (long-run)

The price variable is statistically significant and in line with our expectations which are discussed in more detail below.

There is a reasonable explanatory performance (79% of the variation in domestic coal demand is explained in the short-run and 81% of the variation in domestic coal demand is explained in the long run)

The price elasticity of demand estimates suggest that a 2.58% rise in real price will result in just over a 1% fall in domestic coal demand in the short-run while a 2.23% rise would be required to have the same effect in the long-run. We interpret the relatively high magnitude of these effects, compared to the other own fuel elasticities, as due to coal being seen is a messier fuel (domestic coal usage in Northern Ireland has dropped by nearly 65% in the last twenty years).

The income elasticity of demand estimates were not statistically significant.

The model does estimate recent domestic coal demand within acceptable confidence intervals.Non-Domestic Gas Demand (Northern Ireland)

**Table 8 – Elasticity estimates for Non-Domestic Gas Demand (Northern Ireland)**

|  |  |  |
| --- | --- | --- |
| Variable | Magnitude | Significance |
| Short-Run cross-price elasticity (electricity) | 0.3665 | 91.40% |
| Long-Run cross-price elasticity (electricity) | 0.3735 | 91.54% |

R2 = 0.98 (short-run), 0.98 (long-run)

Because natural gas has only relatively recently been introduced into Northern Ireland, there are not enough annual observation to undertake a statistical analysis of the same form as carried put above for the other fuels using annual data.

Thus a model using quarterly data[[6]](#footnote-6) was estimated for domesticgas demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

Although, the model has a good explanatory performance (98% of the variation in domestic gas demand is explained in the short-run), the only statistically significant effects are the cross-price effect (with respect to electricity) and the seasonality effects.

In both the short-run and the long-run, the cross-price elasticity of demand with respect to electricity is 0.37 so a 2.67% rise in the real price of electricity will result in just over a 1% increase in non-domestic gas demand.

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## Domestic Gas Demand (Northern Ireland)

Because natural gas has only relatively recently been introduced into Northern Ireland, there are not enough annual observation to undertake a statistical analysis of the same form as carried put above for the other fuels using annual data.

Thus a model using quarterly data[[7]](#footnote-7) was estimated for domesticgas demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

Although, the model has a good explanatory performance (91% of the variation in domestic gas demand is explained in the short-run), the seasonality effects overwhelm the price, income and cross-price effect.

The authors conjecture that this is due to the extent of the roll out of gas during this period with the number of customers increasing from 467 in the 1st quarter of 1998 to 91,941 in the 4th quarter of 2006. Thus the consumers either

1. are tenants of the Housing Executive and have minimal control over the choice of fuel (for some types of fuel usage such as cooking and hot water, a switch to electricity is feasible)
2. have relatively recently made a substantial sunk cost in the capital of switching to gas and would have to repeat a relatively large proportion of this sunk cost to switch to another fuel

or

1. were connected to gas when their house was constructed and would have to make a substantial sunk cost in the capital of switching to another fuel

# Conclusions

The importance of obtaining sensible consistent estimates of elasticity, from a sustainability perspective, is that the magnitude of the elasticity has important policy implications.

For domestic electricity, demand did not tend to react much to changes in price. This suggests that price may not be an effective policy instrument to either reduce demand or limit the growth of demand.

For non-domestic electricity, demand is more responsive to changes in price. This suggests that price may be an effective policy instrument to either reduce demand or limit the growth of demand.

The evidence on gas is still unclear until the market has matured sufficiently for a detailed analysis to be undertaken when parameters are stable.

Given the assumption of a 1% annual rise in real GDP in Northern Ireland, the level of annual real price change to reduce total electricity demand by 25% (e.g. parallel to the reduction sought in the draft Programme for Government of a 25% reduction in the carbon footprint of Northern Ireland by 2025) is of the order of 6.2%. Assuming higher levels of economic growth in Northern Ireland will increase this required real price increase.

An important point to bear in mind is that the elasticities calculated here are snapshots for the entire population – it is quite conceivable that different groups of consumers may have different elasticities. Thus fuel poverty could be a significant issue if carbon levies were introduced at household levels of usage.

Focusing on just one group – pensioner households.

The 2004 Interim House Condition Survey (Northern Ireland Housing Executive (2006)) finds that 40.6% of pensioner households were in fuel poverty compared to 23.9% of total households.

An analysis of the Continuous Household Survey for 2005/06 finds that while 2.3% of all households were without central heating, this figure was 3.9% of pensioner households with 100% more pensioner households (0.94% as opposed to 0.46%) using a range (separate from a central heating) as their main form of heating in Winter, with 50% more (2.7% as opposed to 1.8%) using electric storage heaters as their main form of heating in Winter and 32% more (3.8% as opposed to 2.8%) using a closed fire as their main form of heating in Winter.

Let us now turn to the non-domestic sector. If CO2 emissions are to be reduced via demand side mechanisms, then the implication of this analysis is that the impact would be greater if applied to the non-domestic electricity sector. Given that Northern Ireland has significantly less energy-intensive industry than Great Britain, a reduction in energy demand here would require a larger proportion of the business community to be targeted than would be the case in Great Britain for an equivalent reduction in demand.

A potential issue that applies to both sectors is that consumer behaviour does change over time (the relative usage of the different types of energy sources at final user level in Northern Ireland is given in Table 9 (for all users except transport) and Table 10 (for domestic users excluding transport) – a dramatic shift from coal to oil is particularly apparent in the latter),

Some recent international research suggests that consumers have become more responsive to price in recent years, a study of cross-European domestic natural gas consumption by Nilsen et al (2005) suggests that consumers became significantly more responsive to price changes in the period from 1987 onwards (the long-run price elasticity of demand for natural gas increased from -0.99 to -1.45).

The impression one gets is that any action taken would need to be a joined-up approach between NIAUR, government departments and other relevant agencies, a view echoed in a recent press article by the head of the Environment and Heritage service (Rogers (2007) who states

“We are preparing a first-ever *State of the Environment Report* and I expect it to show that a great deal needs to be done to achieve the kind of significant improvement that all of us want to see. The changes go far beyond the remit of the EHS. They include tackling over-dependence on fossil fuels, and on road transport.”

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# Appendix 1 – Non-transport Energy Consumption by type

**Table 9 - Total Non-transport Energy Consumption by final source**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Electricity | Gas | Oil | Coal |
| 1970 | 17.16% | 3.91% | 36.94% | 42.00% |
| 1971 | 17.96% | 4.23% | 37.52% | 40.30% |
| 1972 | 19.46% | 4.42% | 43.58% | 32.54% |
| 1973 | 19.99% | 4.15% | 43.17% | 32.69% |
| 1974 | 20.64% | 4.25% | 39.97% | 35.14% |
| 1975 | 19.86% | 4.69% | 38.54% | 36.91% |
| 1976 | 21.05% | 4.54% | 40.84% | 33.57% |
| 1977 | 20.86% | 3.93% | 41.41% | 33.80% |
| 1978 | 20.84% | 3.71% | 43.72% | 31.73% |
| 1979 | 18.90% | 3.07% | 45.37% | 32.66% |
| 1980 | 22.65% | 0.00% | 42.05% | 35.30% |
| 1981 | 24.54% | 0.00% | 40.45% | 35.01% |
| 1982 | 22.37% | 0.00% | 39.71% | 37.92% |
| 1983 | 20.04% | 0.00% | 30.26% | 49.70% |
| 1984 | 22.16% | 0.00% | 34.53% | 43.30% |
| 1985 | 19.42% | 0.00% | 31.59% | 48.99% |
| 1986 | 20.99% | 0.00% | 36.53% | 42.48% |
| 1987 | 21.92% | 0.00% | 35.19% | 42.90% |
| 1988 | 22.77% | 0.00% | 36.31% | 40.92% |
| 1989 | 22.70% | 0.00% | 35.09% | 42.21% |
| 1990 | 23.61% | 0.00% | 35.47% | 40.92% |
| 1991 | 22.33% | 0.00% | 36.19% | 41.47% |
| 1992 | 22.91% | 0.00% | 40.71% | 36.38% |
| 1993 | 23.04% | 0.00% | 44.04% | 32.92% |
| 1994 | 22.43% | 0.00% | 41.69% | 35.88% |
| 1995 | 25.15% | 0.00% | 43.11% | 31.74% |
| 1996 | 25.28% | 0.00% | 42.86% | 31.86% |
| 1997 | 26.23% | 0.00% | 42.23% | 31.55% |
| 1998 | 26.33% | 1.58% | 50.86% | 21.24% |
| 1999 | 25.24% | 2.52% | 49.84% | 22.40% |
| 2000 | 27.72% | 4.68% | 45.72% | 21.87% |
| 2001 | 25.04% | 6.41% | 50.95% | 17.61% |
| 2002 | 26.36% | 8.10% | 48.60% | 16.93% |
| 2003 | 25.30% | 8.57% | 51.98% | 14.16% |
| 2004 | 22.64% | 8.27% | 55.00% | 14.10% |
| 2005 | 24.97% | 9.32% | 52.53% | 13.18% |

For comparison, the 2005 figures for Great Britain were:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Electricity | Gas | Oil | Coal |
| 2005 | 18.74% | 35.10% | 44.50% | 1.66% |

**Table 10 - Domestic Non-transport Energy Consumption by final source**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Electricity | Gas | Oil | Coal |
| 1970 | 16.68% | 8.44% | 4.67% | 70.21% |
| 1971 | 17.87% | 8.98% | 4.77% | 68.39% |
| 1972 | 22.19% | 10.25% | 6.69% | 60.87% |
| 1973 | 21.31% | 9.87% | 7.29% | 61.52% |
| 1974 | 19.98% | 9.11% | 6.98% | 63.92% |
| 1975 | 16.63% | 9.67% | 8.59% | 65.11% |
| 1976 | 17.92% | 9.66% | 10.30% | 62.13% |
| 1977 | 17.76% | 8.35% | 9.37% | 64.51% |
| 1978 | 18.37% | 8.32% | 9.36% | 63.95% |
| 1979 | 16.66% | 6.90% | 9.09% | 67.36% |
| 1980 | 19.00% | 0.00% | 11.93% | 69.07% |
| 1981 | 19.27% | 0.00% | 13.90% | 66.82% |
| 1982 | 17.13% | 0.00% | 13.46% | 69.41% |
| 1983 | 13.19% | 0.00% | 8.09% | 78.72% |
| 1984 | 15.61% | 0.00% | 9.90% | 74.50% |
| 1985 | 13.15% | 0.00% | 7.83% | 79.03% |
| 1986 | 16.11% | 0.00% | 8.80% | 75.09% |
| 1987 | 16.97% | 0.00% | 9.67% | 73.36% |
| 1988 | 17.37% | 0.00% | 12.17% | 70.46% |
| 1989 | 16.27% | 0.00% | 14.76% | 68.98% |
| 1990 | 17.05% | 0.00% | 16.01% | 66.95% |
| 1991 | 16.04% | 0.00% | 17.43% | 66.53% |
| 1992 | 17.55% | 0.00% | 20.21% | 62.24% |
| 1993 | 18.65% | 0.00% | 21.41% | 59.94% |
| 1994 | 16.89% | 0.00% | 22.63% | 60.48% |
| 1995 | 18.84% | 0.00% | 30.68% | 50.48% |
| 1996 | 18.08% | 0.00% | 34.41% | 47.52% |
| 1997 | 17.27% | 0.00% | 33.03% | 49.70% |
| 1998 | 28.19% | 0.24% | 14.92% | 56.65% |
| 1999 | 18.89% | 0.69% | 39.53% | 40.89% |
| 2000 | 21.10% | 1.78% | 42.70% | 34.42% |
| 2001 | 19.06% | 2.73% | 50.49% | 27.72% |
| 2002 | 20.28% | 4.24% | 53.86% | 21.62% |
| 2003 | 22.82% | 5.90% | 51.70% | 19.58% |
| 2004 | 19.81% | 5.79% | 51.59% | 22.80% |
| 2005 | 21.56% | 7.33% | 50.17% | 20.95% |

For comparison, the 2005 figures for Great Britain were:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Electricity | Gas | Oil | Coal |
| 2005 | 21.44% | 70.47% | 6.60% | 1.06% |

#  Appendix 2 – Raw results

### Total Energy Demand (Northern Ireland)

An Initial Model was estimated for total energy demand as a function of real income, real energy price and dummy variables for the key years where structural breaks might occur.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 6.20866 | 0.441624 | 14.0587 | <0.00001 | \*\*\* |
| l\_NIPDYR | 0.132644 | 0.0413526 | 3.2076 | 0.00391 | \*\*\* |
| l\_REALPTOTALL | -0.0234927 | 0.0657039 | -0.3576 | 0.72394 |  |
| dummy1973 | 0.0101044 | 0.0915134 | 0.1104 | 0.91304 |  |
| dummy1974 | 0.0686208 | 0.0885276 | 0.7751 | 0.44616 |  |
| dummy1975 | 0.0507089 | 0.0872307 | 0.5813 | 0.56668 |  |
| dummy1979 | 0.00798122 | 0.0854303 | 0.0934 | 0.92638 |  |
| dummy1998 | -0.114251 | 0.0887813 | -1.2869 | 0.21094 |  |

Mean of dependent variable = 7.38126 Standard deviation of dep. var. = 0.111062

Sum of squared residuals = 0.157785 Standard error of residuals = 0.0828264

Unadjusted R2 = 0.573601 Adjusted R2 = 0.443827

F-statistic (7, 23) = 4.42001 (p-value = 0.00307)

Durbin-Watson statistic = 1.24699 First-order autocorrelation coeff. = 0.360275

The short-run income elasticity of demand was the only statistically significant variable and is acceptable in terms of magnitude.

However, the model is not good at predicting the post-2000 period where it predicts a continuation (and indeed a slight increase) in demand whereas the downturn continued (The actuality is however within the confidence intervals of the estimate)



An examination of the plot of actual over time suggests that a quadratic trend may exist.



The addition of time and time2 improve the forecast performance of the model enormously.



However, this was at the expense of the significance of the real income variable (and indeed any of the economic variables).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 8.91258 | 2.49557 | 3.5714 | 0.00180 | \*\*\* |
| l\_NIPDYR | -0.31869 | 0.325162 | -0.9801 | 0.33820 |  |
| l\_REALPTOTALL | -0.142818 | 0.14007 | -1.0196 | 0.31951 |  |
| dummy1973 | -0.012741 | 0.0832834 | -0.1530 | 0.87987 |  |
| dummy1974 | 0.0404692 | 0.0801125 | 0.5052 | 0.61871 |  |
| dummy1975 | 0.0685589 | 0.0769642 | 0.8908 | 0.38313 |  |
| dummy1979 | 0.056205 | 0.0815979 | 0.6888 | 0.49849 |  |
| dummy1998 | -0.0983352 | 0.0791737 | -1.2420 | 0.22792 |  |
| Time | 0.102062 | 0.0427484 | 2.3875 | 0.02644 | \*\* |
| Timesq | -0.00195155 | 0.000689978 | -2.8284 | 0.01007 | \*\* |

Mean of dependent variable = 7.38126 Standard deviation of dep. var. = 0.111062

Sum of squared residuals = 0.111101 Standard error of residuals = 0.072736

Unadjusted R2 = 0.699759 Adjusted R2 = 0.571085

F-statistic (9, 21) = 5.43821 (p-value = 0.000673)

Durbin-Watson statistic = 1.67585 First-order autocorrelation coeff. = 0.104282

Removing the dummy variables and the price variable leaves us with

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 6.55496 | 0.274309 | 23.8963 | <0.00001 | \*\*\* |
| Time | 0.0611832 | 0.0174962 | 3.4969 | 0.00165 | \*\*\* |
| Timesq | -0.00142083 | 0.000448687 | -3.1666 | 0.00380 | \*\*\* |
| l\_REALPTOTALL | -0.212066 | 0.0952847 | -2.2256 | 0.03458 | \*\* |

Mean of dependent variable = 7.38126 Standard deviation of dep. var. = 0.111062

Sum of squared residuals = 0.131898 Standard error of residuals = 0.0698935

Unadjusted R2 = 0.643558 Adjusted R2 = 0.603953

F-statistic (3, 27) = 16.2495 (p-value < 0.00001)

Durbin-Watson statistic = 1.65303 First-order autocorrelation coeff. = 0.144168

Thus the short-run price elasticity is -0.2121.

This model does well in terms of forecasting performance and is the one we present here.



The cointegration test suggests that there is at least one cointegrating vector

Rank Eigenvalue Trace test p-value Lmax test p-value

0 0.43261 23.639 [0.0019] 17.001 [0.0161]

1 0.19850 6.6381 [0.0100] 6.6381 [0.0100]

and the ensuing regression

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 5.45851 | 1.32531 | 4.1187 | 0.00037 | \*\*\* |
| Time | 0.0551288 | 0.0233185 | 2.3642 | 0.02615 | \*\* |
| Timesq | -0.00129694 | 0.000573068 | -2.2632 | 0.03256 | \*\* |
| l\_REALPTOTALL | -0.1775 | 0.109874 | -1.6155 | 0.11876 |  |
| EC1d | 0.000882242 | 0.00110857 | 0.7958 | 0.43362 |  |

Mean of dependent variable = 7.38529 Standard deviation of dep. var. = 0.110632

Sum of squared residuals = 0.118493 Standard error of residuals = 0.0688457

Unadjusted R2 = 0.666163 Adjusted R2 = 0.612749

F-statistic (4, 25) = 12.4717 (p-value = 1.03e-005)

Durbin-Watson statistic = 2.05398 First-order autocorrelation coeff. = -0.0386575

Thus the short-run price elasticity is -0.1775.

One important point to be made here relating to the lack of significance of real income is that real income and real energy price seems to be highly correlated (a regression between them has an R2 of 0.61)



 **Electricity**

### Total Electricity Demand (Northern Ireland)

An Initial Model was estimated for total electricity demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 2.99689 | 0.334132 | 8.9692 | <0.00001 | \*\*\* |
| l\_REALPTOTELE | -0.156148 | 0.0662569 | -2.3567 | 0.02694 | \*\* |
| l\_NIPDYR | 0.318449 | 0.0304099 | 10.4719 | <0.00001 | \*\*\* |
| l\_REALPTOTOIL | -0.031646 | 0.0453211 | -0.6983 | 0.49172 |  |
| l\_REALPTOTGAS | -0.110146 | 0.0686287 | -1.6050 | 0.12158 |  |
| dummy1973 | 0.0305804 | 0.0213816 | 1.4302 | 0.16554 |  |
| dummy1974 | 0.0686825 | 0.027134 | 2.5312 | 0.01833 | \*\* |
| dummy1975 | -0.0184676 | 0.0225214 | -0.8200 | 0.42028 |  |
| dummy1979 | 0.0280317 | 0.0168983 | 1.6588 | 0.11016 |  |
| dummy1998 | 0.00911757 | 0.017242 | 0.5288 | 0.60180 |  |

Sum of squared residuals = 0.00996635 Standard error of residuals = 0.020378

Unadjusted R2 = 0.993896 Adjusted R2 = 0.991607

F-statistic (9, 24) = 35.7266 (p-value < 0.00001)

Durbin-Watson statistic = 1.62863 First-order autocorrelation coeff. = 0.116435

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand and the dummy variable for 1974. To double check for one-off effects all of the dummy variables have been left in whilst the other statistically insignificant variables have been dropped..

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 3.6684 | 0.238151 | 15.4037 | <0.00001 | \*\*\* |
| l\_REALPTOTELE | -0.270968 | 0.0320372 | -8.4579 | <0.00001 | \*\*\* |
| l\_NIPDYR | 0.265208 | 0.0265885 | 9.9745 | <0.00001 | \*\*\* |
| dummy1973 | 0.0290111 | 0.0211427 | 1.3722 | 0.18174 |  |
| dummy1974 | 0.0638468 | 0.0241498 | 2.6438 | 0.01371 | \*\* |
| dummy1975 | -0.0107229 | 0.0200611 | -0.5345 | 0.59753 |  |
| dummy1979 | 0.032082 | 0.0166141 | 1.9310 | 0.06445 | \* |
| dummy1998 | 0.00913605 | 0.0165819 | 0.5510 | 0.58636 |  |

Sum of squared residuals = 0.0112909 Standard error of residuals = 0.0208391

Unadjusted R2 = 0.993082 Adjusted R2 = 0.991219

F-statistic (7, 26) = 30.3113 (p-value < 0.00001)

Durbin-Watson statistic = 1.4223 First-order autocorrelation coeff. = 0.271786

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand and the dummy variables for 1974 and 1979.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 3.52021 | 0.233265 | 15.0910 | <0.00001 | \*\*\* |
| l\_REALPTOTELE | -0.315788 | 0.0336789 | -9.3764 | <0.00001 | \*\*\* |
| l\_NIPDYR | 0.278381 | 0.0256274 | 10.8626 | <0.00001 | \*\*\* |
| dummy1974 | 0.0526309 | 0.0164738 | 3.1948 | 0.00376 | \*\*\* |
| dummy1979 | 0.0300704 | 0.0161428 | 1.8628 | 0.07429 | \* |

Sum of squared residuals = 0.0100929 Standard error of residuals = 0.0200927

Unadjusted R2 = 0.990864 Adjusted R2 = 0.989403

F-statistic (4, 25) = 47.1805 (p-value < 0.00001)

Durbin-Watson statistic = 1.66319 First-order autocorrelation coeff. = 0.154706

The model overestimates the forecast demand for electricity in recent years but within acceptable confidence intervals.



There is at least one cointegrating vector.

|  |  |  |  |
| --- | --- | --- | --- |
| Rank  | Eigenvalue  | Trace test p-value  | Lmax test p-value |
|  0  | 0.71609  | 56.477 [0.0000]  | 37.773 [0.0000] |
|  1  | 0.46393  | 18.705 [0.0144]  | 18.705 [0.0078] |
|  2 | 4.0589e-006  | 0.00012177 [0.9912]  | 0.00012177 [0.9912] |

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand and the dummy variables for 1974 and 1979.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 1.1176 | 0.284483 | 3.9285 | 0.00063 | \*\*\* |
| l\_REALPTOTELE | -0.304657 | 0.0160256 | -19.0106 | <0.00001 | \*\*\* |
| l\_NIPDYR | 0.464478 | 0.0198102 | 23.4463 | <0.00001 | \*\*\* |
| dummy1974 | 0.0697214 | 0.0257503 | 2.7076 | 0.01229 | \*\* |
| dummy1979 | 0.0107771 | 0.0262688 | 0.4103 | 0.68525 |  |
| EC1f | 0.605658 | 0.0890034 | 6.8049 | <0.00001 | \*\*\* |

Mean of dependent variable = 6.13668 Standard deviation of dep. var. = 0.19513

Sum of squared residuals = 0.0134925 Standard error of residuals = 0.0237105

Unadjusted R2 = 0.987781 Adjusted R2 = 0.985235

F-statistic (5, 24) = 388.02 (p-value < 0.00001)

Durbin-Watson statistic = 2.08129 First-order autocorrelation coeff. = -0.0634473

### Non-domestic electricity demand (Northern Ireland)

An Initial Model was estimated for non-domesticelectricity demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 4.10493 | 1.15151 | 3.5648 | 0.00173 | \*\*\* |
| l\_REALPTOTELE | -0.18326 | 0.0865484 | -2.1174 | 0.04576 | \*\* |
| l\_NIPDYR | 0.178773 | 0.121675 | 1.4693 | 0.15591 |  |
| l\_RealPTOTCOA | 0.013022 | 0.0684959 | 0.1901 | 0.85096 |  |
| l\_REALPTOTOIL | -0.0101691 | 0.0845241 | -0.1203 | 0.90533 |  |
| dummy1973 | 0.0886372 | 0.033632 | 2.6355 | 0.01511 | \*\* |
| dummy1974 | 0.0698504 | 0.0458692 | 1.5228 | 0.14205 |  |
| dummy1975 | 0.0228874 | 0.0337708 | 0.6777 | 0.50501 |  |
| dummy1979 | 0.0469124 | 0.0264703 | 1.7723 | 0.09020 | \* |
| dummy1998 | 0.00146517 | 0.0276678 | 0.0530 | 0.95824 |  |

Sum of squared residuals = 0.0267807 Standard error of residuals = 0.0348899

Unadjusted R2 = 0.985629 Adjusted R2 = 0.97975

F-statistic (9, 22) = 3.0132 (p-value = 0.0168)

Durbin-Watson statistic = 1.31776 First-order autocorrelation coeff. = 0.335778

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand and the dummy variables for 1973 and 1979.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 3.01378 | 0.562327 | 5.3595 | 0.00001 | \*\*\* |
| l\_REALPTOTELE | -0.292201 | 0.0614868 | -4.7523 | 0.00007 | \*\*\* |
| l\_NIPDYR | 0.283667 | 0.0615748 | 4.6069 | 0.00010 | \*\*\* |
| dummy1973 | 0.0398902 | 0.0256284 | 1.5565 | 0.13216 |  |
| dummy1979 | 0.0400302 | 0.0250277 | 1.5994 | 0.12229 |  |

Sum of squared residuals = 0.0259665 Standard error of residuals = 0.0322282

Unadjusted R2 = 0.983659 Adjusted R2 = 0.981044

F-statistic (4, 25) = 12.8878 (p-value < 0.00001)

Durbin-Watson statistic = 1.38418 First-order autocorrelation coeff. = 0.28734

The model overestimates the forecast demand for electricity in recent years but within acceptable confidence intervals.



There is at least one cointegrating vector.

Johansen test:

|  |  |  |  |
| --- | --- | --- | --- |
| Rank  | Eigenvalue  | Trace test p-value  | Lmax test p-value |
|  0  | 0.64231  | 41.854 [0.0010]  | 30.843 [0.0010] |
|  1  | 0.30443 |  11.011 [0.2142]  | 10.891 [0.1620] |
|  2  | 0.0040072  | 0.12046 [0.7285]  | 0.12046 [0.7286] |

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 0.152082 | 0.233287 | 0.6519 | 0.52065 |  |
| l\_REALPTOTELE | -0.327839 | 0.021261 | -15.4197 | <0.00001 | \*\*\* |
| l\_NIPDYR | 0.601281 | 0.0256136 | 23.4751 | <0.00001 | \*\*\* |
| dummy1973 | 0.0998374 | 0.0353933 | 2.8208 | 0.00946 | \*\*\* |
| dummy1979 | -0.0156472 | 0.0344279 | -0.4545 | 0.65356 |  |
| EC1g | 0.86871 | 0.0957164 | 9.0759 | <0.00001 | \*\*\* |

Mean of dependent variable = 5.62274 Standard deviation of dep. var. = 0.233506

Sum of squared residuals = 0.0224535 Standard error of residuals = 0.0305869

Unadjusted R2 = 0.9858 Adjusted R2 = 0.982842

F-statistic (5, 24) = 333.228 (p-value < 0.00001)

Durbin-Watson statistic = 2.0801 First-order autocorrelation coeff. = -0.0696079

### Domestic Electricity Demand (Northern Ireland)

An Initial Model was estimated for domesticelectricity demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 1.75922 | 1.51315 | 1.1626 | 0.26017 |  |
| l\_realdomelec | -0.219699 | 0.139987 | -1.5694 | 0.13396 |  |
| l\_realdomcoal | -0.032563 | 0.0852511 | -0.3820 | 0.70696 |  |
| l\_realdomoil | -0.0526671 | 0.0335315 | -1.5707 | 0.13367 |  |
| l\_NIPDYR | 0.390716 | 0.195307 | 2.0005 | 0.06076 | \* |
| dummy1973 | -0.00672562 | 0.0325641 | -0.2065 | 0.83869 |  |
| dummy1974 | 0.0904372 | 0.0329765 | 2.7425 | 0.01339 | \*\* |
| dummy1975 | -0.0515682 | 0.0250994 | -2.0546 | 0.05473 | \* |
| dummy1979 | 0.0096258 | 0.0266128 | 0.3617 | 0.72179 |  |
| dummy1998 | -0.00220721 | 0.0225031 | -0.0981 | 0.92295 |  |
| time | -0.0182895 | 0.0190719 | -0.9590 | 0.35027 |  |
| timesq | 0.000292461 | 0.000297494 | 0.9831 | 0.33860 |  |

Sum of squared residuals = 0.00897446 Standard error of residuals = 0.0223289

Unadjusted R2 = 0.986075 Adjusted R2 = 0.977566

F-statistic (11, 18) = 49.3458 (p-value < 0.00001)

Durbin-Watson statistic = 2.09104 First-order autocorrelation coeff. = -0.0589133

Only the income elasticity of demand is statistically significant along with the dummy variables for 1974 and 1975. A decision was made to remove the time quadratic and keep the price variables.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 2.59315 | 0.313416 | 8.2738 | <0.00001 | \*\*\* |
| l\_realdomelec | -0.221822 | 0.0493651 | -4.4935 | 0.00016 | \*\*\* |
| l\_realdomcoal | -0.0224659 | 0.0750558 | -0.2993 | 0.76738 |  |
| l\_realdomoil | -0.0483809 | 0.0289431 | -1.6716 | 0.10816 |  |
| l\_NIPDYR | 0.27397 | 0.0264009 | 10.3773 | <0.00001 | \*\*\* |
| dummy1974 | 0.0864736 | 0.0230027 | 3.7593 | 0.00102 | \*\*\* |
| dummy1975 | -0.0479995 | 0.021435 | -2.2393 | 0.03510 | \*\* |

Sum of squared residuals = 0.00973711 Standard error of residuals = 0.0205755

Unadjusted R2 = 0.984895 Adjusted R2 = 0.980955

F-statistic (6, 23) = 93.7354 (p-value < 0.00001)

Durbin-Watson statistic = 1.97756 First-order autocorrelation coeff. = -0.0012471

The result was that the price elasticity of demand also became significant with the price of oil being marginally significant. The next regression keeps the real price of electricity, the real price of oil, income and the 2 dummy variables in the model.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 2.67865 | 0.140692 | 19.0390 | <0.00001 | \*\*\* |
| l\_realdomelec | -0.231397 | 0.0413574 | -5.5950 | <0.00001 | \*\*\* |
| l\_realdomoil | -0.0531992 | 0.0224805 | -2.3665 | 0.02637 | \*\* |
| l\_NIPDYR | 0.267738 | 0.0168415 | 15.8976 | <0.00001 | \*\*\* |
| dummy1974 | 0.0872123 | 0.0219982 | 3.9645 | 0.00058 | \*\*\* |
| dummy1975 | -0.0471723 | 0.020599 | -2.2900 | 0.03111 | \*\* |

Sum of squared residuals = 0.00976986 Standard error of residuals = 0.0201762

Unadjusted R2 = 0.984844 Adjusted R2 = 0.981686

F-statistic (5, 24) = 112.946 (p-value < 0.00001)

Durbin-Watson statistic = 1.95623 First-order autocorrelation coeff. = 0.0102401

Now all of the remaining variables are significant and with the expected sign and magnitude.

The model does seem to underestimate recent domestic electricity demand but within acceptable confidence intervals.



There is at least one cointegrating vector.

Johansen test:

Case 3: Unrestricted constant

|  |  |  |  |
| --- | --- | --- | --- |
| Rank  | Eigenvalue  | Trace test p-value  | Lmax test p-value |
| 0  |  0.66975  | 57.187 [0.0000]  | 33.238 [0.0003] |
| 1  |  0.54891  | 23.950 [0.0017]  | 23.882 [0.0008] |
| 2  | 0.0022431  | 0.067367 [0.7952]  | 0.067367 [0.7952] |

The price elasticity of demand is statistically significant with the right sign as is the income elasticity of demand.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 2.73415 | 0.129252 | 21.1536 | <0.00001 | \*\*\* |
| l\_realdomelec | -0.208933 | 0.0385147 | -5.4247 | 0.00002 | \*\*\* |
| l\_realdomoil | -0.0678545 | 0.0210213 | -3.2279 | 0.00387 | \*\*\* |
| l\_NIPDYR | 0.259673 | 0.0158444 | 16.3890 | <0.00001 | \*\*\* |
| dummy1974 | 0.0871187 | 0.0233048 | 3.7382 | 0.00114 | \*\*\* |
| dummy1975 | -0.0633753 | 0.0367356 | -1.7252 | 0.09852 | \* |
| EC1e | 0 | 0 | 0.4969 | 0.62420 |  |

Sum of squared residuals = 0.00895071 Standard error of residuals = 0.0201705

Unadjusted R2 = 0.984949 Adjusted R2 = 0.980845

F-statistic (6, 22) = 140.608 (p-value < 0.00001)

Durbin-Watson statistic = 1.6766 First-order autocorrelation coeff. = 0.146594

### Domestic Oil Demand (Northern Ireland)

An Initial Model was estimated for domesticoil demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur. Again a quadratic time trend seemed to be of use based upon a visual observation of the data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 5.85308 | 0.535523 | 10.9297 | <0.00001 | \*\*\* |
| l\_realdomcoal | -0.249098 | 0.263944 | -0.9438 | 0.35603 |  |
| time | -0.205119 | 0.0451397 | -4.5441 | 0.00018 | \*\*\* |
| timesq | 0.00751992 | 0.00117562 | 6.3965 | <0.00001 | \*\*\* |
| l\_realdomoil | -0.193795 | 0.121283 | -1.5979 | 0.12501 |  |
| l\_realdomelec | 1.63183 | 0.34251 | 4.7643 | 0.00010 | \*\*\* |
| dummy1973 | 0.19204 | 0.0964041 | 1.9920 | 0.05953 | \* |
| dummy1974 | 0.227073 | 0.115185 | 1.9714 | 0.06200 | \* |
| dummy1975 | 0.0329725 | 0.0871026 | 0.3785 | 0.70882 |  |
| dummy1979 | 0.107945 | 0.0758944 | 1.4223 | 0.16962 |  |
| dummy1998 | -1.26496 | 0.0766141 | -16.5108 | <0.00001 | \*\*\* |

Sum of squared residuals = 0.143266 Standard error of residuals = 0.0825966

Unadjusted R2 = 0.992393 Adjusted R2 = 0.988771

F-statistic (10, 21) = 90.504 (p-value < 0.00001)

Durbin-Watson statistic = 2.05064 First-order autocorrelation coeff. = -0.1053



The insignificant dummy variables were dropped but all of the price variables were kept.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 5.76844 | 0.5358 | 10.7660 | <0.00001 | \*\*\* |
| l\_realdomcoal | -0.241292 | 0.261673 | -0.9221 | 0.36604 |  |
| time | -0.192595 | 0.0444463 | -4.3332 | 0.00025 | \*\*\* |
| timesq | 0.00718802 | 0.00115673 | 6.2141 | <0.00001 | \*\*\* |
| l\_realdomoil | -0.165987 | 0.119811 | -1.3854 | 0.17922 |  |
| l\_realdomelec | 1.51469 | 0.334938 | 4.5223 | 0.00015 | \*\*\* |
| dummy1973 | 0.166273 | 0.0925142 | 1.7973 | 0.08544 | \* |
| dummy1974 | 0.182463 | 0.101127 | 1.8043 | 0.08430 | \* |
| dummy1998 | -1.26465 | 0.0765209 | -16.5269 | <0.00001 | \*\*\* |

Sum of squared residuals = 0.15781 Standard error of residuals = 0.082833

Unadjusted R2 = 0.991621 Adjusted R2 = 0.988706

F-statistic (8, 23) = 110.046 (p-value < 0.00001)

Durbin-Watson statistic = 2.22609 First-order autocorrelation coeff. = -0.1987

In the next regression, the real price of coal was dropped.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 6.05236 | 0.438849 | 13.7914 | <0.00001 | \*\*\* |
| Time | -0.185644 | 0.0446127 | -4.1612 | 0.00035 | \*\*\* |
| Timesq | 0.00686051 | 0.00112735 | 6.0855 | <0.00001 | \*\*\* |
| l\_realdomoil | -0.223972 | 0.102806 | -2.1786 | 0.03941 | \*\* |
| l\_realdomelec | 1.3376 | 0.289194 | 4.6253 | 0.00011 | \*\*\* |
| dummy1973 | 0.152847 | 0.0909449 | 1.6807 | 0.10580 |  |
| dummy1974 | 0.178079 | 0.100416 | 1.7734 | 0.08885 | \* |
| dummy1998 | -1.27921 | 0.0740192 | -17.2821 | <0.00001 | \*\*\* |

Sum of squared residuals = 0.16333 Standard error of residuals = 0.0824949

Unadjusted R2 = 0.991328 Adjusted R2 = 0.988798

F-statistic (7, 24) = 119.996 (p-value < 0.00001)

Durbin-Watson statistic = 2.13318 First-order autocorrelation coeff. = -0.165798

The 1973 dummy variable was dropped but the real price of oil was kept despite its very marginal significance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 5.70079 | 0.429322 | 13.2786 | <0.00001 | \*\*\* |
| Time | -0.147233 | 0.0426461 | -3.4524 | 0.00191 | \*\*\* |
| Timesq | 0.00584977 | 0.00107285 | 5.4525 | 0.00001 | \*\*\* |
| l\_realdomoil | -0.161178 | 0.0994766 | -1.6203 | 0.11724 |  |
| l\_realdomelec | 0.991068 | 0.243775 | 4.0655 | 0.00039 | \*\*\* |
| dummy1998 | -1.28393 | 0.0746943 | -17.1892 | <0.00001 | \*\*\* |

Sum of squared residuals = 0.18803 Standard error of residuals = 0.0850407

Unadjusted R2 = 0.990016 Adjusted R2 = 0.988096

F-statistic (5, 26) = 142.007 (p-value < 0.00001)

Durbin-Watson statistic = 2.04194 First-order autocorrelation coeff. = -0.109144

The forecast for recent years significantly overpredicts demand an is outside the confidence intervals.





There is at least one cointegrating vector.

Johansen test:

|  |  |  |  |
| --- | --- | --- | --- |
| Rank | Eigenvalue  | Trace test p-value  | Lmax test p-value |
|  0 | 0.55412  | 31.167 [0.1244]  | 25.847 [0.0281] |
|  1 | 0.13641  | 5.3200 [0.9109]  | 4.6931 [0.9157] |
|  2 | 0.019400  | 0.62689 [0.4285]  | 0.62689 [0.4285] |

The price elasticity of demand is statistically significant with the right sign as is the cross-price elasticity of demand with respect to electricity.

,

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 5.57365 | 0.386265 | 14.4296 | <0.00001 | \*\*\* |
| time | -0.161352 | 0.0370854 | -4.3508 | 0.00022 | \*\*\* |
| timesq | 0.00610712 | 0.000921722 | 6.6258 | <0.00001 | \*\*\* |
| l\_realdomoil | -0.190204 | 0.0902201 | -2.1082 | 0.04564 | \*\* |
| l\_realdomelec | 1.03617 | 0.229211 | 4.5206 | 0.00014 | \*\*\* |
| dummy1998 | -1.30616 | 0.0794665 | -16.4366 | <0.00001 | \*\*\* |
| EC1e | 0.0359655 | 0.0361824 | 0.9940 | 0.33014 |  |

Sum of squared residuals = 0.16079 Standard error of residuals = 0.0818509

Unadjusted R2 = 0.990513 Adjusted R2 = 0.988141

F-statistic (6, 24) = 169.745 (p-value < 0.00001)

Durbin-Watson statistic = 2.21703 First-order autocorrelation coeff. = -0.229093

### Domestic Coal Demand (Northern Ireland)

An Initial Model was estimated for domesticcoal demand as a function of real income, the real price of coal and substitutes and dummy variables for the key years where structural breaks might occur. A quadratic time trend was also added as a visual examination of the data indicated that this might be of importance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 15.6488 | 8.64796 | 1.8095 | 0.08471 | \* |
| l\_realdomcoal | -0.533858 | 0.455694 | -1.1715 | 0.25451 |  |
| l\_NIPDYR | -1.47026 | 1.10647 | -1.3288 | 0.19818 |  |
| dummy1973 | -0.01892 | 0.206222 | -0.0917 | 0.92777 |  |
| dummy1974 | 0.0141177 | 0.197734 | 0.0714 | 0.94376 |  |
| dummy1975 | 0.000935484 | 0.165674 | 0.0056 | 0.99555 |  |
| dummy1979 | 0.173141 | 0.192193 | 0.9009 | 0.37787 |  |
| dummy1998 | -0.151443 | 0.161865 | -0.9356 | 0.36011 |  |
| l\_realdomelec | 0.804242 | 0.706804 | 1.1379 | 0.26800 |  |
| l\_realdomoil | -0.0393201 | 0.204116 | -0.1926 | 0.84909 |  |
| Time | 0.273442 | 0.100362 | 2.7246 | 0.01270 | \*\* |
| Timesq | -0.00493398 | 0.00137372 | -3.5917 | 0.00172 | \*\*\* |

Mean of dependent variable = 6.42552 Standard deviation of dep. var. = 0.276649

Sum of squared residuals = 0.463723 Standard error of residuals = 0.1486

Unadjusted R2 = 0.810656 Adjusted R2 = 0.711475

F-statistic (11, 21) = 8.17355 (p-value = 2.31e-005)

Durbin-Watson statistic = 1.58601 First-order autocorrelation coeff. = 0.13463



None of the price or income variables seem to be significant but a decision was made to leave them in along with the time quadratic.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 12.066 | 5.77382 | 2.0898 | 0.04656 | \*\* |
| l\_realdomcoal | -0.570337 | 0.396731 | -1.4376 | 0.16248 |  |
| l\_NIPDYR | -0.996917 | 0.742537 | -1.3426 | 0.19101 |  |
| l\_realdomelec | 0.597502 | 0.457061 | 1.3073 | 0.20256 |  |
| l\_realdomoil | 0.0109487 | 0.165529 | 0.0661 | 0.94777 |  |
| Time | 0.228572 | 0.0782617 | 2.9206 | 0.00713 | \*\*\* |
| Timesq | -0.00452366 | 0.00121219 | -3.7318 | 0.00094 | \*\*\* |

Mean of dependent variable = 6.42552 Standard deviation of dep. var. = 0.276649

Sum of squared residuals = 0.502467 Standard error of residuals = 0.139017

Unadjusted R2 = 0.794836 Adjusted R2 = 0.747491

F-statistic (6, 26) = 16.788 (p-value < 0.00001)

Durbin-Watson statistic = 1.67518 First-order autocorrelation coeff. = 0.09369

The substitute fuels for coal were then dropped with the results that the short-run price elasticity of demand became marginally significant.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 7.23526 | 4.12315 | 1.7548 | 0.09023 | \* |
| l\_realdomcoal | -0.362953 | 0.199602 | -1.8184 | 0.07972 | \* |
| l\_NIPDYR | -0.360802 | 0.53832 | -0.6702 | 0.50820 |  |
| Time | 0.200043 | 0.0746052 | 2.6814 | 0.01215 | \*\* |
| Timesq | -0.004897 | 0.00116685 | -4.1968 | 0.00025 | \*\*\* |

Mean of dependent variable = 6.42552 Standard deviation of dep. var. = 0.276649

Sum of squared residuals = 0.535795 Standard error of residuals = 0.138331

Unadjusted R2 = 0.781228 Adjusted R2 = 0.749975

F-statistic (4, 28) = 24.9968 (p-value < 0.00001)

Durbin-Watson statistic = 1.52946 First-order autocorrelation coeff. = 0.146928

The real income variable was then dropped.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 4.49173 | 0.489946 | 9.1678 | <0.00001 | \*\*\* |
| l\_realdomcoal | -0.450442 | 0.149562 | -3.0117 | 0.00534 | \*\*\* |
| Time | 0.152558 | 0.0231527 | 6.5892 | <0.00001 | \*\*\* |
| Timesq | -0.00421243 | 0.000558818 | -7.5381 | <0.00001 | \*\*\* |

Mean of dependent variable = 6.42552 Standard deviation of dep. var. = 0.276649

Sum of squared residuals = 0.544391 Standard error of residuals = 0.137011

Unadjusted R2 = 0.777718 Adjusted R2 = 0.754723

F-statistic (3, 29) = 33.8216 (p-value < 0.00001)

Durbin-Watson statistic = 1.47613 First-order autocorrelation coeff. = 0.185097

The model does estimate recent domestic coal demand within acceptable confidence intervals.



There are two cointegrating vectors.

|  |  |  |  |
| --- | --- | --- | --- |
| Rank  | Eigenvalue  | Trace test p-value  | Lmax test p-value |
|  0  |  0.18723  |  10.782 [0.4155]  | 6.6339 [0.7529] |
|  1  | 0.12159  | 4.1486 [0.0417]  | 4.1486 [0.0417] |

The price elasticity of demand is statistically significant with the right sign.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 3.94542 | 0.988487 | 3.9914 | 0.00045 | \*\*\* |
| time | 0.153979 | 0.0308183 | 4.9964 | 0.00003 | \*\*\* |
| timesq | -0.00421663 | 0.000791074 | -5.3303 | 0.00001 | \*\*\* |
| l\_realdomcoal | -0.382289 | 0.201585 | -1.8964 | 0.06865 | \* |
| EC1f | 0.0866481 | 0.17526 | 0.4944 | 0.62502 |  |

Mean of dependent variable = 6.4291 Standard deviation of dep. var. = 0.280299

Sum of squared residuals = 0.438112 Standard error of residuals = 0.127383

Unadjusted R2 = 0.820121 Adjusted R2 = 0.793473

F-statistic (4, 27) = 30.7753 (p-value < 0.00001)

Durbin-Watson statistic = 1.94578 First-order autocorrelation coeff. = -0.0477902

**Gas**

### Non-Domestic Gas Demand (Northern Ireland)

An Initial Model was estimated for domesticgas demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

The use of lagged variables of the dependent and independent variables is used to correct for the 4th order autocorrelation common with quarterly data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 51.6205 | 34.5903 | 1.4923 | 0.16647 |  |
| l\_realpcontra | -0.0264764 | 0.0739772 | -0.3579 | 0.72786 |  |
| l\_realpcont\_1 | 0.0823316 | 0.0623556 | 1.3204 | 0.21614 |  |
| l\_realpcont\_2 | -0.0579537 | 0.067631 | -0.8569 | 0.41156 |  |
| l\_realpcont\_3 | -0.0324791 | 0.0682322 | -0.4760 | 0.64430 |  |
| l\_gva | -6.24857 | 3.5415 | -1.7644 | 0.10813 |  |
| l\_gva\_1 | 4.90338 | 3.43415 | 1.4278 | 0.18382 |  |
| l\_gva\_2 | 1.67304 | 4.34312 | 0.3852 | 0.70814 |  |
| l\_gva\_3 | -4.45833 | 4.02679 | -1.1072 | 0.29414 |  |
| S1 | 0.0586467 | 0.146841 | 0.3994 | 0.69800 |  |
| S2 | -0.351504 | 0.176019 | -1.9970 | 0.07376 | \* |
| S3 | -0.58195 | 0.0888535 | -6.5495 | 0.00006 | \*\*\* |
| Time | 0.0662397 | 0.0473146 | 1.4000 | 0.19177 |  |
| l\_realconelec | 1.13998 | 0.497227 | 2.2927 | 0.04481 | \*\* |
| l\_realconel\_1 | -0.375286 | 0.559906 | -0.6703 | 0.51787 |  |
| l\_realconel\_2 | 0.210658 | 0.51658 | 0.4078 | 0.69202 |  |
| l\_realconel\_3 | 1.22701 | 0.505275 | 2.4284 | 0.03555 | \*\* |
| l\_qcontract\_1 | 0.0434794 | 0.281015 | 0.1547 | 0.88012 |  |

Mean of dependent variable = 16.2373 Standard deviation of dep. var. = 0.312447

Sum of squared residuals = 0.0336375 Standard error of residuals = 0.0579978

Unadjusted R2 = 0.987238 Adjusted R2 = 0.965543

F-statistic (17, 10) = 45.5057 (p-value < 0.00001)

LM test for autocorrelation up to order 4 -

 Null hypothesis: no autocorrelation

 Test statistic: LMF = 9.90752

 with p-value = P(F(4,2) > 9.90752) = 0.0937764

Removing the less significant variables.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| const | 1.92009 | 0.414107 | 4.6367 | 0.00007 | \*\*\* |
| S2 | -0.750637 | 0.039144 | -19.1763 | <0.00001 | \*\*\* |
| S3 | -0.785689 | 0.0358939 | -21.8892 | <0.00001 | \*\*\* |
| S1 | -0.285149 | 0.0454558 | -6.2731 | <0.00001 | \*\*\* |
| l\_realconelec | 0.366543 | 0.205951 | 1.7798 | 0.08597 | \* |
| l\_realpcont\_1 | 0.0685303 | 0.0669826 | 1.0231 | 0.31502 |  |
| l\_qcontract\_1 | 0.830999 | 0.0456715 | 18.1951 | <0.00001 | \*\*\* |

Mean of dependent variable = 16.0188 Standard deviation of dep. var. = 0.543384

Sum of squared residuals = 0.152059 Standard error of residuals = 0.073693

Unadjusted R2 = 0.984853 Adjusted R2 = 0.981608

F-statistic (6, 28) = 303.431 (p-value < 0.00001)

LM test for autocorrelation up to order 4 -

 Null hypothesis: no autocorrelation

 Test statistic: LMF = 2.43838

 with p-value = P(F(4,20) > 2.43838) = 0.0805692

Although not statistically significant, the lagged real price of contract gas has been left in as an autocorrelation measure.

A plot of the actual and fitted contract demand for gas is:



The residual from the previous regression was kept and included (when once lagged) as an independent variable.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 1.96344 | 0.471079 | 4.1680 | 0.00030 | \*\*\* |
| l\_realconelec | 0.373513 | 0.208345 | 1.7928 | 0.08465 | \* |
| S1 | -0.28561 | 0.046946 | -6.0838 | <0.00001 | \*\*\* |
| S2 | -0.744019 | 0.0432442 | -17.2051 | <0.00001 | \*\*\* |
| S3 | -0.785179 | 0.0365105 | -21.5056 | <0.00001 | \*\*\* |
| l\_realpcont\_1 | 0.0625835 | 0.0685413 | 0.9131 | 0.36959 |  |
| uhat2\_1 | -0.198621 | 0.196596 | -1.0103 | 0.32166 |  |
| l\_qcontract\_1 | 0.828809 | 0.0487482 | 17.0018 | <0.00001 | \*\*\* |

Mean of dependent variable = 16.0551 Standard deviation of dep. var. = 0.506557

Sum of squared residuals = 0.144304 Standard error of residuals = 0.0744994

Unadjusted R2 = 0.982958 Adjusted R2 = 0.97837

F-statistic (7, 26) = 214.241 (p-value < 0.00001)

LM test for autocorrelation up to order 4 -

 Null hypothesis: no autocorrelation

 Test statistic: LMF = 2.02095

 with p-value = P(F(4,18) > 2.02095) = 0.134483

### Domestic Gas Demand (Northern Ireland)

An Initial Model was estimated for domesticgas demand as a function of real income, the real price of electricity and substitutes and dummy variables for the key years where structural breaks might occur.

The use of lagged variables of the dependent and independent variables is used to correct for the 4th order autocorrelation common with quarterly data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | -7.62858 | 16.9226 | -0.4508 | 0.65784 |  |
| l\_realpdom | -0.268683 | 0.827903 | -0.3245 | 0.74949 |  |
| l\_realpdom\_1 | -0.921086 | 0.906135 | -1.0165 | 0.32364 |  |
| l\_realpdom\_2 | 0.904545 | 0.937751 | 0.9646 | 0.34827 |  |
| l\_realpdom\_3 | -0.43338 | 0.649648 | -0.6671 | 0.51366 |  |
| l\_realgva | -1.78517 | 12.1535 | -0.1469 | 0.88495 |  |
| l\_realgva\_1 | 21.718 | 18.4893 | 1.1746 | 0.25634 |  |
| l\_realgva\_2 | -33.1966 | 16.8695 | -1.9678 | 0.06562 | \* |
| l\_realgva\_3 | 14.4785 | 12.4029 | 1.1673 | 0.25919 |  |
| l\_tempmin | -0.253442 | 0.204747 | -1.2378 | 0.23260 |  |
| S1 | -0.557584 | 0.383059 | -1.4556 | 0.16372 |  |
| S2 | -0.394013 | 0.437888 | -0.8998 | 0.38079 |  |
| S3 | -1.0999 | 0.277188 | -3.9681 | 0.00099 | \*\*\* |
| l\_avqdom\_1 | 0.564462 | 0.192663 | 2.9298 | 0.00935 | \*\*\* |
| l\_avqdom\_2 | -0.350711 | 0.220876 | -1.5878 | 0.13075 |  |
| l\_avqdom\_3 | 0.490169 | 0.19729 | 2.4845 | 0.02369 | \*\* |

Mean of dependent variable = 4.74785 Standard deviation of dep. var. = 0.602414

Sum of squared residuals = 0.486037 Standard error of residuals = 0.169087

Unadjusted R2 = 0.958147 Adjusted R2 = 0.921217

F-statistic (15, 17) = 25.9454 (p-value < 0.00001)

LM test for autocorrelation up to order 4 -

 Null hypothesis: no autocorrelation

 Test statistic: LMF = 1.98744

 with p-value = P(F(4,9) > 1.98744) = 0.180176

Removing the less significant variables.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 6.32936 | 14.682 | 0.4311 | 0.67041 |  |
| l\_realpdom | -0.50755 | 0.802301 | -0.6326 | 0.53322 |  |
| l\_realpdom\_1 | 0.348199 | 0.689216 | 0.5052 | 0.61822 |  |
| l\_realgva\_1 | 12.9936 | 10.3892 | 1.2507 | 0.22362 |  |
| l\_realgva\_2 | -13.2581 | 10.334 | -1.2830 | 0.21229 |  |
| l\_tempmin | -0.262204 | 0.153815 | -1.7047 | 0.10173 |  |
| S1 | -0.875211 | 0.357185 | -2.4503 | 0.02230 | \*\* |
| S2 | -1.23831 | 0.262653 | -4.7146 | 0.00009 | \*\*\* |
| S3 | -1.35103 | 0.224862 | -6.0083 | <0.00001 | \*\*\* |
| l\_avqdom\_1 | 0.536567 | 0.177313 | 3.0261 | 0.00601 | \*\*\* |
| l\_avqdom\_2 | -0.111787 | 0.202411 | -0.5523 | 0.58609 |  |

Mean of dependent variable = 4.71651 Standard deviation of dep. var. = 0.620727

Sum of squared residuals = 0.72709 Standard error of residuals = 0.177799

Unadjusted R2 = 0.942816 Adjusted R2 = 0.917954

F-statistic (10, 23) = 37.9212 (p-value < 0.00001)

LM test for autocorrelation up to order 4 -

 Null hypothesis: no autocorrelation

 Test statistic: LMF = 2.94162

 with p-value = P(F(4,15) > 2.94162) = 0.0558357

Removing the less significant variables.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 2.2633 | 13.1636 | 0.1719 | 0.86487 |  |
| l\_realpdom | -0.320748 | 0.447531 | -0.7167 | 0.48020 |  |
| l\_realgva\_1 | 14.1835 | 9.74505 | 1.4555 | 0.15798 |  |
| l\_realgva\_2 | -14.0101 | 9.70642 | -1.4434 | 0.16133 |  |
| l\_tempmin | -0.228192 | 0.140239 | -1.6272 | 0.11624 |  |
| S1 | -0.681114 | 0.235056 | -2.8977 | 0.00771 | \*\*\* |
| S2 | -1.21546 | 0.241607 | -5.0307 | 0.00003 | \*\*\* |
| S3 | -1.40618 | 0.176425 | -7.9704 | <0.00001 | \*\*\* |
| l\_avqdom\_1 | 0.473763 | 0.147798 | 3.2055 | 0.00367 | \*\*\* |

Mean of dependent variable = 4.71651 Standard deviation of dep. var. = 0.620727

Sum of squared residuals = 0.746485 Standard error of residuals = 0.172799

Unadjusted R2 = 0.941291 Adjusted R2 = 0.922504

F-statistic (8, 25) = 50.1035 (p-value < 0.00001)

Test statistic: LMF = 2.046696,

with p-value = P(F(4,17) > 2.0467) = 0.133

Removing the less significant variables.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Variable* | *Coefficient* | *Std. Error* | *t-statistic* | *p-value* |  |
| Const | 1.98046 | 0.696032 | 2.8454 | 0.00792 | \*\*\* |
| S1 | -0.645371 | 0.217184 | -2.9715 | 0.00579 | \*\*\* |
| S2 | -1.49446 | 0.224584 | -6.6543 | <0.00001 | \*\*\* |
| S3 | -1.66661 | 0.127387 | -13.0831 | <0.00001 | \*\*\* |
| l\_avqdom\_1 | 0.580035 | 0.14751 | 3.9322 | 0.00046 | \*\*\* |

Mean of dependent variable = 4.69755 Standard deviation of dep. var. = 0.621732

Sum of squared residuals = 1.0508 Standard error of residuals = 0.187154

Unadjusted R2 = 0.920047 Adjusted R2 = 0.909386

F-statistic (4, 30) = 86.3046 (p-value < 0.00001)

Breusch-Godfrey test for autocorrelation up to order 4

Test statistic: LMF = 1.000017,

with p-value = P(F(4,22) > 1.00002) = 0.429

A plot of the actual and fitted domestic demand for gas is:



1. the long-run overall price elasticity of demand for electricity has 95% confidence limits of -0.28 to -0.34 (the non-domestic price elasticity of demand for electricity is -0.29 to -0.37, the domestic price elasticity of demand for electricity is -0.13 to- 0.29). [↑](#footnote-ref-1)
2. The domestic energy analysis of Smyth (1996) suggests a real price rise of 29% would be needed to counteract a similar 10% real income rise. [↑](#footnote-ref-2)
3. Phoenix supplied quarterly consumption data for the domestic, SME and contract sectors. [↑](#footnote-ref-3)
4. In the post-privatisation era. the Northern Ireland Annual Abstract of Statistics ceased to detail electricity consumption split into sectors (domestic, farming. small commercial/industrial and large commercial/industrial) as was the case previously. Viridian supplied us with domestic consumption data for this period. [↑](#footnote-ref-4)
5. Both Phoenix and Viridian supplied us with quarterly price data for the domestic, SME and contract markets. [↑](#footnote-ref-5)
6. The quarterly data for consumption was supplied by Phoenix with quarterly price data being supplied by Phoenix and Viridian. [↑](#footnote-ref-6)
7. The quarterly data for consumption was supplied by Phoenix with quarterly price data being supplied by Phoenix and Viridian. [↑](#footnote-ref-7)