Seminar paper in *Panel Analysis*

**Estimation of gasoline demand function**

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**Abstract**

The objective of this seminar paper in the course of the lecture by R. Kunst *Paneldata*, University of Vienna, is the estimation of a gasoline demand function done by Baltagi and Griffin (1983). They used a panel of 18 OECD countries over the period 1960-1978. My idea is to estimate the same equation but with more actual data in order to see whether the estimation outcome can be improved or changes reasonable.
1 Model specification

The model of Baltagi and Griffin specifies gasoline demand by

\[
\text{Gasoline consumption} = \frac{\frac{\text{\# km}}{\text{\# cars}} \cdot \text{Gasoline consumption}}{\frac{\text{\# km}}{\text{\# cars}}} \cdot \frac{\text{\# cars}}{\text{\# cars}}
\]  

(1)

Thus, the three main factors explaining gasoline consumption are the degree of car utilization, inverse of efficiency, and stock of cars in a country. Due to lack of data, they estimated this model by using proxies for utilization and efficiency:

\[
\ln\left(\frac{GAS}{CAR}\right)_{it} = \alpha + \beta \ln\left(\frac{Y}{N}\right)_{it} + \gamma \ln\left(\frac{P_{GAS}}{P_{GDP}}\right)_{it} + \delta \ln\left(\frac{CAR}{N}\right)_{it} + \phi \ln(E)_{it} + (\mu_{i} + \lambda_{t}) + \nu_{it},
\]  

(2)

with country dummy variable \(\mu_{i}\), time dummy variable \(\lambda_{t}\) and error term \(\nu_{it}\).

Expected signs for parameters are \(\beta > 0\) (income-elasticity), \(\gamma < 0\) (relative price effect), \(\delta < 0\) (increased car ownership reduces utilization), and \(\phi < 0\) (higher efficiency decreases consumption per car).

Gestation of cars causes lagged penetration of technical innovation. Thus, efficiency is modeled by lagged polynomial \((L)\):

\[
\ln(E)_{it} = \alpha^{*} + \beta^{*}(L) \ln\left(\frac{Y}{N}\right)_{it} + \gamma^{*}(L) \ln\left(\frac{P_{GAS}}{P_{GDP}}\right)_{it} + \xi_{it}
\]  

(3)

In their paper, Baltagi and Griffin present estimation results of 3 different models. Their first model is equation 1 without efficiency term. No model could fully convince. Own estimation in class revealed some serial correlation of the basic model (equation 1) which is not satisfactory.

One problem could be that CAR in B&G comprises trucks as well as passenger cars driven by gasoline and diesel. A time series consisting merely of gasoline driven cars could perform better. This has been the motivation for the seminar work.

2 Data

The search for corresponding data was tedious. The only relevant data source with broad and costless data I have found at the homepage of Eurostat. Thus, I could include only EU-countries, i.e. unfortunately no USA data.
From this source I took data for gasoline and diesel consumption GAS and DIESEL in thousand tons per year (Energetischer Endverbrauch des Strassenverkehrs), gasoline and diesel prices inclusive taxes per 100 litre averaged per year, passenger gasoline cars (PKW) per year CARG and diesel cars CARD, and total population per year N. From the OECD source I retrieved series for real GDP adjusted by PPP reference 2000 for each country in US-Dollar, GDP-Deflator $P_{GDP}$ and power purchasing parity $PPP$ in US-Dollar.

Out of this I constructed the series for estimation: gasoline consumption per total number of cars (in order to compare it to B&G) in logarithm $\ln(GAS/CAR)$, gasoline consumption per gasoline-car in logarithm $\ln(GAS/CARG)$, diesel consumption per diesel-car in logarithm $\ln(GAS/CARD)$ real output per capital PPP-adjusted in US$ in logarithm $\ln(Y/N)$, number of total cars per capita in logarithm $\ln(CAR/N)$, number of gasoline-cars per capita in logarithm $\ln(CARG/N)$, number of diesel-cars per capita in logarithm $\ln(CARD/N)$, the relative price of gasoline to other goods - where the GDP-Deflator is taken as a proxy - $\ln(PG/P_{GDP})$, the relative price of diesel to other goods $\ln(PD/P_{GDP})$, and relative price of diesel to gasoline $\ln(PD/PG)$.

Note that the relative prices of gasoline/diesel to other goods are calculated different to Baltagi and Griffin: They shortly mentioned in the appendix "the purchasing power parity adjustment affects both real per capita income and the price of other goods $P_{GDP}$." By this, they probably multiplied the GDP Deflator $P_{GDP}$ with PPP being in US$. Thus, the gasoline price in is related to an adjusted GDP-Deflator in US$. But what is of interest here is the true fraction of the gasoline price w.r.t. all goods within a specific country which is obviously distorted. Hence, I did not the PPP adjustment in this case.

Of course, it would be better to take harmonized CPI instead of GDP-Deflator, but for comparison reasons I have chosen to stick to B&G setting.

The following summarizes and indicate the data ranges for each constructed series. Some problems encountered during data constructing are shortly mentioned:

Relative Gasoline price: 1985-2004 (partially 1995-2004); € per 100 Liter divided by GDP-Deflator (indexed 1995); incl. taxes, thus wide country differences;

- Divided by GDP-Deflator $P_{GDP}$ not PPP-adjusted
- Constructed out of overlapping leaded and unleaded gasoline series

Price diesel relative to gasoline: In order to test effect of diesel substitution against gasoline (in B&G insignificant); to account for higher efficiency of Diesel, multiplication with factor $0.769$.


Problems:
- Germany interpolation (1991 reunion with Eastern Germany)
- France no Gasoline cars series, thus constructed from other two
- Portugal no Diesel/Gasoline cars series
- Greece, Italy truncated
- short series for Austria, Finland, Sweden, Norway leading to unbalanced panel

In order to work with balanced data I had to skip some countries. What remained three balanced panels consisting of

- **Total Car** series with $T = 18$ (1985-2002) and $N = 10$ (BE, DN, DE, ES, FR, IT, IR, NL, PO, UK), and


The visualized series are given below.

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1 Although this factor would be included in the constant and no change of the coefficient estimate would occur if left out, I decided to leave it in the constructed series. Intuitively, I didn’t want it to have it in the intercept.
3 Estimation results

For estimation I used STATA 8.0. I stuck to following procedure for all three model types:

First, I estimated a one-way random effects model given by a standardized command in STATA. Then, I checked the Breusch-Pagan LM-test for presence of individual effects, i.e. $\sigma^2_\mu = 0$ one- and two-sided, which is provided by the ado-command \textit{xttest1}. Unfortunately, this package doesn’t test for time effects and time as well as individual effects. However, it provides a serial correlation test.

Next, fixed effects one-way model estimation was done. The command \textit{xttest3} gives a Wald test for heteroscedasticity and \textit{pantest2} for serial correlation, significance of fixed effects, and normality of residuals in FE-models. Then, I calculated Hausman-test upon which to decide for RE or FE-model. Unfortunately, STATA doesn’t provide two-way RE-model estimation routine so that after accepting Hausman’s $H_0$ I couldn’t further distinguish between one-way and two-way random effects model via tests.

Next, I constructed dummies for individual and time effects in order to manually run regression for one-way and two-way FE-model via OLS. I calculated LR- and F-statistics to decide upon the better model.

Due to prevailing serial correlation, I run with standard command a GLS estimation accounting for heteroscedasticity with or without cross-sectional correlation, and also cross-sectional correlation alone with common or panel-specific AR(1) process in error terms.

To account for the efficiency term in B&G demand equation, I tried estimation in first differences with lagged explaining variables of varying order. In all estimations, I could not observe improvements. Still, some tests indicated existence of autocorrelation. Especially, the gasoline/diesel car series are too short for dealing with differences\footnote{One severe problem I encountered in STATA has been, that I could not run standard residual diagnostic packages. This would have been useful to check whether GLS estimation accounting for cross-sectional correlation would have improved the quality compared to simple panel estimation.}.

For the results see log-files of STATA given below. Now the discussion
of the results which I revised in some points after my presentation in class:

First, I estimated the data given by B&G, and - for comparison reasons - I skipped the countries not contained in my specific panel consisting of 11 countries. Because data for Portugal are not available in B&G, the resulting panel comprises 10 countries. The results of the estimation correspond to those given in their paper. The estimates of the coefficients of the truncated B&G-panel are similar to the published results and are highly significant, too: 0.63, -0.26, -0.55, and 2.92 for output per capita, relative gasoline price, car per capita, and the constant, respectively.

There is, however, one observed difference between the two panels: Whereas the coefficients of the time effects are significant and gradually increasing in the two-way fixed effects model of the total B&G-panel, all these coefficients are insignificant and no clear trend is observable.

The estimation of both panels suffers from serial correlation which I encounter in every examined panel (see below). It is remedied by using GLS estimation with heteroscedastic and AR(1) correlated errors.

Next, I estimated the equation using my constructed total car series. In nearly all estimations, the sign of the coefficient correspond to B&G and thus to the predicted ones, i.e. positive income-elasticity, negative relative gasoline price and negative car per capita. For instance, in the FE model we get: 0.49, -0.52, -1.27, and -0.56, respectively. The constant term is insignificant except in the two-way FE model and the heteroscedastic and cross-section correlated GLS-models as well as the dynamic models. Latter still suffer from autocorrelation and to short time series for estimating.

Breusch-Pagan LM tests indicate strong serial correlation and presence of individual effects. Hausman-test does not reject the null, thus RE-model is not rejected. The $R^2$ within and overall of RE-model is marginally higher than that of FE. Both models show a high fraction of $\sigma_\mu$ to overall variance indicating strong individual effects. LR- and F-statistics, however, show preference for a combination of individual and time effects: the two-way FE model.

Due to strong serial correlation found in the standard models, it was no surprise in finding heteroscedasticity with cross-sectional correlation adjusted GLS estimation performing better. As mentioned above, no extensive
To explain the effect of positive correlation of gasoline consumption with car per capita, one has to look at the increasing mobility of the second person in a family household either for work or organizing the household. The underlying assumption is that the major part of private persons own gasoline driven cars which is in line with the data throughout the countries. However, the diesel motor share is strongly increasing recently so consequently one could expect parameter shift also in the Diesel and total car series estimations.

Next difference to the previous estimation, is the insignificant constant term over all standard estimation methods. Further, Hausman-test rejects the null, thus one takes the FE-model. LR- and F-test strongly decide

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3 not to be mixed up with passenger cars (dt. Personenkraftwagen) as it seemed to happened with the OECD data.

4 Here I would like to stress again, that due to the explosive increase in Diesel cars (f.i. in Austria, France, and Belgium) the work suffers a lot from the absence of data from 2002 till now.
for two-way FE-model. This model is also an exception to the above said in so far that output elasticity is positive being in line with the B&Gs’ prediction. The *beautyspot* of the latter model is the insignificance of the coefficient of relative gasoline price, because, although generally fuel demand is strongly inelastic, the households - especially in the first years of the used data series - mainly use gasoline driven cars and they should react somehow to increased prices. In contrast, this coefficient is significant in the total car as well in diesel car estimation. However, the negative coefficient of the relative gasoline price in the gasoline car estimation becomes significant after estimating implemented serial correlation.

Looking at the coefficients of the time dummies, except the first they are all significant and gradually decreasing. The same applies also to the total car estimation. One explanation could be that efficiency of motor cars increased over time due to technological innovations. I personally doubt this. No substantial improvement in motor technology occurred in the last ten years. Further, increased usage of air condition in cars and more car overcrowding in cities, which results in more wasteful *stop-and-go* driving behaviour, would compensate any efficiency gains by far. The most reasonable interpretation of the observed gradual decrease of gasoline consumption over time considers the strong diesel substitution for gasoline which can be directly read off the data of all countries.

Looking now at the corresponding coefficients of the diesel constructed series estimation one should observe the opposite. Indeed, one finds - though all time coefficients are insignificant - a gradual increase over time which strongly supports the interpretation of the observed effect.

Again one observes serial correlation which is more or less fixed by heteroscedasticity adjusted GLS panel estimation provided by STATA. Interestingly again, with some GLS-models the sign of the car per capita effect changes to the predicted sign by B&G.

The best estimation is the one with heteroscedastic, cross-sectional correlation, but without autocorrelation in the errors. All coefficients are highly significant and have predicted sign. As already mentioned, this renders the above interpretation of the effect of the positive sign of the cars per capita and of output obsolete. The values for the coefficients are: approx. 0.57,
-0.55, -0.44, and -0.54 for output per capita, relative gasoline price, gasoline cars per capita, and intercept, respectively.

Estimations with differenced and lagged dependent and/or exogenous regressors did not improve results. Still autocorrelation can be observed.

Addition of regressor relative price of Diesel to gasoline turned out to be insignificant corresponding to findings of B&G and in our total car estimation.

Lastly, I estimated the Diesel car constructed series. The qualitative results resemble to those of the total car estimation. All coefficients obtain the predicted sign throughout nearly all types of estimation. The quantitative effects of output and car per capita are larger than those in total car and gasoline car estimation. The exception is the value of the effect of relative diesel price which is reasonably smaller compared to the former cases. This could be again a hint for the substitution effect of diesel combined with inelastic fuel demand of the individual households and transportation industry.

Both RE and FE are doing quiet well. $R^2$ within and total is higher than in the other compared cases. Again, one observes strong serial correlation given by LM-test. The value of the Hausman-test does clearly not reject the null. LR-test and F-test prefer the one-way FE to the two-way FE-model. Looking at the estimation with individual dummies, all countries except Spain develop lower than Belgium. Each coefficient estimate is significant except the individual country effect for Ireland.

Again, heteroscedastic, cross-sectional correlation adjusted GLS estimation cures the observed serial correlation. The highly significant coefficient estimates, which are more distinct as in the case of gasoline series, are 0.78, -0.33, -0.78, and -2.26 for output per capita, relative diesel price, diesel car per capita, and the constant, respectively. Here, allowing for autocorrelation of error term improves even further the estimation results in the panel-specific AR(1)-case as well as in the common case\(^5\). In the latter case, one gets for $y$, $pd$, $card$, and constant 1.018, -0.07, -0.81, and -3.96, respectively. Note, that the impact of a rise in relative diesel price nearly vanishes

\(^5\)Second best estimation is panel-specific AR(1) autocorrelation giving very similar results
compared to the one of the gasoline estimation. The first reveals the very inelastic fuel demand in general, whereas the second reflects the more elastic diesel-substitution effect.

Taking first differences and lagged dependent and exogenous regressors could not improve estimation results\textsuperscript{6}.

Again, the coefficient of the included regressor relative diesel price to gasoline price has been insignificant.

4 Conclusion

The qualitative results of the estimation of the total car series correspond to those obtained by B&G, which are given in their paper and in the textbook by Baltagi. In addition, I checked the estimates of the whole B&G-panel as well as of a truncated version for the sake of comparison with my constructed panel. The income elasticity is positive, relative price effect is negative, and effect of increased car ownership is negative on gasoline consumption. However, all estimations suffer from serious serial correlation as indicated by tests. This is again in line with the results by B&G. A GLS estimation with heteroscedastic errors improved the quality, and even more with cross-section correlation with or without AR(1)-errors in all three investigated cases. The estimated coefficient of the AR-term seemed to be high. Thus, I tried estimation with first differences and lagged dependent and exogenous variables. The results were ambiguous.

The effect of relative price of diesel to gasoline turned out to be insignificant in all cases which corresponds to the results by B&G.

The GLS estimation accounting for heteroscedastic, cross-sectional correlation turned out to be promising for all three investigated types of fuel demand function. To verify this result, more intensive residual diagnostics should be undertaken.

What can be improved is the inclusion of countries with shorter time

\textsuperscript{6}Especially after taking first differences, the gasoline/diesel car series became too short. At this point, I have to point out, that I could not manage to run diverse residual diagnostic packages for the panel estimations in STATA, such that my obtained results and conclusions are qualified.
series so that one deals with unbalanced panels. Also, for future research it
would be interesting to examine similar data but with longer time horizon
and including period 2003 till at least 2005. In this period, we will observe a
sharp increase in oil price which should induce strong effects on the demand
function.

Appendix:
Gasoline demand per total cars

Random-effects GLS regression  Number of obs      =       198
Group variable (i): id                          Number of groups   =        11

R-sq:  within  = 0.5960                         Obs per group: min =        18
between = 0.5561                                    avg =      18.0
overall = 0.5563                                     max =        18

Random effects u_i ~ Gaussian                   Wald chi2(3)       =    280.23
corr(u_i, X) = 0 (assumed)                        Prob > chi2        =    0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .4864349   .0859576     5.66   0.000     .3179611    .6549087
pg |  -.5086575   .0403008   -12.62   0.000    -.5876456   -.4296695
car |  -1.250908    .093972   -13.31   0.000    -1.43509   -1.066727
_cons |  -.4733032   1.983410    -0.48   0.630    -2.350752    1.404145
-------------+----------------------------------------------------------------
sigma_u |  .19949125
sigma_e |  .08727359
rho |  .83935611   (fraction of variance due to u_i)
------------------------------------------------------------------------------

Tests for the error component model:

\[ \text{gas}^{[id,t]} = Xb + u^{[id]} + v^{[id,t]} \]
\[ v^{[id,t]} = \rho v^{[id,(t-1)]} + e^{[id,t]} \]

Estimated results:

<table>
<thead>
<tr>
<th></th>
<th>Var</th>
<th>sd = sqrt(Var)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gas</td>
<td>.098387</td>
<td>.3136671</td>
</tr>
<tr>
<td>e</td>
<td>.0076167</td>
<td>.08727359</td>
</tr>
<tr>
<td>u</td>
<td>.0397968</td>
<td>.19949125</td>
</tr>
</tbody>
</table>

Tests:

Random Effects, Two Sided:

|         | Pr>|chi2(1) | 0.0000 |
|---------|---------|---------|
| LM(Var(u)=0) | 891.54 | 0.0000 |
| ALM(Var(u)=0) | 709.04 | 0.0000 |

Random Effects, One Sided:

|         | Pr>|N(0,1) | 0.0000 |
|---------|---------|---------|
| LM(Var(u)=0) | 29.86 | 0.0000 |
| ALM(Var(u)=0) | 26.63 | 0.0000 |

Serial Correlation:

|         | Pr>|chi2(1) | 0.0000 |
|---------|---------|---------|
| LM(rho=0) | 203.38 | 0.0000 |
| ALM(rho=0) | 20.88 | 0.0000 |

Joint Test:

|         | Pr>|chi2(2) | 0.0000 |
|---------|---------|---------|
| LM(Var(u)=0,rho=0) | 912.43 | 0.0000 |

Fixed-effects (within) regression  Number of obs      =       198
Group variable (i): id                          Number of groups   =        11

R-sq:  within  = 0.5961                         Obs per group: min =        18
between = 0.5549                                    avg =      18.0
overall = 0.5553                                     max =        18

F(3,184)       = 90.50
Prob > F        = 0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .4906543   .0880458     5.57   0.000     .3169451    .6643635
pg |  -.5177339   .0412172   -12.56   0.000    -.599053   -.4364148
car |  -1.273783   .0979822   -13.00   0.000    -1.467096    -1.08047
<table>
<thead>
<tr>
<th>_cons</th>
<th>-0.5616356</th>
<th>1.009873</th>
<th>-0.56</th>
<th>0.579</th>
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<th>1.430784</th>
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<tr>
<td>sigma_u</td>
<td>0.2148558</td>
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<td></td>
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<tr>
<td>sigma_e</td>
<td>0.08727359</td>
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<td></td>
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<td></td>
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<tr>
<td>rho</td>
<td>85837234</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(fraction of variance due to u_i)

F test that all u_i=0:  F(10, 184) = 83.03  Prob > F = 0.0000

Hausman specification test

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed</td>
</tr>
<tr>
<td></td>
<td>Effects</td>
</tr>
<tr>
<td>y</td>
<td>0.4906543</td>
</tr>
<tr>
<td>pg</td>
<td>-0.5177339</td>
</tr>
<tr>
<td>car</td>
<td>-1.273783</td>
</tr>
</tbody>
</table>

Test:  Ho:  difference in coefficients not systematic

\[ \chi^2(3) = (b-B)'[S^{-1}](b-B), \ S = (S_{fe} - S_{re}) \]
Prob>\chi^2 = 0.1474

Regression fixed effect country and time dummies - one-way

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 198</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>17.9807778</td>
<td>13</td>
<td>1.38313675</td>
<td>F(13, 184) = 181.59</td>
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<tr>
<td>Residual</td>
<td>1.40146892</td>
<td>184</td>
<td>0.007616679</td>
<td>R-squared = 0.9277</td>
</tr>
<tr>
<td>Total</td>
<td>19.3822467</td>
<td>197</td>
<td>0.098387039</td>
<td>Root MSE = 0.08727</td>
</tr>
</tbody>
</table>

| gas | Coef.  | Std. Err. | t     | P>|t| | [95% Conf. Interval] |
|-----|--------|-----------|-------|-----|------------------|
| y   | 0.4906543 | 0.0880458 | 5.57  | 0.000 | 0.3169451 - 0.6643635 |
| pg  | -0.5177339 | 0.0412172 | -12.56 | 0.000 | -0.599053 - 0.4364148 |
| car | -1.273783 | 0.0979822 | -13.00 | 0.000 | -1.467096 - 0.08047 |
| DK  | 0.1594472 | 0.0411584 | 3.87  | 0.000 | 0.0782441 - 0.2406503 |
| DE  | 0.3794523 | 0.0343083 | 11.06  | 0.000 | 0.31764 - 0.4471405 |
| GR  | -0.000849 | 0.0500588 | -0.02  | 0.986 | -0.099612 - 0.0979141 |
| ES  | -0.712933 | 0.032681 | -21.24 | 0.000 | -0.357771 - 0.668157 |
| FR  | 0.0924119 | 0.0299217 | 3.09  | 0.002 | 0.033782 - 0.151445 |
| IE  | 0.0996686 | 0.040401 | 2.47  | 0.015 | 0.0199599 - 0.1793773 |
| IT  | 0.1804287 | 0.0416498 | 4.33  | 0.000 | 0.0982561 - 0.2626014 |
| NL  | -0.0554366 | 0.0302994 | -1.83  | 0.069 | -0.1152155 - 0.043422 |
| PT  | -0.3222081 | 0.0367659 | -8.76  | 0.000 | -0.394751 - 0.2496712 |
| UK  | 0.3964964 | 0.0294703 | 13.45  | 0.000 | 0.3383532 - 0.4546396 |
| _cons (BE) | -0.6305554 | 1.007996 | -0.63  | 0.532 | -2.619271 - 1.35816 |

Regression fixed effect country and time dummies - two-way

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 198</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
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<td>30</td>
<td>0.6082385</td>
<td>F(30, 167) = 89.49</td>
</tr>
<tr>
<td>Residual</td>
<td>1.13509174</td>
<td>167</td>
<td>0.006796579</td>
<td>R-squared = 0.9414</td>
</tr>
<tr>
<td>Total</td>
<td>19.3822467</td>
<td>197</td>
<td>0.098387039</td>
<td>Root MSE = 0.08727</td>
</tr>
</tbody>
</table>

| gas | Coef.  | Std. Err. | t     | P>|t| | [95% Conf. Interval] |
|-----|--------|-----------|-------|-----|------------------|
| y   | 0.4906543 | 0.0880458 | 5.57  | 0.000 | 0.3169451 - 0.6643635 |
| pg  | -0.5177339 | 0.0412172 | -12.56 | 0.000 | -0.599053 - 0.4364148 |
| car | -1.273783 | 0.0979822 | -13.00 | 0.000 | -1.467096 - 0.08047 |
| DK  | 0.1594472 | 0.0411584 | 3.87  | 0.000 | 0.0782441 - 0.2406503 |
| DE  | 0.3794523 | 0.0343083 | 11.06  | 0.000 | 0.31764 - 0.4471405 |
| GR  | -0.000849 | 0.0500588 | -0.02  | 0.986 | -0.099612 - 0.0979141 |
| ES  | -0.712933 | 0.032681 | -21.24 | 0.000 | -0.357771 - 0.668157 |
| FR  | 0.0924119 | 0.0299217 | 3.09  | 0.002 | 0.033782 - 0.151445 |
| IE  | 0.0996686 | 0.040401 | 2.47  | 0.015 | 0.0199599 - 0.1793773 |
| IT  | 0.1804287 | 0.0416498 | 4.33  | 0.000 | 0.0982561 - 0.2626014 |
| NL  | -0.0554366 | 0.0302994 | -1.83  | 0.069 | -0.1152155 - 0.043422 |
| PT  | -0.3222081 | 0.0367659 | -8.76  | 0.000 | -0.394751 - 0.2496712 |
| UK  | 0.3964964 | 0.0294703 | 13.45  | 0.000 | 0.3383532 - 0.4546396 |
| _cons (BE) | -0.6305554 | 1.007996 | -0.63  | 0.532 | -2.619271 - 1.35816 |

Regression fixed effect country and time dummies - two-way
Total |  19.3822467   197 .098387039           Root MSE      =  .08244
------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .7569654   .0988987     7.65   0.000     .5617127    .9522182
pg |   -.514977   .0504471   -10.21   0.000    -.6145733   -.4153807
car |  -1.085439   .1200854    -9.04   0.000     -1.32252    -.848358
DK |   .1756457   .0415382     4.23   0.000      .093638    .2576534
DE |   .3625091   .0339971    10.66   0.000     .2953896    .4296286
GR |   .2526158   .0809674     3.12   0.002     .0927641    .4124674
ES |  -.0624024   .0395083    -1.58   0.116    -.1404025    .0155977
FR |   .0741538   .0292193     2.54   0.012      .016467    .1318407
IE |   .2374178   .0542408     4.38   0.000     .1303317    .3445039
IT |   .1401379   .0460565     3.04   0.003       .04921    .2310658
NL |  -.0441861   .0289902    -1.52   0.129    -.1014207    .0130485
PT |  -.1047926    .060118    -1.74   0.083    -.2234818    .0138967
UK |   .4241119   .028776     14.74   0.000     .3673004    .4809235
1986 |    -.05987   .0357605    -1.67   0.096    -.1304708    .0107309
1987 |  -.1067793   .0367532    -2.91   0.004    -.1793401   -.0342875
1988 |  -.1325431   .0376085    -3.50   0.001    -.2074512   -.0576002
1991 |  -.1402506   .0408331    -3.50   0.001    -.2193860   -.0611521
1992 |   -.1338625   .0410992    -3.40   0.001     -.221027    -.0587456
1993 |   -.1705733   .0422913    -4.03   0.000    -.2540677   -.0570788
1995 |  -.2065542   .0437704    -4.72   0.000    -.2929688   -.1201395
1996 |  -.1840664   .0447248    -4.17   0.000    -.2747053   -.0981076
1997 |  -.1941772   .0460532    -4.08   0.000    -.2857938   -.1025605
1999 |  -.2483691   .0508378    -4.89   0.000    -.3487366   -.1480016
2000 |  -.2332983   .0537487    -4.33   0.000    -.3394114   -.1271852
2001 |  -.2763128   .0554089    -4.99   0.000    -.3857049   -.1669207
2002 |  -.3308617   .0564938    -5.00   0.000    -.4324303    -.2303627
cons(BE,1985) |  -2.950763   1.079525    -2.73   0.007      -.8194874    -5.082038
------------------------------------------------------------------------------
Test for $H_0: \lambda_i = 0$, comparing one-way against two-way FE-model
LR=2*(230.0439 - 209.174) = 41.74   Chi^2(18) p=0.0012
F = (1.40146 - 1.13509)*183 / 1.13509*10 = 4.294 F(10,183) p=0.00002

dta .xtgls gas y pg car, panel(hetero)

**Cross-sectional time-series FGLS regression**

Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: no autocorrelation

Estimated covariances      =        11          Number of obs      =       198
Estimated autocorrelations =         0          Number of groups   =        11
Estimated coefficients     =         4          Time periods       =        18
Wald chi2(3)       = 2191.41
Log likelihood             =  96.344          Prob > chi2        = 0.0000

------------------------------------------------------------------------------

gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .8023007    .043241    18.55   0.000     .7175499    .8870514
pg |  -.4000542   .0325038   -12.31   0.000    -.4637605   -.3363478
car |  -.2195841   .028108    -7.40   0.000    -.2746747   -.1644933
_cons |   .1977778   .0356502    -5.53   0.000     .1276289    .2679267
------------------------------------------------------------------------------

dta .xtgls gas y pg car, panel(correlated)

**Cross-sectional time-series FGLS regression**

Coefficients: generalized least squares
Panels: heteroskedastic with cross-sectional correlation
Correlation: no autocorrelation

Estimated covariances      =       66          Number of obs      =       198
Estimated autocorrelations =         0          Number of groups   =        11
Estimated coefficients = 4  Time periods = 18  
Wald chi2(3) = 21192.26  Prob > chi2 = 0.0000

| gas  | Coef. | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|------|-------|-----------|-------|------|----------------------|
| y    | .7931605 | .0091448 | 86.73 | 0.000 | .775237 - .8110841 |
| pg   | -.4565131 | .0068595 | -66.55 | 0.000 | -.4699575 - -.4430687 |
| car  | -1.156407 | .0082692 | -139.85 | 0.000 | -1.172614 - -1.140199 |
| _cons | -3.276874 | .0983149 | -33.33 | 0.000 | -3.469568 - -3.084181 |

.xtgls gas y pg car, panel(hetero) corr(ar1)

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: common AR(1) coefficient for all panels (0.9073)

Estimated covariances = 11  Number of obs = 198
Estimated autocorrelations = 1  Number of groups = 11
Estimated coefficients = 4  Time periods = 18
Wald chi2(3) = 271.76  Prob > chi2 = 0.0000

| gas  | Coef. | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|------|-------|-----------|-------|------|----------------------|
| y    | .4244021 | .0837576 | 5.07  | 0.000 | .2602402 - .588564 |
| pg   | -.2168621 | .0290442 | -7.47 | 0.000 | -.2737877 - -.1599365 |
| car  | -1.00271 | .0676626 | -14.82 | 0.000 | -1.135327 - -0.8700942 |
| _cons | 1.134649 | .8936769 | 1.27  | 0.204 | -.6169254 - 2.886224 |

.xtgls gas y pg car, panel(hetero) corr(psar1)

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: panel-specific AR(1)

Estimated covariances = 11  Number of obs = 198
Estimated autocorrelations = 11  Number of groups = 11
Estimated coefficients = 4  Time periods = 18
Wald chi2(3) = 823.87  Prob > chi2 = 0.0000

| gas  | Coef. | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|------|-------|-----------|-------|------|----------------------|
| y    | .5663818 | .0504493 | 11.23 | 0.000 | .4675029 - .6652606 |
| pg   | -.2842756 | .0223492 | -12.72 | 0.000 | -.3280792 - -.240472 |
| car  | -1.092482 | .0410568 | -26.61 | 0.000 | -1.172952 - -1.012012 |
| _cons | -0.4742299 | .542888 | -0.87 | 0.382 | -1.538271 - .5898111 |

.xtgls gas y pg car, panel(correlated) corr(ar1)

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares
Panels: heteroskedastic with cross-sectional correlation
Correlation: common AR(1) coefficient for all panels (0.9073)

Estimated covariances = 66  Number of obs = 198
Estimated autocorrelations = 1  Number of groups = 11
Estimated coefficients = 4  Time periods = 18
Wald chi2(3) = 829.62  Prob > chi2 = 0.0000

| gas  | Coef. | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|------|-------|-----------|-------|------|----------------------|
| y    | .4489298 | .038502 | 11.66 | 0.000 | .3734673 - .5243922 |
\[ \begin{align*} 
\text{pg} & \quad -0.2186174 \quad 0.0156383 \quad -13.98 \quad 0.000 \quad -0.2492679 \quad -0.1879669 \\
\text{car} & \quad -0.9418968 \quad 0.0352567 \quad -26.72 \quad 0.000 \quad -1.010999 \quad -0.872795 \\
\text{cons} & \quad 0.9439878 \quad 0.4161472 \quad 2.27 \quad 0.023 \quad 0.1283544 \quad 1.759621 \\
\end{align*} \]
Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
  H0: no autocorrelation  z = -5.48  Pr > z = 0.0000
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
  H0: no autocorrelation  z = 1.46  Pr > z = 0.1437
Gasoline demand per gasoline car

```
. xtreg gas y pg carg, re

Random-effects GLS regression                       Number of obs =     80
Group variable (i): id                              Number of groups =     8

R-sq: within = 0.5464                                Obs per group: min =     10
          between = 0.1285                             avg =     10.0
          overall = 0.0420                            max =     10

Random effects u_i ~ Gaussian                       Wald chi2(3) = 67.90
corr(u_i, X) = 0 (assumed)                          Prob > chi2 = 0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |  -.4354506   .0985217    -4.42   0.000    -.6285497   -.2423515
pg |  -.271826    .0557396    -4.88   0.000    -.3810735   -.1625785
carg |   .4787866   .1617361     2.96   0.003     .1617896    .7957836
    _cons |  11.33054    1.202541     9.42   0.000     8.97360    13.68747
------------------------------------------------------------------------------

sigma_u |  .15469492
sigma_e |  .04290251
rho    |  .92857806  (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xttest1
Tests for the error component model:

gas[id,t] = Xb + u[id] + v[id,t]
  v[id,t] = rho v[id,(t-1)] + e[id,t]

Estimated results:

<table>
<thead>
<tr>
<th>Var</th>
<th>sd = sqrt(Var)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gas</td>
<td>.0370514       .1924874</td>
</tr>
<tr>
<td>e</td>
<td>.0018406       .04290251</td>
</tr>
<tr>
<td>u</td>
<td>.0239305       .15469492</td>
</tr>
</tbody>
</table>

Tests:
Random Effects, Two Sided:
LM(Var(u)=0) = 221.19  Pr>chi2(1) = 0.0000
ALM(Var(u)=0) = 149.77  Pr>chi2(1) = 0.0000

Random Effects, One Sided:
LM(Var(u)=0) = 14.87  Pr>M(0,1) = 0.0000
ALM(Var(u)=0) = 12.24  Pr>M(0,1) = 0.0000

Serial Correlation:
LM(rho=0) = 77.07  Pr>chi2(1) = 0.0000
ALM(rho=0) = 5.66  Pr>chi2(1) = 0.0173

Joint Test:
LM(Var(u)=0,rho=0) = 226.85  Pr>chi2(2) = 0.0000

. xtreg gas y pg carg, fe

Fixed-effects (within) regression                      Number of obs =     80
Group variable (i): id                                  Number of groups =     8

R-sq: within = 0.5545                                    Obs per group: min =     10
          between = 0.1524                                 avg =     10.0
          overall = 0.0669                                max =     10

F(3,69) = 28.62  Prob > F = 0.0000

corr(u_i, Xb) = -0.6854

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |  -.5465466   .0982248    -5.56   0.000    -.7424997   -.3505935
pg |  -.253281    .0523826    -4.84   0.000    -.3577815   -.1487805
carg |   .678013    .1646229     4.12   0.000     .3495994    1.006427
------------------------------------------------------------------------------
```
. pantest2 time

Test for serial correlation in residuals
Null hypothesis is either that rho=0 if residuals are AR(1)
or that lamda=0 if residuals are MA(1)
LM= 13.726125
which is asy. distributed as chisq(1) under null, so:
Probability of value greater than LM is .00021149
LM5= 3.7048786
which is asy. distributed as N(0,1) under null, so:
Probability of value greater than abs(LM5) is .00010575

Test for significance of fixed effects
F= 160.85829
Probability>F= 3.844e-40

Test for normality of residuals
Skewness/Kurtosis tests for Normality
------- joint ------
Variable |  Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------
__00000B |      0.092         0.345            3.87       0.1442

. hausman random_effects

---- Coefficients ----
|      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
|  random_eff~s      .          Difference          S.E.
-------------+----------------------------------------------------------------
y |   -.4354506     .5605347       -.9959853               .
pg |    -.271826    -.5678034        .2959774               .
carg |    .4787866    -.4420031        .9207896        .0982743
-------------+----------------------------------------------------------------

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from fit
Test:  Ho: difference in coefficients not systematic
chi2(3) = (b-B)'*[(V_b-V_B)^(-1)](b-B) =       84.03
Prob>chi2 =      0.0000
(V_b-V_B is not positive definite)

.  reg gas y pg carg _x_1-_x_7
Regression fixed effect country and time dummies - one-way

Number of obs =      80
F( 10,    69) =  152.13
Prob > F      =  0.0000
R-squared     =  0.9566
Adj R-squared =  0.9503
Root MSE      =   .0429

Source |       SS       df       MS              Number of obs =      80
-------------+------------------------------           F( 10,    69) =  152.13
Model |  2.80005616    10  .280005616           Prob > F      =  0.0000
Residual |  .127003143    69  .001840625           R-squared     =  0.9566
-------------+------------------------------           Adj R-squared =  0.9503
Total |   2.9270593    79  .037051384           Root MSE      =   .0429

gas |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+--------------------------------------------------
y |  -.5465466   .0982248    -5.56   0.000    -.7424997   -.3505935
pg |   -.253281   .0523826    -4.84   0.000    -.3577815   -.1487805
carg |    .678013   .1646229     4.12   0.000     .3495994    1.006427
DK |   .1898635   .0222901     8.52   0.000      .145396     .234331
DE |  -.3756909   .0749468    -5.01   0.000    -.5252057   -.2261761
ES |  -.5007717   .0443227   -11.30   0.000    -.5891931   -.4123504
FR |  -.1881824   .0221015    -8.52   0.000    -.242023    -.1343418
IE |   .2826536   .0221015    12.79   0.000     .2385624    .3267449
**Regression fixed effect country and time dummies - two-way**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>2.86712933</td>
<td>19</td>
<td>0.150901544</td>
<td>F( 19, 60) = 151.08</td>
</tr>
<tr>
<td>Residual</td>
<td>0.059929971</td>
<td>60</td>
<td>0.000998833</td>
<td>R-squared = 0.9795</td>
</tr>
<tr>
<td>Total</td>
<td>2.9270593</td>
<td>79</td>
<td>0.037051384</td>
<td>Root MSE = 0.0316</td>
</tr>
</tbody>
</table>

| gas | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] |
|-----|-------|-----------|---|-------|-------------------|
| y   | 0.2377113 | .1249086 | 1.90 | 0.062 | -0.012143 | .4875657 |
| pg  | -0.0280023 | .0525213 | -0.53 | 0.596 | -0.1330604 | .0770559 |
| carg | 0.2817035 | .1328165 | 2.12 | 0.038 | .0160311 | .547376 |
| DK  | 0.1715972 | .0166213 | 10.32 | 0.000 | .1383496 | .2048447 |
| DE  | -0.19406 | .0604912 | -3.21 | 0.002 | -0.3150603 | -.0730596 |
| ES  | -0.2016587 | .0513565 | -3.93 | 0.000 | -0.304387 | -0.099305 |
| FR  | -0.1658507 | .0201753 | -8.22 | 0.000 | -0.2062074 | -0.1254941 |
| IE  | 0.2022515 | .0188747 | -6.85 | 0.000 | -0.1696985 | -0.094586 |
| NL  | 0.1145693 | .0389181 | 2.94 | 0.004 | .0367215 | .1924717 |
| UK  | 0.1145693 | .0389181 | 2.94 | 0.004 | .0367215 | .1924717 |
| 1993 | -0.0065026 | .0158603 | -0.41 | 0.683 | -0.0382279 | .0252228 |
| 1994 | -0.0346571 | .0160024 | -2.17 | 0.034 | -0.0666666 | -.002647 |
| 1995 | -0.070464 | .0165252 | -4.30 | 0.000 | -0.1041016 | -0.037991 |
| 1996 | -0.0769266 | .0172494 | -4.46 | 0.000 | -0.1114306 | -0.042227 |
| 1997 | -0.1249696 | .0188747 | -6.85 | 0.000 | -0.1696985 | -0.094586 |
| 1998 | -0.154687 | .0228196 | -6.78 | 0.000 | -0.200333 | -.109041 |
| 2000 | -0.1992371 | .0266594 | -6.72 | 0.000 | -0.2586007 | -.1399454 |
| 2001 | -0.2320162 | .0297251 | -7.81 | 0.000 | -0.2914752 | -.1725571 |
| cons(BE,1992) | 0.3703215 | .0202251 | 18.31 | 0.000 | .3298652 | .4107778 |

---

**Test for H_0: \lambda_i=0 , comparing one-way against two-way FE-model**

\[ LR= 2*(174.349 - 144.307) = 60,08 \]
\[ F= (0.1270 - 0.0599) * 68/0.0599 *7 = 10,88 \]

\[ LR= 2*(174.349 - 144.307) = 60,08 \]
\[ F= (0.1270 - 0.0599) * 68/0.0599 *7 = 10,88 \]

\[ LR= 2*(174.349 - 144.307) = 60,08 \]
\[ F= (0.1270 - 0.0599) * 68/0.0599 *7 = 10,88 \]

---

**Cross-sectional time-series FGLS regression**

Coefficients: generalized least squares
Panels: homoskedastic
Correlation: no autocorrelation

Estimated covariances = 1
Number of obs = 80
Estimated autocorrelations = 0
Number of groups = 8
Estimated coefficients = 4
Time periods = 10
Log likelihood = 30.23565
Prob > chi2 = 0.0000

| gas | Coef. | Std. Err. | z | P>|z| | [95% Conf. Interval] |
|-----|-------|-----------|---|-------|-------------------|
| y   | 0.5605347 | .1580728 | 3.55 | 0.000 | .2507177 | .8703516 |
| pg  | -0.5678034 | .1627194 | -3.49 | 0.000 | -.8867275 | -.2488793 |
| carg | -0.4420031 | .1252026 | -3.53 | 0.000 | -.6873957 | -.1966104 |
| cons | -0.4590795 | 1.861315 | -0.25 | 0.805 | -4.10719 | 3.189032 |

---

**Cross-sectional time-series FGLS regression**

Coefficients: generalized least squares
Panels: heteroskedastic
Correlation: no autocorrelation

Estimated covariances = 8
Number of obs = 80
```
Estimated autocorrelations =         0          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Log likelihood             =  49.38727          Wald chi2(3)        =     60.02
Prob > chi2               =     0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .5186168   .1682102     3.08   0.002     .1889309    .8483028
pg |  -.9425805   .1538007    -6.13   0.000    -.2463817   -.6411877
carg |  -.2917766   .0686774    -4.25   0.000    -.4263817   -.1571714
_cons |  -.8040832   1.932866    -0.42   0.677    -4.592432    2.984265
------------------------------------------------------------------------------
.xtgls gas y pg carg, panel(correlated)

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic with cross-sectional correlation
Correlation:   no autocorrelation

Estimated covariances =         36          Number of obs      =        80
Estimated autocorrelations =         0          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Log likelihood             =  158.9458          Wald chi2(3)        =    5987.24
Prob > chi2               =     0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .5731473   .0248694    23.05   0.000     .5244041    .6218905
pg |  -.5477575   .0182347   -30.04   0.000    -.5834968   -.5120181
carg |  -.4440043   .0070595   -62.89   0.000    -.4578408   -.4301679
_cons |  -.537192   .2443208    -2.20   0.028    -.1016052   -.0583321
------------------------------------------------------------------------------
.xtgls gas y pg carg, panel(hetero) corr(ar1)

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.9837)

Estimated covariances =         8          Number of obs      =        80
Estimated autocorrelations =         1          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Log likelihood             =  164.1461          Wald chi2(3)        =     24.91
Prob > chi2               =     0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |  -.2378287   .1415885    -1.68   0.093    -.5153369    .0396796
pg |  -.1682994   .0488197    -3.45   0.001    -.2639842   -.0726146
carg |   .1083424   .1992829    -0.54   0.587    -.4989297    .282245
_cons |  8.968121   1.606769     5.58   0.000     5.818917   12.11733
------------------------------------------------------------------------------
.xtgls gas y pg carg, panel(correlated) corr(ar1)

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic with cross-sectional correlation
Correlation:   common AR(1) coefficient for all panels  (0.9837)

Estimated covariances =         36          Number of obs      =        80
Estimated autocorrelations =         1          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Log likelihood             =  192.1598          Wald chi2(3)        =    114.90
Prob > chi2               =     0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```
. xtgls gas y pg carg, panel(correlated) corr(psar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  heteroskedastic with cross-sectional correlation
Correlation:  panel-specific AR(1)

Estimated covariances  =  36  Number of obs  =  80
Estimated autocorrelations  =  8  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald ch2(3)  =  758.40
Log likelihood  =  155.0019  Prob > chi2  =  0.0000

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .1331203   .0384813     3.46   0.001     .0576985    .2085422
pg |  -.2080793    .013864   -15.01   0.000    -.2352523   -.1809063
carg |  -.5543796   .0363142   -15.27   0.000    -.6255542    -.4832050
_cons |   4.774339   .4183465    11.41   0.000     3.954395    5.594283
------------------------------------------------------------------------------

. xtgls gas y pg carg, corr(ar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  homoskedastic
Correlation:  common AR(1) coefficient for all panels  (0.9837)

Estimated covariances  =  1  Number of obs  =  80
Estimated autocorrelations  =  1  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald ch2(3)  =  12.24
Log likelihood  =  156.3345  Prob > chi2  =  0.0066

------------------------------------------------------------------------------
gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |  -.2386033   .1528398    -1.56   0.118    -.5381638    .0609571
pg |   -.128791   .0570698    -2.26   0.024    -.2406458   -.0169362
carg |  -.0407414   .2253566    -0.18   0.857    -.4824322    .4009494
_cons |   9.116903   1.755682     5.19   0.000     5.675829    12.55798
------------------------------------------------------------------------------

. xtabond gas y pg carg, lags(1)

Arellano-Bond dynamic panel-data estimation
Number of obs  =  64
Group variable (i): id  Number of groups  =  8
Wald ch2(4)  =  43.39
Obs per group:  min =  8  avg =  8  max =  8

One-step results
------------------------------------------------------------------------------
D.gas |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
gas |  -.3246483   .1779284    -1.82   0.068    -.6733816    .0240849
y |   .1098794   .1732320     0.63   0.526    -.2296491    .4494080
pg |  -.1153381   .0503915    -2.29   0.022    -.2141035   -.0165726
carg |   .2428223   .1923124     1.26   0.207    -.1341030    .6197476
_cons |  -.0160555   .0060226    -2.66   0.008    -.0278096    -.0042013
------------------------------------------------------------------------------
Sargan test of over-identifying restrictions:
\[
\chi^2(35) = 24.33 \quad \text{Prob} > \chi^2 = 0.9119
\]

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
\[
H_0: \text{no autocorrelation} \quad z = -2.88 \quad \text{Pr} > z = 0.0040
\]

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
\[
H_0: \text{no autocorrelation} \quad z = -0.22 \quad \text{Pr} > z = 0.8225
\]

\[
.xtabond \text{ gas} \ y \ \text{pg} \ \text{carg}, \ lags(2)
\]

Arellano-Bond dynamic panel-data estimation

| Coef. Std. Err. | z     | P>|z| [95% Conf. Interval] |
|-----------------|-------|-------|------------------------|
| gas             |       |       |                        |
| LD              | 0.3417027 | 0.1711125 | 2.00 0.046 | 0.0063283 | 0.6770771 |
| L2D             | 0.0573777 | 0.1262439 | 0.45 0.649 | -0.1900559 | 0.3048113 |
| y               |       |       |                        |
| D1              | 0.0737191 | 0.1618368 | 0.46 0.649 | -0.2434751 | 0.3909134 |
| pg              |       |       |                        |
| D1              | -0.1044829 | 0.0528548 | -1.98 0.048 | -0.2080764 | -0.0008895 |
| carg            |       |       |                        |
| D1              | 0.1823972 | 0.1896828 | 0.96 0.336 | -0.1893743 | 0.5546168 |
| _cons           |       |       |                        |
|                 | -0.0130253 | 0.0070058 | -1.86 0.063 | -0.0267564 | 0.0007058 |

Sargan test of over-identifying restrictions:
\[
\chi^2(33) = 25.52 \quad \text{Prob} > \chi^2 = 0.8205
\]

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
\[
H_0: \text{no autocorrelation} \quad z = -3.34 \quad \text{Pr} > z = 0.0008
\]

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
\[
H_0: \text{no autocorrelation} \quad z = 0.11 \quad \text{Pr} > z = 0.9150
\]

\[
.xtabond \text{ gas} \ y \ l(0/2).pg \ \text{carg}, \ lags(1)
\]

Arellano-Bond dynamic panel-data estimation

| Coef. Std. Err. | z     | P>|z| [95% Conf. Interval] |
|-----------------|-------|-------|------------------------|
| gas             |       |       |                        |
| LD              | 0.2890519 | 0.1657595 | 1.74 0.081 | -0.0358307 | 0.6139346 |
| y               |       |       |                        |
| D1              | 0.258327 | 0.1724108 | 1.50 0.134 | -0.795919 | 0.562459 |
| pg              |       |       |                        |
| D1              | -0.111542 | 0.0528548 | -2.04 0.042 | -0.2189227 | -0.004162 |
| L2D             | 0.0297447 | 0.0584539 | -0.51 0.611 | -0.1443122 | 0.0848229 |
| carg            |       |       |                        |
| D1              | 0.1296301 | 0.0608942 | 2.13 0.033 | -0.0102797 | 0.2489804 |
| _cons           |       |       |                        |
|                 | -0.019425 | 0.0059967 | -3.24 0.001 | -0.0311783 | 0.0007618 |

Sargan test of over-identifying restrictions:
\[
\chi^2(34) = 24.82 \quad \text{Prob} > \chi^2 = 0.8750
\]

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
\[
H_0: \text{no autocorrelation} \quad z = -2.91 \quad \text{Pr} > z = 0.0036
\]

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
\[
H_0: \text{no autocorrelation} \quad z = 0.23 \quad \text{Pr} > z = 0.8170
\]
```
.xtabond gas l(0/2).(y pg) carg, lags(1)

Arellano-Bond dynamic panel-data estimation
Arellano-Bond dynamic panel-data estimation
Number of obs = 56
Number of groups = 8
Wald chi2(8) = 58.74

Group variable (i): id

Time variable (t): time
Obs per group: min = 7
avg = 7
max = 7

One-step results
------------------------------------------------------------------------------
D.gas | Coef. Std. Err. z P>|z| [95% Conf. Interval]
-------------+----------------------------------------------------------------
  gas | 
LD | .3284291 .1601912 2.05 0.040 .0144601 .6423982
  y  | 
D1 | -.094895 .3452215 -0.27 0.783 -.7715167 .5817268
LD | .5168482 .436443 1.18 0.236 -.3385644 1.372261
L2D | -.0993624 .2804888 -0.35 0.723 -.6491103 .4503855
  pg | 
D1 | -.1107427 .054501 -2.03 0.042 -.2175627 -.0039227
LD | -.0536881 .0622949 -0.86 0.389 -.1757838 .0684077
L2D | .1580554 .0649933 2.43 0.015 .0306708 .28544
  carg | 
D1 | .0277547 .1935123 0.14 0.886 -.3515223 .4070318
_cons | -.020184 .0060093 -3.36 0.001 -.0319619 -.0084061
------------------------------------------------------------------------------

Sargan test of over-identifying restrictions:
  chi2(34) = 23.45 Prob > chi2 = 0.9129

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
  H0: no autocorrelation  z = -2.80  Pr > z = 0.0052
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
  H0: no autocorrelation  z = 0.14  Pr > z = 0.8851
```
Diesel consumption demand per diesel car

`. xtreg diesel y pd card, re`

**Random-effects GLS regression**

|              | Coef. | Std. Err. | z     | P>|z|   | [95% Conf. Interval] |
|--------------|-------|-----------|-------|-------|----------------------|
| diesel       | 1.287942 | 0.0681484 | 18.90 | 0.000 | 1.154374 - 1.42151   |
| y            | -0.1583023 | 0.0503231 | -3.15 | 0.002 | -0.2569337 - -0.0596709 |
| pd           | -0.8257338 | 0.0289138 | -28.56 | 0.000 | -0.8824038 - -0.7690639 |
| card         | -6.959788 | 0.7446489 | -9.35 | 0.000 | -8.419273 - -5.500303 |

Random effects u_i ~ Gaussian

Wald chi2(3) = 1020.25
Prob > chi2 = 0.0000

---

`. xttest1`

Breusch and Pagan Lagrangian multiplier test for random effects:

Tests for the error component model:

\[
\text{diesel}_{\text{id},t} = X\beta + u_{\text{id}} + v_{\text{id},t} \\
v_{\text{id},t} = \rho v_{\text{id},(t-1)} + e_{\text{id},t}
\]

Estimated results:

<table>
<thead>
<tr>
<th>Var</th>
<th>sd - sqrt(Var)</th>
</tr>
</thead>
<tbody>
<tr>
<td>diesel</td>
<td>0.3370639</td>
</tr>
<tr>
<td>e</td>
<td>0.0019781</td>
</tr>
<tr>
<td>u</td>
<td>0.275408</td>
</tr>
</tbody>
</table>

Tests:

**Random Effects, Two Sided:**

<table>
<thead>
<tr>
<th>LM(Var(u)=0)</th>
<th>Pr&gt;chi2(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>214.85</td>
<td>0.0000</td>
</tr>
<tr>
<td>142.03</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Random Effects, One Sided:**

<table>
<thead>
<tr>
<th>LM(Var(u)=0)</th>
<th>Pr&gt;N(0,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.66</td>
<td>0.0000</td>
</tr>
<tr>
<td>11.92</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Serial Correlation:**

<table>
<thead>
<tr>
<th>LM(rho=0)</th>
<th>Pr&gt;chi2(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>79.94</td>
<td>0.0000</td>
</tr>
<tr>
<td>7.11</td>
<td>0.0076</td>
</tr>
</tbody>
</table>

**Joint Test:**

<table>
<thead>
<tr>
<th>LM(Var(u)=0,rho=0)</th>
<th>Pr&gt;chi2(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>221.96</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

---

`. xtreg diesel y pd card, fe`

**Fixed-effects (within) regression**

|              | Coef. | Std. Err. | t    | P>|t|   | [95% Conf. Interval] |
|--------------|-------|-----------|------|-------|----------------------|
| diesel       | 1.312313 | 0.0701813 | 18.70 | 0.000 | 1.172306 - 1.452321   |
pd |  -.1481031   .0507667    -2.92   0.005    -.2493799   -.0468263
  card |  -.8371178   .0307916   -27.19   0.000    -.8985453   -.7756903
  _cons |  -7.208604   .7627813    -9.45   0.000   -8.730311   -5.686897
------------------------------------------------------------------------------
sigma_u |  .18033059
sigma_e |  .04447564
rho |  .94265963   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(7, 69) =   113.29               Prob > F = 0.0000

. hausman random_effects

---- Coefficients ----
|      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
|  random_eff~s      .          Difference          S.E.
-------------+----------------------------------------------------------------
   y |   1.287942   1.312313       -.0243715               .
  pd |  -.1583023    -.1481031       -.0101992               .
  card |  -.8257338    -.8371178        .0113839               .
------------------------------------------------------------------------------

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test:  Ho:  difference in coefficients not systematic

\[ \chi^2(3) = (b-B)'[(V_b-V_B)^{-1}](b-B) \]
\[ = 1.22 \]
\[ \text{Prob} > \chi^2 = 0.7490 \]
(V_b-V_B is not positive definite)

. pantest2 time

Test for serial correlation in residuals
Null hypothesis is either that rho=0 if residuals are AR(1)
or that lambda=0 if residuals are MA(1)
LM= 7.1872079
which is asy. distributed as chisq(1) under null, so:
Probability of value greater than LM is .00734251
LM5= 2.6808969
which is asy. distributed as N(0,1) under null, so:
Probability of value greater than abs(LM5) is .00367126

Test for significance of fixed effects
F= 113.28916
Probability>F= 2.841e-35

Test for normality of residuals

Skewness/Kurtosis tests for Normality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi2(2)</th>
<th>Prob&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>__00000B</td>
<td>0.078</td>
<td>0.202</td>
<td>4.74</td>
<td>0.0934</td>
</tr>
</tbody>
</table>

. reg diesel y pd card _x_1-_x_7

Regression fixed effect country and time dummies - one-way

Source | SS    | df   | MS    | Number of obs = 80
-------------+----------------------------------|----------------------------------|
 Model       | 26.4915591 | 10  | 2.64915591 | F( 10,  69) = 1339.25
 Residual    | .136487683 | 69  | .001978082 | Prob > F = 0.0000
 Total       | 26.6280468 | 79  | .337063884 | R-squared = 0.9949
----------+----------------------------------|----------------------------------|
diesel | Coef. | Std. Err. | t | P>|t| [95% Conf. Interval]
-------------+----------------------------------|----------------------------------|
   y | 1.312313 |  .0701813 | 18.70 | 0.000 | 1.172306 | 1.452321
(pd | -.1481031 | .0507667 | -2.92 | 0.005 | -.2493799 | -.0468263
  card | -.8371178 | .0307916 | -27.19 | 0.000 | -.8985453 | -.7756903

reg diesel y pd card _x_1-_x_7
DIESEL REGRESSION

**Regression fixed effect country and time dummies - two-way**

```
<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>26.508186</td>
<td>19</td>
<td>1.39504308</td>
<td>Prob &gt; F = 0.0000</td>
</tr>
<tr>
<td>Residual</td>
<td>0.122228223</td>
<td>60</td>
<td>0.002037137</td>
<td>R-squared = 0.9954</td>
</tr>
<tr>
<td>Total</td>
<td>26.6280468</td>
<td>79</td>
<td>0.337063844</td>
<td>Root MSE = 0.04513</td>
</tr>
</tbody>
</table>
```

**Coefficients**

| Coeff. Std. Err. | t | P>|t| | 95% Conf. Interval |
|------------------|---|------|------------------|
| y | 1.219232 | .1102129 | 11.06 | 0.000 | .9987737 | 1.439691 |
| pd | -.2327536 | .0700621 | -3.32 | 0.002 | -.3728986 | -.0926085 |
| card | -.846178 | .0358432 | -23.61 | 0.000 | -.9178784 | -.7744809 |
| DK | -.1631466 | .0477411 | 2.54 | 0.014 | .0256249 | .2166178 |
| DE | -.3008088 | .0207622 | -3.04 | 0.004 | -.3621289 | -.2394889 |
| ES | -.0442966 | .0523849 | -0.85 | 0.401 | -.149082 | .0604889 |
| FR | -.0631172 | .0207622 | -3.04 | 0.004 | -.1046479 | -.0215866 |
| IE | -.0272963 | .0424204 | -0.64 | 0.522 | -.1119227 | .0573302 |
| NL | -.386374 | .0343581 | -11.25 | 0.000 | -.4551005 | -.3176475 |
| UK | -.2616893 | .0580219 | -4.51 | 0.000 | -.377503 | -.1456282 |
```

**Test for H0: \lambda_i = 0 , comparing one-way against two-way FE-model**

```
LR = 2*(145.84059-141.4268)=8.828  Ch2(10) p=0.5485
F= (0.1364-0.1222)*68/0.1222*7=1.1288  F(7,68)  p=0.3556
```

**xtgls diesel y pd card**

**Cross-sectional time-series FGLS regression**

```
Coefficients:  generalized least squares
Panels:  homoskedastic
Correlation:  no autocorrelation
Estimated covariances = 1
Estimated autocorrelations = 0
Estimated coefficients = 4
Estimated time periods = 10
Log likelihood = 40.41975  Prob > ch2 = 0.0000
```

**xtgls diesel y pd card, panel(hetero)**

**Cross-sectional time-series FGLS regression**

```
| Coeff. Std. Err. | z | P>|z| | 95% Conf. Interval |
|------------------|---|------|------------------|
| y | .8062464 | .1205435 | 6.69 | 0.000 | .5698363 | 1.042506 |
| pd | -.3589045 | .1164514 | -3.08 | 0.002 | -.587145 | -.1306639 |
| card | -.7843869 | .023091 | -33.97 | 0.000 | -.8296444 | -.7391294 |
| _cons | -2.561024 | 1.354267 | -1.89 | 0.059 | -.851439 | .0941915 |
```
Coefficients:  generalized least squares
Panels:  heteroskedastic
Correlation:  no autocorrelation

Estimated covariances  =  8  Number of obs  =  80
Estimated autocorrelations  =  0  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald chi2(3)  =  2307.26
Log likelihood  =  56.26765  Prob > chi2  =  0.0000

| Coef.  | Std. Err.  | z    | P>|z|  | [95% Conf. Interval] |
|--------|-------------|------|------|----------------------|
| y      | 1.017673    | .1083898 | 9.39 | 0.000 | .805233 - 1.230113 |
| pd     | -.449832    | .077441 | -5.81 | 0.000 | -.6016136 - -.2980504 |
| card   | -.7666731   | .0159832 | -47.97 | 0.000 | -.7979996 - -.7353467 |
| _cons  | 4.850705    | 1.181773 | -4.11 | 0.000 | -7.173237 - 2.540773 |

.xtgls diesel y pd card, panel(correlated)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  heteroskedastic with cross-sectional correlation
Correlation:  no autocorrelation

Estimated covariances  =  36  Number of obs  =  80
Estimated autocorrelations  =  0  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald chi2(3)  =  46506.78
Log likelihood  =  148.8087  Prob > chi2  =  0.0000

| Coef.  | Std. Err.  | z    | P>|z|  | [95% Conf. Interval] |
|--------|-------------|------|------|----------------------|
| y      | .7833108    | .0191966 | 40.80 | 0.000 | .7456862 - .8209355 |
| pd     | -.3321969   | .0164491 | -20.20 | 0.000 | -.3644366 - -.2999572 |
| card   | -.7859309   | .0040034 | -196.32 | 0.000 | -.7937774 - -.7780844 |
| _cons  | -2.262758   | .2219776 | -10.19 | 0.000 | -2.697826 - -1.82769 |

.xtgls diesel y pd card, panel(correlated) corr(ar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  heteroskedastic with cross-sectional correlation
Correlation:  common AR(1) coefficient for all panels  (0.9665)

Estimated covariances  =  36  Number of obs  =  80
Estimated autocorrelations  =  1  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald chi2(3)  =  9790.46
Log likelihood  =  182.1719  Prob > chi2  =  0.0000

| Coef.  | Std. Err.  | z    | P>|z|  | [95% Conf. Interval] |
|--------|-------------|------|------|----------------------|
| y      | 1.018488    | .07707 | 13.22 | 0.000 | .8674341 - 1.169543 |
| pd     | -.0711882   | .0146844 | -4.85 | 0.000 | -.0999692 - -.0424073 |
| card   | -.8074713   | .0115425 | -69.96 | 0.000 | -.8300942 - -.7848483 |
| _cons  | -3.968646   | .8122939 | -4.89 | 0.000 | -5.560713 - -2.375659 |

.xtgls diesel y pd card, panel(correlated) corr(psar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  heteroskedastic with cross-sectional correlation
Correlation:  panel-specific AR(1)

Estimated covariances  =  36  Number of obs  =  80
Estimated autocorrelations  =  8  Number of groups  =  8
Estimated coefficients  =  4  Time periods  =  10
Wald chi2(3)       =  10410.18
Log likelihood             =  147.9478          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
diesel |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   1.291594   .0555141    23.27   0.000     1.182788      1.4004
pd |  -.096869   .0121108    -8.00   0.000    -.1206057   -.0731322
card |  -.8507615   .0111222   -76.49   0.000    -.8725606   -.8289625
    _cons |  -7.087153   .5987569   -11.84   0.000    -8.260695   -5.913611
------------------------------------------------------------------------------
.xtgls diesel y pd card, panel(hetero) corr(psar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  heteroskedastic
Correlation:  panel-specific AR(1)
Estimated covariances      =         8          Number of obs      =        80
Estimated autocorrelations =         8          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Wald chi2(3)       =   1234.34          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
diesel |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   .9132192   .1250445     7.30   0.000     .6681365    1.158302
pd |  -.0857943   .0347558    -2.47   0.014    -.1539143   -.0176743
    card |  -.8594665   .0276366   -31.10   0.000    -.9136332   -.8052998
    _cons |  -3.243283   1.329919    -2.44   0.015    -5.849876   -.6366894
------------------------------------------------------------------------------
.xtgls diesel y pd card, corr(psar1)

Cross-sectional time-series FGLS regression
Coefficients:  generalized least squares
Panels:  homoskedastic
Correlation:  panel-specific AR(1)
Estimated covariances      =         1          Number of obs      =        80
Estimated autocorrelations =         8          Number of groups   =         8
Estimated coefficients     =         4          Time periods       =        10
Wald chi2(3)       =    336.76          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
diesel |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
y |   1.036291   .1498768     6.91   0.000     .7425376    1.330044
pd |  -.0655656   .0589673    -1.11   0.266    -.1811395    .0500083
    card |  -.8724396   .0482841   -18.07   0.000    -.9670748   -.7778045
    _cons |  -4.451799   1.606996    -2.77   0.006    -7.601453   -1.302145
------------------------------------------------------------------------------
.xtabond diesel y pd card

Arellano-Bond dynamic panel-data estimation
Number of obs      =        64
Group variable (i): id                          Number of groups   =         8
Wald chi2(4)       =    637.15
Time variable (t): time                         Obs per group: min =         8
                                                  avg =         8
                                                  max =         8
One-step results
------------------------------------------------------------------------------
D.diesel |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    LD |   .2061316   .1190926     1.73   0.083    -.0272826    .4395488
    y |
### One-step results

| D.diesel | Coef. | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|----------|-------|-----------|-------|------|---------------------|
| diesel   |       |           |       |      |                     |
| LD       | .2061316 | .1190926 | 1.73  | 0.083| -.0272856,.4395488  |
| y        | 1.070071 | .1797725 | 5.95  | 0.000| .71772,.1422418    |
| pd       | -0.1124007 | .0642994 | -1.75 | 0.080| -.2384252,.0136239 |
| card     | -0.6650061 | .1277177 | -5.21 | 0.000| -.9153282,-.414684 |
| _cons    | -0.000132  | .0048327 | -0.03 | 0.978| -.009604,.0093399  |

Sargan test of over-identifying restrictions:

chi2(35) = 42.38 Prob > chi2 = 0.1826

### Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  
Pr > z = 0.0034

### Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  
Pr > z = 0.1272

### One-step results

| D.diesel | Coef. | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|----------|-------|-----------|-------|------|---------------------|
| diesel   |       |           |       |      |                     |
| LD       | .125125 | .1552441 | 0.81  | 0.420| -.1791478,.4293978  |
| L2D      | -.0962694 | .0933966 | -1.03 | 0.303| -.2793234,.0867846  |
| y        | 1.216902 | .2014503 | 6.04  | 0.000| .8220671,1.611738   |
| pd       | -0.1347477 | .0720007 | -1.87 | 0.061| -.2758664,.0063711  |
| card     | -0.8438203 | .1327199 | -6.36 | 0.000| -.1039346,.5836941  |
| _cons    | .0047901  | .0062476 | 0.77  | 0.443| -.007455,.0170352   |

Sargan test of over-identifying restrictions:

chi2(33) = 37.00 Prob > chi2 = 0.2896
Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  z = -3.49  Pr > z = 0.0005
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  z =  2.30  Pr > z = 0.0217

. xtabond diesel y l(0/1).pd card, lags(2)

Arellano-Bond dynamic panel-data estimation
Number of obs   =      56
Number of groups =       8
Wald chi2(6)    =   373.07
Obs per group: min =      7
              avg =      7
              max =      7

One-step results
------------------------------------------------------------------
D.diesel        |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
diesel        |
LD |   .1635903   .1668486     0.98   0.327    -.1634269    .4906075
LD2 |  -.0886154   .0957733    -0.93   0.355    -.2763276    .0990968
y            |
D1 |   1.173976   .2078943     5.65   0.000     .7665102    1.581441
pd           |
D1 |  -.1503338   .0787279    -1.91   0.056    -.3046377    .0039701
LD |  -.0120166   .0809957    -0.15   0.882    -.1707653    .146732
card         |
D1 |  -.7752369   .1422169    -5.45   0.000    -1.053977   -.4964969
_cons        |   .0031297   .0066418     0.47   0.637     -.009888    .0161474
------------------------------------------------------------------
Sargan test of over-identifying restrictions:
        chi2(33) =   42.19  Prob > chi2 = 0.1312

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  z =  -3.60  Pr > z = 0.0003
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  z =   2.23  Pr > z = 0.0258

. xtabond diesel y l(0/1).pd card, lags(1)

Arellano-Bond dynamic panel-data estimation
Number of obs   =      64
Number of groups =       8
Wald chi2(5)    =   612.66
Obs per group: min =      8
              avg =      8
              max =      8

One-step results
------------------------------------------------------------------
D.diesel        |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
diesel        |
LD |   .2376583   .1281778     1.85   0.064    -.0135656    .488821
LD2 |  -.1343749   .0721187    -1.86   0.062    -.2757248    .0069751
y            |
D1 |   1.063859   .1851579     5.75   0.000     .7009561    1.426762
pd           |
D1 |  -.0072949   .0722492    -0.10   0.920    -.1343109   .1489006
LD |  .0072949   .0722492     0.10   0.920    -.1343109   .1489006
card         |
D1 |  -.623344   .136557     -4.56   0.000    -.8909772    -.3557109
_cons        |   .0016841   .0052844    -0.32   0.750     -.0120414    .0186732
------------------------------------------------------------------
Sargan test of over-identifying restrictions:
chi2(35) =   42.17  Prob > chi2 = 0.1886

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  z =  -2.97  Pr > z = 0.0030
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  z =   1.50  Pr > z = 0.1323

. xtabond diesel y l(0/2).pd card, lags(1)
Arellano-Bond dynamic panel-data estimation  
Number of obs  =    56
Group variable (i): id                          Number of groups   =     8

Wald ch2(6)  = 431.77

Time variable (t): time                          Obs per group: min = 7
                                                  avg = 7
                                                  max = 7

One-step results

| D.diesel | Coef.  | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|----------|--------|-----------|------|------|---------------------|
| diesel   |        |           |      |      |                     |
| LD       | .0118841 | .1346477 | 0.09 | 0.930 | -.2520205 -.2757886 |
| y        | 1.272778 | .1854081 | 6.86 | 0.000 | 1.09385 1.636172   |
| pd       |         |           |      |      |                     |
| D1       | -.1554671 | .0737939 | -2.11 | 0.035 | -.3001006 -.0108336 |
| LD       | .0132314 | .0779292 | 0.17 | 0.865 | -.1395071 .1659698 |
| L2D      | -.0870453 | .0846661 | -1.03 | 0.304 | -.2529878 .0788973 |
| card     |         |           |      |      |                     |
| D1       | -.8381178 | .1384569 | -6.05 | 0.000 | -1.109488 -.5667473 |
| _cons    | .0036044 | .0062872 | 0.57 | 0.566 | -.0087182 .015927  |

Sargan test of over-identifying restrictions:
chi2(34) = 49.12  Prob > chi2 = 0.0451

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  z =  -2.41  Pr > z = 0.0160
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  z =   1.22  Pr > z = 0.2209

.xtabond diesel l(0/1).(y pd card), lags(1)

Arellano-Bond dynamic panel-data estimation  
Number of obs  = 64
Group variable (i): id                          Number of groups   = 8
Wald ch2(7)  = 667.97

Time variable (t): time                          Obs per group: min = 8
                                                  avg = 8
                                                  max = 8

One-step results

| D.diesel | Coef.  | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|----------|--------|-----------|------|------|---------------------|
| diesel   |        |           |      |      |                     |
| LD       | .4025039 | .1658613 | 2.43 | 0.015 | .0774216 .7275861  |
| y        | .4540846 | .3922962 | 1.16 | 0.247 | -.3148019 1.222971 |
| PD       |         |           |      |      |                     |
| D1       | -.153973 | .0757777 | -2.03 | 0.042 | -.3024931 -.0054529 |
| LD       | -.0489411 | .066681 | -0.64 | 0.523 | -.1992079 .1013256 |
| card     |         |           |      |      |                     |
| D1       | -.9990571 | .1652028 | -6.05 | 0.000 | -1.322849 -.6752655 |
| LD       | .4916564 | .1668064 | 2.95 | 0.003 | .1647219 .8185908  |
| _cons    | .0020583 | .0057695 | 0.36 | 0.721 | -.0092497 .0133663 |

Sargan test of over-identifying restrictions:
chi2(35) = 38.52  Prob > chi2 = 0.3130

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:
H0: no autocorrelation  z =  -3.63  Pr > z = 0.0003
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:
H0: no autocorrelation  z =   1.89  Pr > z = 0.0586

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