Determinants of Inflation in Denmark and a Panel Data analysis of Denmark and 4 other countries.

Section I: Introduction

Inflation is defined as the sustained rise in the general price level (Blanchard, Amighini, & Giavazzi, 2021, p. 577).

The negative effects of inflation are well documented. One such cost of inflation is the “shoe leather cost” (Mishkin & Posen, 1997, p. 3) – the extra cost needed to conduct day-to-day transactions rises to >1% of GDP when inflation rates rise above 100%. Another cost is that inflation induces overinvestment in the financial sector: as price instability increases, arbitrage opportunities grow (*ibid*, p. 4); the rise in the financial sector share of GDP increases by 1pp for every 10pp rise in inflation (English, 1999). This transfer of resources out of the productive sector can be “as large as a few percentage points of GDP and can even be seen at relatively low or moderate rates of inflation.” (Mishkin & Posen, 1997, p. 4) Inflation is passed onto the population not only through increased prices – which reduce the purchasing power of an individual’s income – but also through fiscal drag. Fiscal drag occurs when nominal income rises while real income and tax brackets remain frozen; as a result, income after tax decreases in real terms; Fischer (1994, p. 14) estimates that an inflation rate of 10% could put the social cost of fiscal drag at 2-3% of GNP.

Due to the misallocation of resources and damage to the standard of living caused by inflation, governments around the world have decided to specifically target low and stable inflation as a policy objective of their monetary authorities (Mishkin & Posen, 1997). To succeed, these monetary authorities must have a clear model for producing inflation forecasts (Masson, Savastano, & Sharma, 1997, p. 9), and must consequently understand the determinants of inflation. This paper will contribute to this understanding by estimating the relationship between inflation and past inflation, money supply, exchange rates, and global energy prices. I have chosen first to conduct a timeseries analysis of inflation, from Q1 2001 to Q4 2023, in Denmark, and then a panel data analysis of inflation in Denmark, Sweden, Iceland, Norway and the UK.

Section II will review existing evidence on the determinants of inflation and examine the models and specifications used. Section III will cover a timeseries summary and analysis of Denmark, estimating inflation as an ARMA model and then as an ARDL model. Section IV will cover a panel data analysis of inflation in the five countries. Section V will use a probit model to estimate the average marginal effects (AME) and marginal effects at average (MEA) of a change in energy price on the probability of a country achieving their inflation target.

Section II: Literature Review

Among economists, there are competing explanations for the fundamental causes of inflation. Friedman provides the well-known monetarist explanation where inflation is the result of money supply rising faster than output (Leeson & Palm, 2012, p. 3). This view is popular and the relationship between money supply growth and inflation has been examined by a number of studies.

Holod (2000) uses a VEC model to investigate the relationship between price level, exchange rate and money supply in Ukraine; a VEC rather than VAR model is used because evidence of cointegration between the variables exists at a 5% significance level. Holod (2000) finds that the influence of money supply on inflation is not very strong, which he explains is due to concurrent fluctuations in the money demand.

Lim & Sek (2015) explore panel data on 28 countries by estimating inflation as an ARDL model against money supply (M4) and a number of other regressors. In high inflation countries, every 1% increase in the money supply is found to induce a 0.77% increase in inflation, in the long-run. In low-inflation countries, increased money supply does not have a significant effect in the long-run and decreases inflation in the short-run in low inflation countries.

Money growth leads to inflation by increasing aggregate demand, known as demand-pull inflation. On the other hand, cost-push inflation, which follows a reduction in aggregate supply, has also been examined in the literature. Cost-push inflation is typically caused by high factor prices (Ellahi, 2017, p. 3). Global energy prices are one example of a variable which should have such an effect on factor prices, and this view is supported by existing evidence.

Jatuporn (2024) and Liang & Long (2018) both estimated the impacts of global oil price changes on CPI and PPI using ARDL and NARDL models to analyse Thailand and China, respectively. Both found evidence of cointegration using the bounds cointegration methodology introduced by Perasan at al. (2001). Both studies find that ARDL models do not find evidence of long-run effects of oil price shocks on inflation, however NARDL models can capture the effects at a 1% significance level. Jatuporn (2024) finds: +1% change in oil price led to +0.147% CPI change; -1% change in oil price led to -0.115% CPI change. Liang & Long (2018) did not find significant long-run effects due to a drop in oil prices, but found a +1% change in oil price led to a +0.143% CPI change.

Finally, there is also a lot of evidence examining the effects of a currency's exchange rate on domestic prices. Movements in the exchange rate influence domestic prices through various channels, from direct effects on energy prices (discussed above) to indirect effects on import prices (Ha et al., 2019); this raises the price of inputs and thus the price of capital, reducing aggregate supply. The marginal effect of a 1% depreciation in the exchange rate on inflation is known as the exchange rate pass-through ratio (Ha et al., 2019, p. 271).

The exchange rate pass-through varies across countries and time (Ha, Kose, Ohnsorge, & Yilmazkuday, 2019, p. 284). Choudhri & Hakura (2001) estimated inflation as an ARDL model, using panel data of 71 countries. The explanatory variables were the nominal exchange rate and foreign CPI. No evidence of cointegration was found however the stationarity of the error term has not been settled (Choudhri & Hakura, 2001, p. 14). They find that the long-run pass-through rates in Denmark, Sweden, Norway, and the UK are 0.24, 0.03, 0.13, and 0.03, respectively – Iceland did not form part of the panel. They also determine that the main reason for cross-country variation in the pass-through rate is due to the different inflationary regimes between countries.

Section III: Timeseries variables, data and models

A. *Data sources*

The databases utilised are the IMF, OECD, Bank for International Statistics (BIS), and Federal Reserve Economic Data (FRED). CPI data was obtained from the IMF, money supply (M3) data from OECD, the exchange rate from BIS and global energy prices from FRED. The literature varies between using real effective exchange rates (Deniz, Tekce, & Yilmaz, 2016) and nominal effective exchange rates (Choudhri & Hakura, 2001; Campa & Goldberg, 2005) – in this paper I will use the nominal exchange rate following from Campa & Goldberg's (2005) model where it is the nominal rate that influences decision-makers at the microlevel. Any monthly data was converted into quarterly data by taking the value for the last month of each quarter.

B. *Presenting and transforming the data*

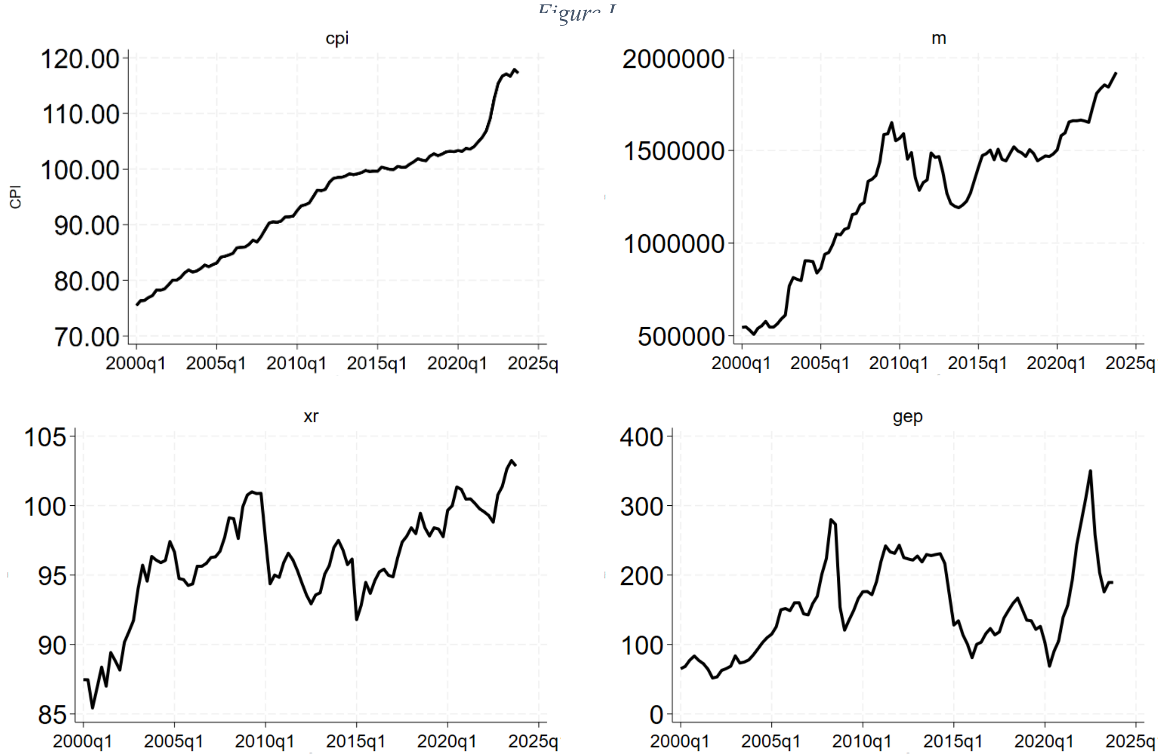
Table I contains the summary statistics for Denmark in the studied period (2000:1-2023:4). This includes the consumer price index (cpi) in 2015=100, money supply aggregate M4 (m), nominal effective exchange rate index (xr) in 2020=100, and the global energy price index (gep) in 2016=100.

Table I

Statistic	cpi	m	xr	gep
Mean	94.527	1271726.000	96.050	153.268
Median	96.967	1394929.000	96.120	148.764
S.D.	10.845	377165.800	3.815	64.919
Min	75.429	507134.000	85.430	61.703
Max	117.867	1922206.000	103.240	350.124
Obs	96	96	96	96

Figure I represents the variables visually in the studied period (2000:1-2023:4).

Figure I



To reduce data variability and find elastic relationships (Jatuporn, 2024), all variables have been transformed into logarithmic functions (lcpi, lm, lxr, lgep).

C. Stationarity Testing

The Augmented Dickey-Fuller (ADF) test will be used to test for stationarity.

Each variable is first estimated as:

$$\Delta z_t = \gamma z_{t-1} + \sum_{i=1}^{i=p} \phi_i \Delta z_{t-i} + X + e_t$$

Where $Z = [lcpi, lm, lmxr, lgep]$, p is the number of lagged, differenced, dependent variables to include to eliminate serial correlation, X is an array of variables that may or may not be added if the variable is exhibiting drifting or trending behaviour, and e_t is a stochastic error term.

To find the value of p, the Breusch-Godfrey (BG) test is used which to indicate how many lagged, differenced, dependent variables should be included to eliminate serial correlation. As all variables have non-zero means, they must have a drift/constant component. All variables – except $lgep$ – appear to be increasing over time, and thus will also be testing with trend components.

First, all variables – other than $lgep$ – are estimated using the ADF test **with a trend term** and then tested for serial correlation. $lgep$ is only estimated with a drift. Once p was found[1], an ADF test with lags p and a trend (drift for $lgep$) term was estimated[2]. Table II displays the value of p for each variable the BG test recommends to eliminate serial correlation, as well as the test statistic, 5% critical value and the MacKinnon approximate p-value from the ADF test.

Table II

Variable	Lags (p)	Test statistic	5% critical value	MacKinnon p-value
$lcpi$	5	-2.131	-3.460	0.5289
lm	0	-1.616	-3.455	0.7861
lxr	3	-3.271	-3.458	0.0712
$lgep$*	1	-2.743	-1.662	0.0059***

**** denotes the 1% significance level*

H_0: $Random\ walk\ with\ or\ without\ drift$

$*H_0$: $Random\ walk\ with\ drift$

We do not accept the alternate hypothesis that $lcpi, lm, lxr$ are trend-stationary. We accept the alternate hypothesis that $lgep$ stationary with drift.

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[1] Appendix 1

[2] Appendix 2

$lcpi, lm$, and lxr are then re-estimated using the ADF test **with a drift constant** and tested for serial correlation[3]. Table III contains the new p, test statistic, 5% critical value and MacKinnon approximate p-value for this new estimation[4].

Table III

Variable	Lags (p)	Test statistic	5% critical value	MacKinnon p-value
$\boldsymbol{lcpi}$	5	-0.286	-1.663	0.3879
$\boldsymbol{lm}$	0	-1.937	-1.661	0.0279**
$\boldsymbol{lxr}$	4	-2.095	-1.663	0.0196**

*** denotes the 5% significance level*
**** denotes the 1% significance level*
H_0: $Random\ walk\ with\ drift$

We accept the null hypothesis that $lcpi$ is a random walk with drift, and accept the alternative hypothesis that lm and lxr are drift-stationary processes due to their non-zero means.

As $lcpi$ is non-stationary, it is differenced (=$dlcpi$) and tested again for stationarity. Like before, serial correlation is tested[5] and then an ADF test is used[6]. As $dlcpi$ has a non-zero mean, tests are conducted using a **drift constant**. Results are shown in Table IV.

Table IV

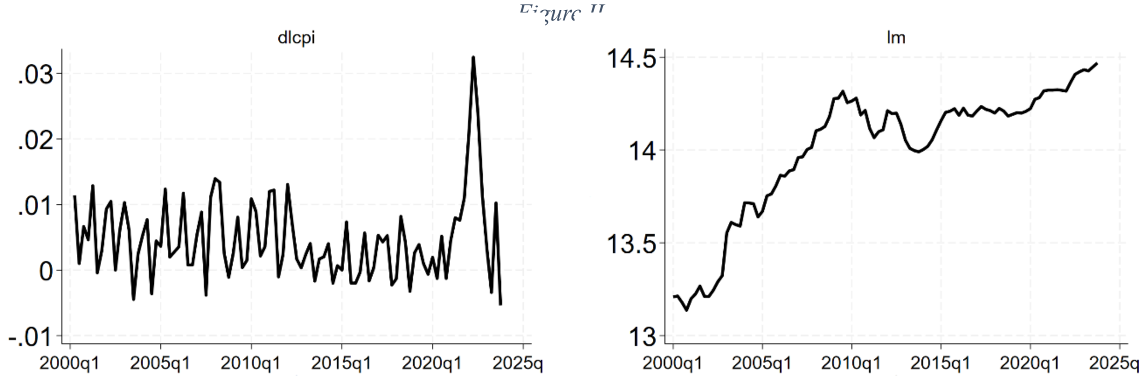
Variable	Lags (p)	Test statistic	5% critical value	MacKinnon p-value
$\boldsymbol{dlcpi}$	4	-4.114	-1.663	0.0000***

**** denotes the 1% significance level*

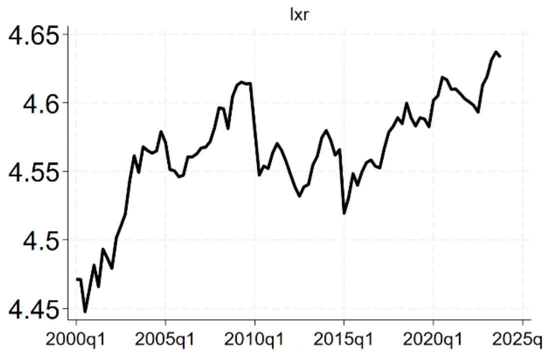
We accept the alternate hypothesis that $dlcpi$ is drift-stationary.

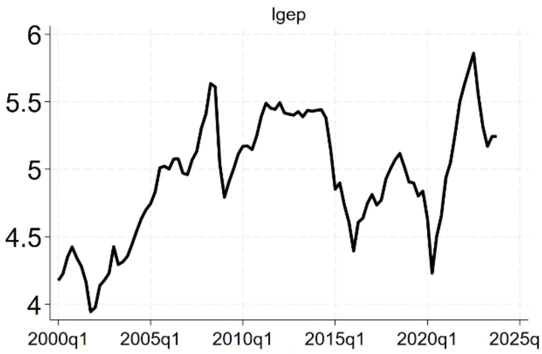
All stationary variables are displayed in Figure II.

Figure II



[3] Appendix 3
[4] Appendix 4
[5] Appendix 5
[6] Appendix 6





D. <u>*Estimating inflation as an ARMA model*</u>

$dlcpi$ will be estimated as an ARMA(p,q) model:

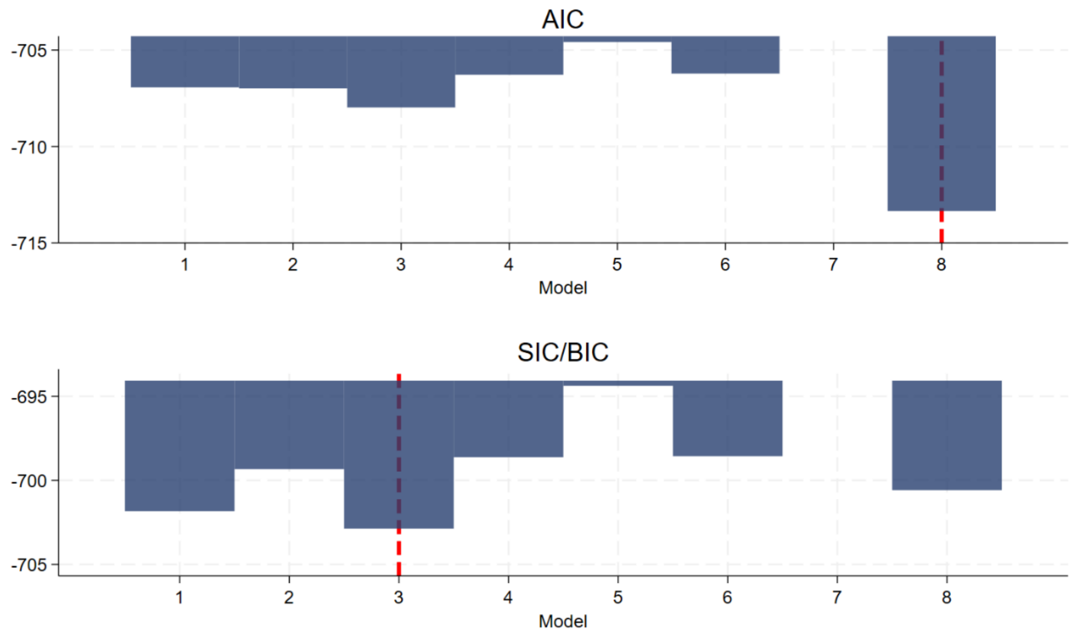
$$dlcpi_t = \alpha + \sum_{i=1}^{i=p} \beta_i dlcpi_{t-i} + \sum_{i=0}^{i=q} \gamma_i \epsilon_{t-i} + \epsilon_t$$

To select lags (p and q), I will be using the AIC and BIC up to a maximum of $p = q = 2$.

Table V

Model	**ARMA Specification**	**AIC**	**BIC**
1	(0,1)	-706.9376	-701.8299
2	(0,2)	-706.9988	-699.3292
3	(1,0)	-707.9764	-702.8686
4	(1,1)	-706.2838	-698.6222
5	(1,2)	-704.5892	-694.3737
6	(2,0)	-706.2211	-698.5594
7	(2,1)	-704.2863	-694.0708
8	(2,2)	-713.3489	-700.5795

Figure III



Shown in Figure III and Table V, AIC selects model 8, ARMA(2,2), whereas SIC/BIC selects model 3, ARMA(1,0), i.e., a pure AR(1) model[7]. The regression results are given as:

Model 3:[8]

$$dlcpi_t = \beta_1 dlcpi_{t-1} + \epsilon_t$$

Variable	Coefficient (Robust Std. Err)	p-value
$\boldsymbol{dlcpi_{t-1}}$	0.380355 (0.1405789)	0.000***

**** denotes the 1% significance level*

Model 8:[9]

$$dlcpi_t = \beta_1 dlcpi_{t-1} + \beta_2 dlcpi_{t-2} + \gamma_1 \epsilon_{t-1} + \gamma_2 \epsilon_{t-2} + \epsilon_t$$

Variable	Coefficient (Robust Std. Err)	p-value
$\boldsymbol{dlcpi_{t-1}}$	-0.899534 (0.2194136)	0.000***
$\boldsymbol{dlcpi_{t-2}}$	0.076611 (0.221312)	0.688
$\boldsymbol{\epsilon_{t-1}}$	1.427597 (0.1399993)	0.000***
$\boldsymbol{\epsilon_{t-2}}$	0.5024687 (0.1556634)	0.006***

**** denotes the 1% significance level*

I will exercise discretion and choose model 8 to estimate $dlcpi$ for two reasons. First, the extra parameters which it adds are mostly very significant and make theoretical sense;

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[7] Appendix 7

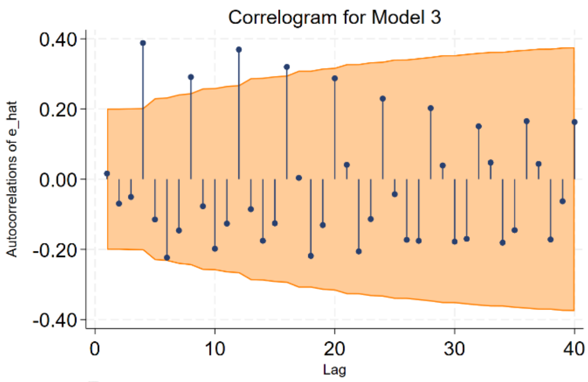
[8] Appendix 8

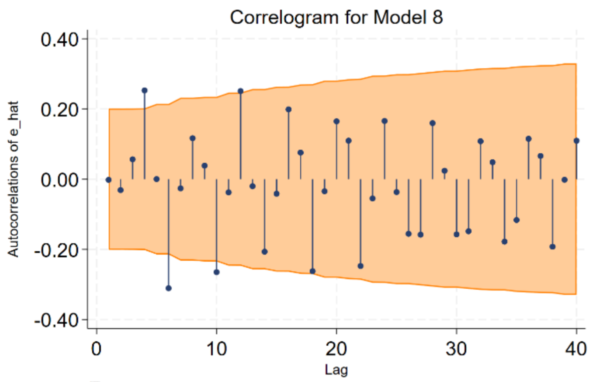
[9] *Appendix 9*. arima dlcpi, ar(1) robust

```
(setting optimization to BHHH)
Iteration 0:  Log pseudolikelihood =  355.98779
Iteration 1:  Log pseudolikelihood =  355.98812
Iteration 2:  Log pseudolikelihood =  355.98816
Iteration 3:  Log pseudolikelihood =  355.98817
Iteration 4:  Log pseudolikelihood =  355.98818

ARIMA regression

Sample: 2000q2 thru 2023q4                      Number of obs     =         95
                                                Wald chi2(1)      =       7.32
Log pseudolikelihood = 355.9882                 Prob > chi2       =     0.0068

------------------------------------------------------------------------------
             |             Semirobust
       dlcpi | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
dlcpi        |
       _cons |   .0046215   .0009386     4.92   0.000     .0027819    .0064611
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |    .380355   .1405789     2.71   0.007     .1048253    .6558846
-------------+----------------------------------------------------------------
      /sigma |   .0057014   .0005091    11.20   0.000     .0047036    .0066993
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.
```

Appendix 9

second, while the extra autoregressive term is insignificant, it decreases overall autocorrelation. This can be seen when estimating the correlogram for each model:





For these reasons, model 8, i.e., ARMA(2,2) is preferred for inflation estimation.

E. *Estimating inflation as an ARDL model*

$dlcpi$ will be estimated as an ARDL model:

$$dlcpi_t = \alpha + \sum_{i=1}^{i=p} \beta_i dlcpi_{t-i} + \sum_{i=0}^{i=q} \gamma_i lm_{t-i} + \sum_{i=0}^{i=r} \delta_i lxr_{t-i} + \sum_{i=0}^{i=s} \kappa_i lgep_{t-i} + \epsilon_t$$

Specification selection, i.e., choosing p, q, r, s, will be done on the basis of AIC/BIC testing and prevalence of autocorrelation. All 54 possible specification combinations will be checked and the entire table of results is available in Appendix 10.

Figure IV

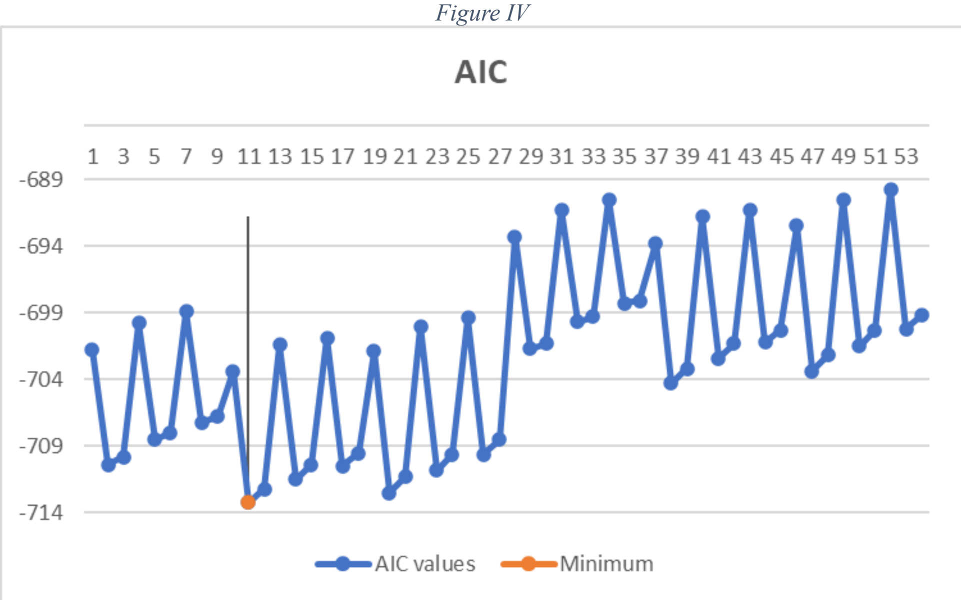
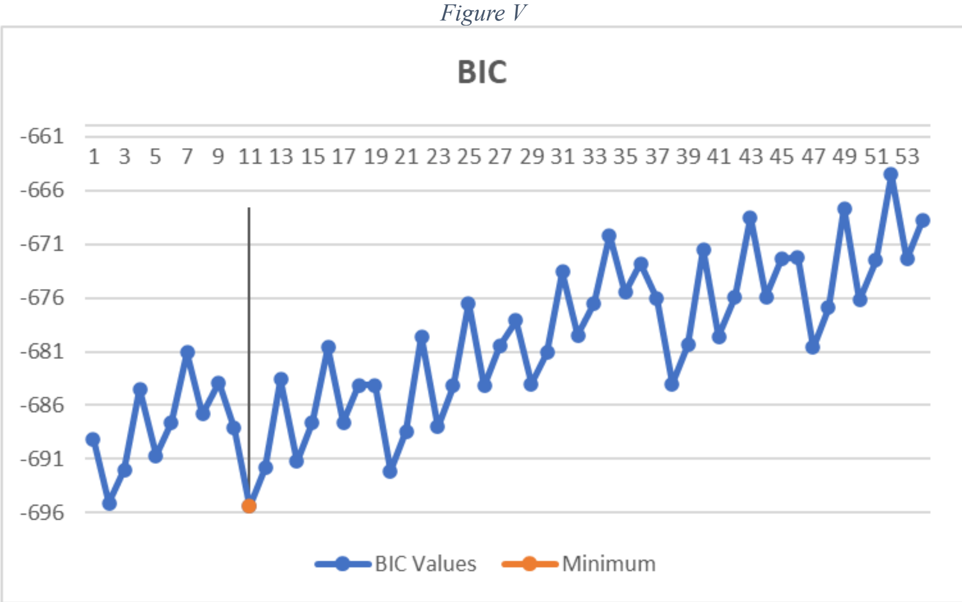


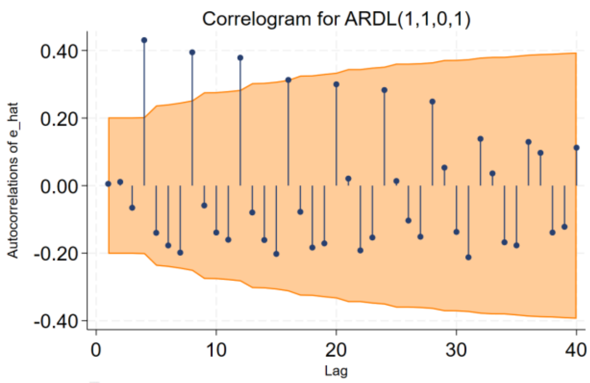
Figure V

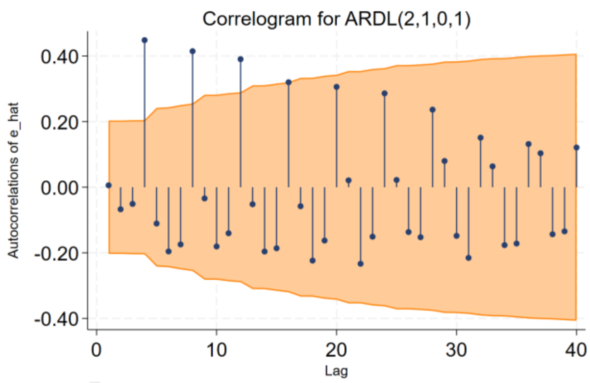


Model 11 is selected by both AIC and BIC, shown in Figure IV and Figure V.

This model does suffer from autocorrelation which can be eliminated by adjusting the model to ARDL(5,1,0,1). However, this is an overspecification beyond the specified constraint (maximum of 2 lags) and will not be considered. Instead, autocorrelation is compared between ARDL(2,1,0,1) and ARDL(1,1,0,1) in Figure VI.

Figure VI





Because the extra autoregressive term does not appear to decrease autocorrelation in any way, I will retain model 11, ARDL(1,0,1,1).

Model 11:

$$dlcpi_t = \beta_1 dlcpi_{t-1} + \gamma_1 lm_t + \gamma_2 lm_{t-1} + \delta_1 lxr_t + \kappa_1 lgep_t + \kappa_2 lgep_{t-1} + \epsilon_t$$

Table VI

Variable	**Coefficient (Robust Std. Err)**	**p-value**
$\boldsymbol{dlcpi_{t-1}}$	0.250 (0.124)	0.046**
$\boldsymbol{lm_t}$	0.0249 (0.0102)	0.016**

$\boldsymbol{lm_{t-1}}$	-0.0265 (0.00943)	0.006***
$\boldsymbol{lxr_t}$	-0.0105 (0.0185)	0.572
$\boldsymbol{lgep_t}$	0.0176 (0.00316)	0.000***
$\boldsymbol{lgep_{t-1}}$	-0.0134 (0.00277)	0.000***

*** denotes the 5% significance level*

**** denotes the 1% significance level*

Section IV: Panel Data Estimation

Inflation will be modelled using the Fixed Effect, Random Effect, and Pooled OLS Models (FEM, REM, POLS). Then I will test each model against each other to decide which provides the most consistent, efficient and unbiased estimators. The units and their corresponding time periods are shown in Table VII.

Table VII

Unit	Time Period
Denmark	2000Q1-2023Q4 [no omissions]
Sweden	2000Q1-2023Q4 [no omissions]
Norway	2000Q1-2023Q4 [no omissions]
Iceland	2000Q1-2023Q4 [no omissions]
United Kingdom	2000Q1-2023Q4 [no omissions]

A. *Defining and testing each model*

In the POLS, inflation is modelled as:

$$dlcpi_{it} = \beta_1 lm_{it} + \beta_2 lxr_{it} + \beta_3 lgep_{it} + \epsilon_{it}$$

In the FEM, inflation is modelled as:

$$d\ddot{lcpi}_{it} = \beta_1 l\ddot{m}_{it} + \beta_2 l\ddot{xr}_{it} + \beta_3 lg\ddot{ep}_{it} + \epsilon_{it}$$

Where $\ddot{z}_{it} = z_{it} - \bar{z}_i$, i.e., the variable has been de-meaned. It can also be modelled as:

$$dlcpi_{it} = \beta_1 lm_{it} + \beta_2 lxr_{it} + \beta_3 lgep_{it} + \sum_{j=1}^{j=N-1} \delta_j f_j + \epsilon_{it}$$

Where N is the total number of units.

In the REM, inflation is modelled as:

$$dlcpi_{it}^* = \beta_1 lm_{it}^* + \beta_2 lxr_{it}^* + \beta_3 lgep_{it}^* + \epsilon_{it}$$

Where $z_{it}^* = z_{it} - \lambda \bar{z}_{it}$ and $\lambda = 1 - \frac{\sigma_\epsilon}{\sqrt{T\sigma_u^2 + \sigma_\epsilon^2}}$, i.e., the variable has been de-meaned to a certain degree λ.

i. *FEM and POLS (F-test)*

The F-test for FEM and POLS tests to see if the coefficients $\delta_1, \dots, \delta_{N-1}$ of the fixed effect dummies $f_1, \dots, f_{N-1}$ in the FEM are jointly statistically significant.

$$H_0\text{: All } \delta_j = 0$$

The null hypothesis is rejected at the 1% significance level: $Prob > F = 0.0000$.[10] The FEM is preferred to the POLS.

ii. *REM and POLS (Breusch-Pagan test)*

The Breusch-Pagan test for REM and POLS tests for heterogeneity between units. If there is no heterogeneity, i.e., if $\sigma_u = 0$, then $\lambda = 0$ and the REM is the same as POLS.

$$H_0: \sigma_u = 0$$

The null hypothesis is rejected at the 1% significance level: $Prob > \bar{\chi}^2 = 0.0000$.[11] The REM is preferred to the POLS.

iii. *FEM and REM (Hausman test)*

The Hausman test for FEM and REM tests if $Cov(X_{it}, f_i) = 0$. If there is covariance, the variables must be fully de-meaned to preserve consistency and thus the FEM is preferred.

$$H_0: Cov(X_{it}, f_i) = 0$$

The null hypothesis is not rejected at any conventionally significance level: $Prob > \chi^2 = 0.1085$.[12] The REM is preferred to the FEM.

B. Results of the REM

After tests have concluded the model is re-estimated with cluster-robust standard errors.[13]

Variable	Coefficient (Robust Std. Error)	p-value
lm	-0.0012355 (0.0012365)	0.318
lxr	-0.0031661 (0.0041577)	0.446
$lgep$	0.005667 (0.0012543)	0.000***

**** denotes the 1% significance level*

Section V: Inflation Targeting Probit Estimation

[10] Appendix 11
[11] Appendix 12
[12] Appendix 13
[13] Appendix 14

Appendix

Appendix 1

*Estimated using a foreach loop in Stata. The name of the variable, e.g., lcpi, is at the top of each section followed by the results of the BG test looking at 4 lags of the error term, up to a maximum of 5 lags in the ADF test. Each variable section is then followed by a dashed line to indicate the next variable's estimation has begun. Output has been split into two columns to reduce pagination. The ADF test includes a **trend term**.*

```
. foreach v of varlist lcpi lm lxr lgep {
  2.        display "`v'"
  3.        display "Lags: 0"
  4.        quietly regress D.`v' L.`v' trend
  5.        estat bgodfrey, lags(1/4) nomiss0
  6.        forvalues lags = 1/5 {
  7.                display "Lags: `lags'"
  8.                quietly regress D.`v' L(1/`lags')D.`v' L.`v' trend
  9.                estat bgodfrey, lags(1/4) nomiss0
 10.        }
 11.        display "*-----------------*"
 12. }

lcpi
Lags: 0

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         15.522               1                   0.0001
       2     |         16.469               2                   0.0003
       3     |         18.263               3                   0.0004
       4     |         28.871               4                   0.0000
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.112               1                   0.7378
       2     |          2.358               2                   0.3076
       3     |         15.398               3                   0.0015
       4     |         22.773               4                   0.0001
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.284               1                   0.1307
       2     |         15.294               2                   0.0005
       3     |         14.431               3                   0.0024
       4     |         21.716               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 3

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         13.099               1                   0.0003
       2     |         20.590               2                   0.0000
       3     |         19.580               3                   0.0002
       4     |         19.510               4                   0.0006
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 4

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         10.241               1                   0.0014
       2     |          9.600               2                   0.0082
       3     |          9.516               3                   0.0232
       4     |         13.602               4                   0.0087
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 5

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.712               1                   0.3989
       2     |          0.758               2                   0.6844
       3     |          4.798               3                   0.1872
       4     |          5.159               4                   0.2714
---------------------------------------------------------------------------
                        H0: no serial correlation
*-----------------*
lm
Lags: 0

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.513               1                   0.1129
       2     |          3.532               2                   0.1710
       3     |          3.916               3                   0.2707
       4     |          4.498               4                   0.3428
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          1.045               1                   0.3065
       2     |          1.908               2                   0.3851
       3     |          2.318               3                   0.5091
       4     |          2.432               4                   0.6568
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.487               1                   0.4852
       2     |          0.954               2                   0.6205
       3     |          1.118               3                   0.7728
       4     |          1.954               4                   0.7442
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 3

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.674               1                   0.4115
       2     |          0.680               2                   0.7117
       3     |          1.444               3                   0.6953
       4     |          2.043               4                   0.7278
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 4

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.048               1                   0.8259
       2     |          0.884               2                   0.6429
       3     |          2.181               3                   0.5358
       4     |          7.039               4                   0.1338
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 5

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.815               1                   0.3668
       2     |          1.882               2                   0.3903
       3     |          6.664               3                   0.0834
       4     |          7.755               4                   0.1010
---------------------------------------------------------------------------
                        H0: no serial correlation
*-----------------*
lxr
Lags: 0

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.349               1                   0.5548
       2     |          1.141               2                   0.5654
       3     |          7.332               3                   0.0620
       4     |         10.069               4                   0.0393
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.524               1                   0.4692
       2     |          6.704               2                   0.0350
       3     |          9.631               3                   0.0220
       4     |          8.957               4                   0.0622
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          6.436               1                   0.0112
```

```
       2    |        9.533              2                   0.0085
       3    |       10.641              3                   0.0138
       4    |       10.119              4                   0.0385
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 3

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        3.419              1                   0.0644
       2    |        6.294              2                   0.0430
       3    |        6.598              3                   0.0859
       4    |        9.300              4                   0.0540
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 4

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        3.080              1                   0.0792
       2    |        3.800              2                   0.1496
       3    |        7.488              3                   0.0579
       4    |        8.155              4                   0.0861
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 5

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        1.058              1                   0.3036
       2    |        3.835              2                   0.1470
       3    |        4.354              3                   0.2257
       4    |        4.601              4                   0.3308
---------------------------------------------------------------------------
                       H0: no serial correlation
*-----------------*
lgep
Lags: 0

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |       14.588              1                   0.0001
       2    |       14.576              2                   0.0007
       3    |       14.406              3                   0.0024
       4    |       14.619              4                   0.0056
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 1

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        0.261              1                   0.6093
       2    |        0.293              2                   0.8636
       3    |        0.235              3                   0.9718
       4    |        0.340              4                   0.9871
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 2

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        0.039              1                   0.8443
       2    |        0.099              2                   0.9517
       3    |        0.266              3                   0.9664
       4    |        0.548              4                   0.9687
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 3

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        0.050              1                   0.8237
       2    |        0.200              2                   0.9049
       3    |        0.441              3                   0.9316
       4    |        1.328              4                   0.8566
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 4

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        0.104              1                   0.7469
       2    |        0.271              2                   0.8732
       3    |        0.899              3                   0.8257
       4    |        0.923              4                   0.9213
---------------------------------------------------------------------------
                       H0: no serial correlation
Lags: 5

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1    |        0.123              1                   0.7254
       2    |        0.876              2                   0.6452
       3    |        1.435              3                   0.6974
       4    |        2.940              4                   0.5679
---------------------------------------------------------------------------
                       H0: no serial correlation
*-----------------*
```

Appendix 2

ADF test using trend term for $lcpi, lm, lxr$ and drift term for $lgep$. Horizontal lines added to split output into variable sections.

```
. dfuller lcpi, lags(5) trend

Augmented Dickey-Fuller test for unit root

Variable: lcpi                          Number of obs  = 90
                                        Number of lags =  5

H0: Random walk with or without drift

                                       Dickey-Fuller
                   Test      -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -2.131       -4.062       -3.460       -3.156
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.5289
```

```
. dfuller lm, trend

Dickey-Fuller test for unit root        Number of obs  = 95
Variable: lm                            Number of lags =  0

H0: Random walk with or without drift

                                       Dickey-Fuller
                   Test      -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -1.616       -4.051       -3.455       -3.153
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7861.
```

```
. dfuller lxr, lags(3) trend

Augmented Dickey-Fuller test for unit root

Variable: lxr                           Number of obs  = 92
                                        Number of lags =  3
```

```
H0: Random walk with or without drift

                                          Dickey–Fuller
                 Test        -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -3.271       -4.058       -3.458       -3.155
--------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0712.
```

```
. dfuller lgep, lags(1) drift

Augmented Dickey–Fuller test for unit root

Variable: lgep                           Number of obs  = 94
                                         Number of lags =  1

H0: Random walk with drift, d = 0

                                         t-distribution
                 Test        -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -2.568       -2.368       -1.662       -1.291
--------------------------------------------------------------
p-value for Z(t) = 0.0059
```

Appendix 3

Estimated using a foreach loop in Stata. The name of the variable, e.g., lcpi, is at the top of each section followed by the results of the BG test looking at 4 lags of the error term, up to a maximum of 5 lags in the ADF test. Each variable section is then followed by a dashed line to indicate the next variable's estimation has begun. Output has been columnated to reduce pagination. The ADF test includes a ***drift term***

```
. foreach v of varlist lcpi lm lxr lgep {
  2.         display "`v'"
  3.         display "Lags: 0"
  4.         quietly regress D.`v' L.`v'
  5.         estat bgodfrey, lags(1/4) nomiss0
  6.         forvalues lags = 1/5 {
  7.                 display "Lags: `lags'"
  8.                 quietly regress D.`v' L(1/`lags')D.`v' L.`v'
  9.                 estat bgodfrey, lags(1/4) nomiss0
 10.         }
 11.         display "*-----------------*"
 12. }
lcpi
Lags: 0

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         13.451               1                   0.0002
       2     |         14.315               2                   0.0008
       3     |         15.226               3                   0.0016
       4     |         21.778               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.300               1                   0.5839
       2     |          1.331               2                   0.5139
       3     |          9.225               3                   0.0264
       4     |         22.072               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.992               1                   0.3193
       2     |          8.887               2                   0.0118
       3     |         21.834               3                   0.0001
       4     |         21.661               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 3

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          7.893               1                   0.0050
       2     |         20.768               2                   0.0000
       3     |         20.442               3                   0.0001
       4     |         20.547               4                   0.0004
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 4

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |         15.204               1                   0.0001
       2     |         15.393               2                   0.0005
       3     |         15.608               3                   0.0014
       4     |         18.000               4                   0.0012
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 5

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          1.482               1                   0.2235
       2     |          1.910               2                   0.3847
       3     |          4.187               3                   0.2420
       4     |          5.560               4                   0.2345
---------------------------------------------------------------------------
                        H0: no serial correlation
*-----------------*
lm
Lags: 0

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          2.122               1                   0.1452
       2     |          2.793               2                   0.2474
       3     |          3.303               3                   0.3472
       4     |          3.642               4                   0.4566
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.715               1                   0.3977
       2     |          1.701               2                   0.4272
       3     |          1.824               3                   0.6096
       4     |          2.000               4                   0.7357
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.674               1                   0.4118
       2     |          0.850               2                   0.6538
       3     |          1.059               3                   0.7870
       4     |          2.289               4                   0.6827
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 3

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.398               1                   0.5281
       2     |          0.463               2                   0.7934
```

lags(p)	chi2	df	Prob > chi2
3	1.657	3	0.6464
4	2.587	4	0.6292

H0: no serial correlation

Lags: 4

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.115	1	0.7350
2	1.354	2	0.5082
3	2.863	3	0.4132
4	6.626	4	0.1570

H0: no serial correlation

Lags: 5

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	1.232	1	0.2671
2	2.450	2	0.2938
3	6.109	3	0.1064
4	9.148	4	0.0575

H0: no serial correlation

----

lxr

Lags: 0

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.143	1	0.7049
2	0.873	2	0.6464
3	5.573	3	0.1343
4	9.625	4	0.0472

H0: no serial correlation

Lags: 1

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.484	1	0.4866
2	5.191	2	0.0746
3	9.390	3	0.0245
4	8.767	4	0.0672

H0: no serial correlation

Lags: 2

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	4.962	1	0.0259
2	9.383	2	0.0092
3	11.411	3	0.0097
4	10.156	4	0.0379

H0: no serial correlation

Lags: 3

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	4.735	1	0.0296
2	8.342	2	0.0154
3	8.134	3	0.0433
4	10.126	4	0.0384

H0: no serial correlation

Lags: 4

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	3.883	1	0.0488
2	4.222	2	0.1211
3	7.269	3	0.0638
4	7.522	4	0.1107

H0: no serial correlation

Lags: 5

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.713	1	0.3984
2	2.754	2	0.2523
3	2.880	3	0.4105
4	3.511	4	0.4762

H0: no serial correlation

----

lgep

Lags: 0

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	13.833	1	0.0002
2	13.977	2	0.0009
3	13.824	3	0.0032
4	14.161	4	0.0068

H0: no serial correlation

Lags: 1

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.466	1	0.4950
2	0.453	2	0.7972
3	0.350	3	0.9503
4	0.449	4	0.9783

H0: no serial correlation

Lags: 2

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.004	1	0.9503
2	0.076	2	0.9625
3	0.277	3	0.9642
4	0.451	4	0.9781

H0: no serial correlation

Lags: 3

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.058	1	0.8101
2	0.249	2	0.8831
3	0.401	3	0.9400
4	1.012	4	0.9080

H0: no serial correlation

Lags: 4

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.153	1	0.6956
2	0.275	2	0.8714
3	0.972	3	0.8080
4	1.621	4	0.8051

H0: no serial correlation

Lags: 5

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.096	1	0.7564
2	0.839	2	0.6572
3	1.488	3	0.6850
4	3.106	4	0.5402

H0: no serial correlation

Appendix 4

ADF test using drift term for $lcpi, lm, lxr$. Horizontal lines added to split output into variable sections.

```
. dfuller lcpi, lags(5) drift

Augmented Dickey–Fuller test for unit root

Variable: lcpi                            Number of obs  = 90
                                          Number of lags =  5

H0: Random walk with drift, d = 0

                                    t-distribution
                   Test      -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -0.286       -2.372       -1.663       -1.292
--------------------------------------------------------------
p-value for Z(t) = 0.3879
```

```
. dfuller lm, drift

Dickey–Fuller test for unit root          Number of obs  = 95
Variable: lm                              Number of lags =  0

H0: Random walk with drift, d = 0

                                    t-distribution
                   Test      -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -1.937       -2.367       -1.661       -1.291
--------------------------------------------------------------
p-value for Z(t) = 0.0279
```

```
. dfuller lxr, lags(4) drift

Augmented Dickey–Fuller test for unit root

Variable: lxr                             Number of obs  = 91
                                          Number of lags =  4

H0: Random walk with drift, d = 0

                                    t-distribution
                   Test      -------- critical value ---------
              statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)            -2.095       -2.371       -1.663       -1.292
--------------------------------------------------------------
p-value for Z(t) = 0.0196
```

Appendix 5

Estimated using a foreach loop in Stata. The ADF test includes a ***drift term***

```
. foreach v of varlist D.lcpi {
  2.         display "`v'"
  3.         display "Lags: 0"
  4.         quietly regress D.`v' L.`v'
  5.         estat bgodfrey, lags(1/4) nomiss0
  6.         forvalues lags = 1/5 {
  7.                 display "Lags: `lags'"
  8.                 quietly regress D.`v' L(1/`lags')D.`v' L.`v'
  9.                 estat bgodfrey, lags(1/4) nomiss0
 10.         }
 11.         display "*-----------------*"
 12. }
D.lcpi
Lags: 0

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.261               1                   0.6092
       2     |          1.283               2                   0.5265
       3     |          8.876               3                   0.0310
       4     |         22.001               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 1

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
       1     |          0.920               1                   0.3374
       2     |          8.535               2                   0.0140
       3     |         21.670               3                   0.0001
       4     |         21.553               4                   0.0002
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 2

Breusch–Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
```

```
        1    |          7.627              1                   0.0058
        2    |         20.688              2                   0.0000
        3    |         20.412              3                   0.0001
        4    |         20.398              4                   0.0004
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 3

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
        1    |         15.287              1                   0.0001
        2    |         15.647              2                   0.0004
        3    |         15.757              3                   0.0013
        4    |         18.242              4                   0.0011
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 4

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
        1    |          1.411              1                   0.2348
        2    |          1.737              2                   0.4197
        3    |          4.249              3                   0.2358
        4    |          5.497              4                   0.2400
---------------------------------------------------------------------------
                        H0: no serial correlation
Lags: 5

Breusch-Godfrey LM test for autocorrelation
---------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+-------------------------------------------------------------
        1    |          0.349              1                   0.5547
        2    |          3.125              2                   0.2096
        3    |          4.429              3                   0.2187
        4    |          5.378              4                   0.2507
---------------------------------------------------------------------------
                        H0: no serial correlation
```

Appendix 6

ADF test using drift term for dlcpi.

```
. dfuller d.lcpi, lags(4) drift

Augmented Dickey-Fuller test for unit root

Variable: D.lcpi                           Number of obs  = 90
                                           Number of lags =  4

H0: Random walk with drift, d = 0

                                       t-distribution
               Test      -------- critical value ---------
             statistic           1%           5%          10%
--------------------------------------------------------------
 Z(t)           -4.114       -2.372       -1.663       -1.292
--------------------------------------------------------------
p-value for Z(t) = 0.0000
```

Appendix 7

```
. eststo ARMA: arimasel d.lcpi, ar(2) ma(2)
Model1: AR(0) MA(1)
Model2: AR(0) MA(2)
Model3: AR(1) MA(0)
Model4: AR(1) MA(1)
Model5: AR(1) MA(2)
Model6: AR(2) MA(0)
Model7: AR(2) MA(1)
Model8: AR(2) MA(2)

             |        AR          MA      Nparm         LLF         AIC         SIC
-------------+---------------------------------------------------------------------
      Model1 |         0           1          2    355.4688   -706.9376   -701.8299
      Model2 |         0           2          3    356.4954   -706.9908   -699.3292
      Model3 |         1           0          2    355.9882   -707.9764   -702.8686
      Model4 |         1           1          3    356.1419   -706.2838   -698.6222
      Model5 |         1           2          4    356.2946   -704.5892   -694.3737
      Model6 |         2           0          3    356.1105   -706.2211   -698.5594
      Model7 |         2           1          4    356.1431   -704.2863   -694.0708
      Model8 |         2           2          5    361.6745   -713.3489   -700.5795
```

Appendix 8

```
. arima dlcpi, ar(1) robust

(setting optimization to BHHH)
Iteration 0:  Log pseudolikelihood =  355.98779
Iteration 1:  Log pseudolikelihood =  355.98812
Iteration 2:  Log pseudolikelihood =  355.98816
Iteration 3:  Log pseudolikelihood =  355.98817
Iteration 4:  Log pseudolikelihood =  355.98818

ARIMA regression

Sample: 2000q2 thru 2023q4                      Number of obs     =         95
                                                Wald chi2(1)      =       7.32
Log pseudolikelihood = 355.9882                 Prob > chi2       =     0.0068

------------------------------------------------------------------------------
             |             Semirobust
       dlcpi | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
dlcpi        |
       _cons |   .0046215   .0009386     4.92   0.000     .0027819    .0064611
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |    .380355   .1405789     2.71   0.007     .1048253    .6558846
-------------+----------------------------------------------------------------
      /sigma |   .0057014   .0005091    11.20   0.000     .0047036    .0066993
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.
```

Appendix 9

```
. arima dlcpi, ar(1/2) ma(1/2) robust

(setting optimization to BHHH)
Iteration 0:  Log pseudolikelihood =  347.23067
Iteration 1:  Log pseudolikelihood =  352.68152
Iteration 2:  Log pseudolikelihood =  353.68017
Iteration 3:  Log pseudolikelihood =  355.04277
Iteration 4:  Log pseudolikelihood =  359.79432
(switching optimization to BFGS)
Iteration 5:  Log pseudolikelihood =   361.0122
Iteration 6:  Log pseudolikelihood =  361.10737
Iteration 7:  Log pseudolikelihood =  361.39219
Iteration 8:  Log pseudolikelihood =  361.61468
Iteration 9:  Log pseudolikelihood =  361.65691
Iteration 10: Log pseudolikelihood =  361.65801
Iteration 11: Log pseudolikelihood =  361.67069
Iteration 12: Log pseudolikelihood =  361.67379
Iteration 13: Log pseudolikelihood =  361.67444
Iteration 14: Log pseudolikelihood =  361.67445

ARIMA regression

Sample: 2000q2 thru 2023q4                      Number of obs     =         95
                                                Wald chi2(4)      =     680.78
Log pseudolikelihood = 361.6745                 Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |             Semirobust
       dlcpi | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
dlcpi        |
       _cons |   .0045876   .0008768     5.23   0.000     .0028691    .0063061
-------------+----------------------------------------------------------------
ARMA         |
          ar |
         L1. |  -.8995348   .2194136    -4.10   0.000    -1.329578   -.4694921
         L2. |    .076611    .221312     0.35   0.729    -.3571526    .5103746
             |
          ma |
         L1. |   1.427597   .1399993    10.20   0.000     1.153203    1.701991
         L2. |   .5024687   .1556634     3.23   0.001      .197374    .8075633
-------------+----------------------------------------------------------------
      /sigma |   .0053414   .0005515     9.68   0.000     .0042605    .0064224
------------------------------------------------------------------------------
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.
```

Appendix 10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi
L.Dlcpi	0.278*	0.284*	0.317*	0.278*	0.283*	0.316*	0.280*	0.285*	0.321*	0.247	0.250*	0.278*	0.246	0.249*
	(0.136)	(0.129)	(0.132)	(0.137)	(0.130)	(0.133)	(0.137)	(0.131)	(0.134)	(0.130)	(0.124)	(0.127)	(0.131)	(0.124)
L2.Dlcpi														
lm	-0.00451	-0.00219	-0.00310	-0.00450	-0.00182	-0.00274	-0.00541*	-0.00252	-0.00359	0.0200	0.0249*	0.0227*	0.0202	0.0258*
	(0.00236)	(0.00220)	(0.00230)	(0.00259)	(0.00245)	(0.00253)	(0.00258)	(0.00249)	(0.00257)	(0.0106)	(0.0102)	(0.0105)	(0.0106)	(0.0104)
lxr	0.00884	-0.00258	0.00119	0.00930	0.0130	0.0158	0.0121	0.0148	0.0181	0.00200	-0.0105	-0.00715	0.00653	0.0101
	(0.0207)	(0.0198)	(0.0196)	(0.0429)	(0.0416)	(0.0425)	(0.0429)	(0.0416)	(0.0424)	(0.0203)	(0.0185)	(0.0186)	(0.0421)	(0.0393)
lgep	0.00495**	0.0166***	0.0185***	0.00495**	0.0168***	0.0188***	0.00464**	0.0163***	0.0183***	0.00550**	0.0176***	0.0191***	0.00552**	0.0180***
	(0.00167)	(0.00312)	(0.00350)	(0.00169)	(0.00318)	(0.00350)	(0.00168)	(0.00318)	(0.00345)	(0.00173)	(0.00316)	(0.00345)	(0.00174)	(0.00325)
L.lgep		-0.0129***	-0.0197***		-0.0131***	-0.0198***		-0.0128***	-0.0199***		-0.0134***	-0.0187***		-0.0137***
		(0.00283)	(0.00525)		(0.00283)	(0.00519)		(0.00277)	(0.00507)		(0.00277)	(0.00506)		(0.00279)
L2.lgep			0.00536			0.00532			0.00565			0.00418		
			(0.00352)			(0.00354)			(0.00349)			(0.00343)		
L.lxr				-0.000564	-0.0192	-0.0181	-0.0460	-0.0506	-0.0536				-0.00556	-0.0256
				(0.0477)	(0.0450)	(0.0459)	(0.0596)	(0.0564)	(0.0572)				(0.0462)	(0.0428)
L2.lxr							0.0534	0.0375	0.0424					
							(0.0418)	(0.0410)	(0.0410)					
L.lm										-0.0241*	-0.0265**	-0.0250*	-0.0242*	-0.0269**
										(0.00982)	(0.00943)	(0.00957)	(0.00980)	(0.00959)
L2.lm														
_cons	0.00164	0.0273	0.0202	0.00196	0.0386	0.0309	-0.0330	0.0133	0.00164	0.0240	0.0529	0.0459	0.0273	0.0684
	(0.0782)	(0.0769)	(0.0755)	(0.0844)	(0.0802)	(0.0786)	(0.0889)	(0.0867)	(0.0860)	(0.0768)	(0.0723)	(0.0714)	(0.0821)	(0.0753)
N	94	94	94	94	94	94	94	94	94	94	94	94	94	94
aic	-701.8	-710.4	-709.8	-699.8	-708.5	-708.0	-698.9	-707.2	-706.8	-703.4	-713.2	-712.2	-701.4	-711.5
bic	-689.1	-695.1	-692.0	-684.5	-690.7	-687.6	-681.1	-686.8	-683.9	-688.1	-695.4	-691.8	-683.6	-691.2

	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi
L.Dlcpi	0.276*	0.248	0.250*	0.280*	0.227	0.223	0.250	0.227	0.221	0.248	0.231	0.224	0.254	0.327*
	(0.127)	(0.132)	(0.125)	(0.128)	(0.141)	(0.133)	(0.137)	(0.142)	(0.133)	(0.138)	(0.143)	(0.134)	(0.139)	(0.145)
L2.Dlcpi														-0.107
														(0.0847)
lm	0.0236*	0.0203	0.0257*	0.0233*	0.0192	0.0239*	0.0219*	0.0194	0.0249*	0.0228*	0.0196	0.0249*	0.0226*	-0.00492*
	(0.0107)	(0.0107)	(0.0105)	(0.0108)	(0.0107)	(0.0102)	(0.0105)	(0.0107)	(0.0104)	(0.0107)	(0.0109)	(0.0106)	(0.0109)	(0.00241)
lxr	0.0124	0.00953	0.0122	0.0148	-0.000623	-0.0145	-0.0112	0.00423	0.00692	0.00922	0.00738	0.00904	0.0117	0.00501
	(0.0401)	(0.0421)	(0.0392)	(0.0400)	(0.0206)	(0.0186)	(0.0187)	(0.0432)	(0.0397)	(0.0405)	(0.0429)	(0.0394)	(0.0403)	(0.0213)
lgep	0.0194***	0.00520**	0.0174***	0.0189***	0.00584**	0.0184***	0.0198***	0.00587**	0.0188***	0.0201***	0.00551**	0.0182***	0.0196***	0.00526**
	(0.00348)	(0.00173)	(0.00325)	(0.00344)	(0.00175)	(0.00319)	(0.00345)	(0.00177)	(0.00327)	(0.00347)	(0.00177)	(0.00326)	(0.00342)	(0.00173)
L.lgep	-0.0188***		-0.0133***	-0.0189***		-0.0138***	-0.0186***		-0.0140***	-0.0188***		-0.0137***	-0.0188***	
	(0.00500)		(0.00275)	(0.00488)		(0.00279)	(0.00510)		(0.00278)	(0.00504)		(0.00273)	(0.00491)	
L2.lgep	0.00411			0.00445			0.00388			0.00380			0.00414	
	(0.00345)			(0.00338)			(0.00345)			(0.00348)			(0.00341)	
L.lxr	-0.0243	-0.0569	-0.0628	-0.0644				-0.00597	-0.0267	-0.0255	-0.0551	-0.0603	-0.0620	
	(0.0438)	(0.0591)	(0.0554)	(0.0566)				(0.0473)	(0.0439)	(0.0448)	(0.0592)	(0.0551)	(0.0567)	
L2.lxr		0.0602	0.0442	0.0477							0.0576	0.0399	0.0435	
		(0.0408)	(0.0399)	(0.0403)							(0.0413)	(0.0405)	(0.0410)	
L.lm	-0.0254*	-0.0253*	-0.0276**	-0.0261*	-0.0134	-0.0117	-0.0111	-0.0135	-0.0119	-0.0113	-0.0158	-0.0136	-0.0131	
	(0.00970)	(0.0101)	(0.00989)	(0.01000)	(0.0164)	(0.0155)	(0.0155)	(0.0164)	(0.0157)	(0.0157)	(0.0171)	(0.0163)	(0.0164)	
L2.lm					-0.00990	-0.0138	-0.0131	-0.00992	-0.0139	-0.0132	-0.00874	-0.0130	-0.0122	
					(0.0114)	(0.0107)	(0.0107)	(0.0115)	(0.0108)	(0.0108)	(0.0117)	(0.0111)	(0.0112)	
_cons	0.0607	-0.0109	0.0393	0.0286	0.0339	0.0675	0.0602	0.0374	0.0838	0.0760	-0.000359	0.0565	0.0455	0.0236
	(0.0744)	(0.0866)	(0.0822)	(0.0816)	(0.0781)	(0.0734)	(0.0727)	(0.0836)	(0.0771)	(0.0766)	(0.0893)	(0.0853)	(0.0851)	(0.0813)
N	94	94	94	94	94	94	94	94	94	94	94	94	94	93
aic	-710.4	-700.9	-710.5	-709.5	-701.9	-712.5	-711.3	-700.0	-710.8	-709.6	-699.4	-709.6	-708.5	-693.3
bic	-687.6	-680.6	-687.6	-684.1	-684.1	-692.1	-688.4	-679.6	-688.0	-684.2	-676.5	-684.2	-680.5	-678.1

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)
Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi
0.301*	0.340*	0.327*	0.301*	0.339*	0.329*	0.303*	0.344*	0.284*	0.245	0.278*	0.284*	0.244
(0.131)	(0.134)	(0.145)	(0.133)	(0.135)	(0.147)	(0.134)	(0.138)	(0.140)	(0.124)	(0.128)	(0.141)	(0.125)
0.00320	-0.00731	-0.106	0.00238	-0.00795	-0.106	0.000231	-0.0110	-0.0692	0.0611	0.0490	-0.0692	0.0600
(0.0884)	(0.0904)	(0.0861)	(0.0889)	(0.0910)	(0.0869)	(0.0900)	(0.0920)	(0.0887)	(0.0906)	(0.0924)	(0.0896)	(0.0905)
-0.00199	-0.00300	-0.00501	-0.00186	-0.00290	-0.00590*	-0.00256	-0.00376	0.0164	0.0255*	0.0228*	0.0164	0.0261*
(0.00229)	(0.00240)	(0.00264)	(0.00253)	(0.00262)	(0.00266)	(0.00260)	(0.00271)	(0.0112)	(0.0110)	(0.0114)	(0.0113)	(0.0113)
-0.0102	-0.00618	0.000544	-0.00440	-0.00157	0.00328	-0.00237	0.000922	-0.000310	-0.0182	-0.0146	-0.000497	-0.00618
(0.0204)	(0.0199)	(0.0445)	(0.0420)	(0.0427)	(0.0447)	(0.0422)	(0.0429)	(0.0214)	(0.0198)	(0.0198)	(0.0450)	(0.0414)
0.0171***	0.0190***	0.00524**	0.0171***	0.0191***	0.00493**	0.0166***	0.0186***	0.00561**	0.0185***	0.0198***	0.00561**	0.0186***
(0.00329)	(0.00368)	(0.00175)	(0.00333)	(0.00368)	(0.00174)	(0.00333)	(0.00363)	(0.00176)	(0.00330)	(0.00357)	(0.00178)	(0.00336)
-0.0135***	-0.0205***		-0.0136***	-0.0205***		-0.0132***	-0.0205***		-0.0146***	-0.0198***		-0.0148***
(0.00310)	(0.00548)		(0.00310)	(0.00548)		(0.00304)	(0.00532)		(0.00297)	(0.00525)		(0.00298)
	0.00559			0.00557			0.00591			0.00419		
	(0.00352)			(0.00354)			(0.00350)			(0.00353)		
		0.00531	-0.00693	-0.00555	-0.0397	-0.0379	-0.0409				0.000225	-0.0146
		(0.0487)	(0.0451)	(0.0460)	(0.0604)	(0.0572)	(0.0582)				(0.0480)	(0.0438)
					0.0530	0.0368	0.0421					
					(0.0418)	(0.0413)	(0.0415)					
								-0.0208*	-0.0266*	-0.0247*	-0.0208*	-0.0269*
								(0.0104)	(0.0101)	(0.0102)	(0.0104)	(0.0103)
0.0599	0.0529	0.0211	0.0633	0.0557	-0.0135	0.0382	0.0264	0.0386	0.0821	0.0752	0.0385	0.0895
(0.0776)	(0.0752)	(0.0865)	(0.0811)	(0.0788)	(0.0913)	(0.0877)	(0.0865)	(0.0817)	(0.0754)	(0.0741)	(0.0856)	(0.0781)
93	93	93	93	93	93	93	93	93	93	93	93	93
-701.7	-701.3	-691.3	-699.7	-699.3	-690.5	-698.3	-698.1	-693.8	-704.3	-703.2	-691.8	-702.4
-684.0	-681.1	-673.6	-679.5	-676.5	-670.2	-675.5	-672.8	-676.1	-684.0	-680.4	-671.5	-679.6

(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)
Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi	Dlcpi
0.277*	0.285*	0.245	0.281*	0.266	0.222	0.255	0.266	0.221	0.253	0.269	0.223	0.258
(0.130)	(0.142)	(0.126)	(0.132)	(0.149)	(0.132)	(0.138)	(0.151)	(0.134)	(0.140)	(0.152)	(0.135)	(0.142)
0.0481	-0.0661	0.0590	0.0461	-0.0780	0.0523	0.0414	-0.0781	0.0511	0.0404	-0.0742	0.0507	0.0391
(0.0923)	(0.0904)	(0.0907)	(0.0923)	(0.0891)	(0.0916)	(0.0932)	(0.0899)	(0.0913)	(0.0929)	(0.0908)	(0.0914)	(0.0929)
0.0233*	0.0166	0.0260*	0.0230	0.0153	0.0243*	0.0218	0.0153	0.0249*	0.0224	0.0157	0.0249*	0.0222
(0.0116)	(0.0114)	(0.0114)	(0.0117)	(0.0114)	(0.0111)	(0.0115)	(0.0114)	(0.0113)	(0.0117)	(0.0117)	(0.0115)	(0.0118)
-0.00394	0.00249	-0.00386	-0.00124	-0.00287	-0.0216	-0.0181	-0.00226	-0.00845	-0.00624	0.000787	-0.00619	-0.00358
(0.0420)	(0.0453)	(0.0416)	(0.0421)	(0.0217)	(0.0197)	(0.0197)	(0.0463)	(0.0418)	(0.0424)	(0.0462)	(0.0418)	(0.0424)
0.0200***	0.00529**	0.0181***	0.0195***	0.00601**	0.0192***	0.0204***	0.00601**	0.0193***	0.0206***	0.00566**	0.0188***	0.0201***
(0.00359)	(0.00176)	(0.00337)	(0.00356)	(0.00178)	(0.00334)	(0.00359)	(0.00181)	(0.00340)	(0.00361)	(0.00181)	(0.00340)	(0.00357)
-0.0198***		-0.0144***	-0.0198***		-0.0149***	-0.0197***		-0.0150***	-0.0197***		-0.0146***	-0.0198***
(0.00523)		(0.00293)	(0.00508)		(0.00300)	(0.00531)		(0.00299)	(0.00528)		(0.00294)	(0.00513)
0.00415			0.00449			0.00394			0.00389			0.00422
(0.00355)			(0.00348)			(0.00353)			(0.00357)			(0.00350)
-0.0130	-0.0502	-0.0509	-0.0522				-0.000725	-0.0160	-0.0144	-0.0486	-0.0489	-0.0503
(0.0447)	(0.0608)	(0.0561)	(0.0575)				(0.0493)	(0.0449)	(0.0459)	(0.0609)	(0.0559)	(0.0576)
	0.0590	0.0429	0.0465							0.0562	0.0390	0.0426
	(0.0410)	(0.0395)	(0.0402)							(0.0414)	(0.0400)	(0.0407)
-0.0250*	-0.0220*	-0.0276*	-0.0256*	-0.00908	-0.0123	-0.0112	-0.00909	-0.0125	-0.0114	-0.0115	-0.0141	-0.0130
(0.0104)	(0.0107)	(0.0105)	(0.0106)	(0.0169)	(0.0163)	(0.0163)	(0.0169)	(0.0164)	(0.0164)	(0.0176)	(0.0169)	(0.0169)
				-0.0107	-0.0131	-0.0124	-0.0107	-0.0132	-0.0125	-0.00946	-0.0123	-0.0115
				(0.0114)	(0.0107)	(0.0107)	(0.0115)	(0.0109)	(0.0108)	(0.0116)	(0.0111)	(0.0112)
0.0819	0.000912	0.0609	0.0502	0.0485	0.0950	0.0879	0.0489	0.103	0.0954	0.0119	0.0762	0.0653
(0.0771)	(0.0904)	(0.0854)	(0.0848)	(0.0828)	(0.0760)	(0.0750)	(0.0869)	(0.0793)	(0.0786)	(0.0926)	(0.0874)	(0.0872)
93	93	93	93	93	93	93	93	93	93	93	93	93
-701.3	-691.3	-701.2	-700.3	-692.5	-703.4	-702.2	-690.5	-701.5	-700.3	-689.8	-700.2	-699.2
-675.9	-668.5	-675.9	-672.4	-672.2	-680.6	-676.9	-667.7	-676.2	-672.5	-664.5	-672.4	-668.8

Appendix 11

```
. xtreg dlcpi lm lxr lgep, fe

Fixed-effects (within) regression               Number of obs      =       475
Group variable: countryID                       Number of groups   =         5
```

```
R-squared:                                      Obs per group:
     Within  = 0.0915                                        min =         95
     Between = 0.0248                                        avg =       95.0
     Overall = 0.0718                                        max =         95

                                                F(3, 467)         =      15.68
corr(u_i, Xb) = -0.0684                         Prob > F          =     0.0000

------------------------------------------------------------------------------
       dlcpi | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          lm |  -.0012838   .0011473    -1.12   0.264    -.0035382    .0009707
         lxr |   -.004254   .0031981    -1.33   0.184    -.0105385    .0020305
        lgep |   .0056259   .0009738     5.78   0.000     .0037124    .0075394
       _cons |   .0172206   .0264191     0.65   0.515    -.0346944    .0691355
-------------+----------------------------------------------------------------
     sigma_u |  .00311715
     sigma_e |  .00727819
         rho |  .15499753   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(4, 467) = 14.31                     Prob > F = 0.0000
```

Appendix 12

```
. reg dlcpi lm lxr lgep

      Source |       SS           df       MS      Number of obs   =       475
-------------+----------------------------------   F(3, 471)       =     16.06
       Model |  .002840985         3  .000946995   Prob > F        =    0.0000
    Residual |  .027770526       471  .000058961   R-squared       =    0.0928
-------------+----------------------------------   Adj R-squared   =    0.0870
       Total |   .03061151       474  .000064581   Root MSE        =    .00768

------------------------------------------------------------------------------
       dlcpi | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          lm |   -.001447   .0008487    -1.70   0.089    -.0031148    .0002207
         lxr |   .0029066   .0024725     1.18   0.240    -.0019518    .0077651
        lgep |   .0061984   .0009348     6.63   0.000     .0043616    .0080353
       _cons |  -.0169459   .0191463    -0.89   0.377    -.0545686    .0206768
------------------------------------------------------------------------------

. xtreg dlcpi lm lxr lgep, re

Random-effects GLS regression                   Number of obs     =        475
Group variable: countryID                       Number of groups  =          5

R-squared:                                      Obs per group:
     Within  = 0.0912                                        min =         95
     Between = 0.0021                                        avg =       95.0
     Overall = 0.0769                                        max =         95

                                                Wald chi2(3)      =      46.33
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       dlcpi | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          lm |  -.0012355   .0010923    -1.13   0.258    -.0033764    .0009053
         lxr |  -.0031661    .003064    -1.03   0.301    -.0091715    .0028393
        lgep |    .005667    .000961     5.90   0.000     .0037835    .0075505
       _cons |   .0112128   .0250962     0.45   0.655    -.0379748    .0604005
-------------+----------------------------------------------------------------
     sigma_u |  .00222592
     sigma_e |  .00727819
         rho |  .08553384   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        dlcpi[countryID,t] = Xb + u[countryID] + e[countryID,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   dlcpi |    .0000646       .0080362
                       e |     .000053       .0072782
                       u |    4.95e-06       .0022259

        Test: Var(u) = 0
                             chibar2(01) =   151.19
                          Prob > chibar2 =   0.0000
```

Appendix 13

```
. eststo fixed: qui xtreg dlcpi lm lxr lgep, fe

. xtreg dlcpi lm lxr lgep, re

Random-effects GLS regression                   Number of obs     =        475
Group variable: countryID                       Number of groups  =          5
```

```
R-squared:                                      Obs per group:
     Within  = 0.0912                                         min =         95
     Between = 0.0021                                         avg =       95.0
     Overall = 0.0769                                         max =         95

                                                Wald chi2(3)      =      46.33
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       dlcpi | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          lm |  -.0012355   .0010923    -1.13   0.258    -.0033764    .0009053
         lxr |  -.0031661    .003064    -1.03   0.301    -.0091715    .0028393
        lgep |    .005667    .000961     5.90   0.000     .0037835    .0075505
       _cons |   .0112128   .0250962     0.45   0.655    -.0379748    .0604005
-------------+----------------------------------------------------------------
     sigma_u |  .00222592
     sigma_e |  .00727819
         rho |  .08553384   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. hausman fixed

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed          .          Difference       Std. err.
-------------+----------------------------------------------------------------
          lm |   -.0012838    -.0012355       -.0000482        .0003508
         lxr |    -.004254    -.0031661       -.0010879        .0009165
        lgep |    .0056259      .005667       -.0000411        .0001573
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   6.07
Prob > chi2 = 0.1085
(V_b-V_B is not positive definite)
```

Appendix 14

```
. xtreg dlcpi lm lxr lgep, re robust

Random-effects GLS regression                   Number of obs     =        475
Group variable: countryID                       Number of groups  =          5

R-squared:                                      Obs per group:
     Within  = 0.0912                                         min =         95
     Between = 0.0021                                         avg =       95.0
     Overall = 0.0769                                         max =         95

                                                Wald chi2(3)      =    1290.99
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000

                              (Std. err. adjusted for 5 clusters in countryID)
------------------------------------------------------------------------------
             |               Robust
       dlcpi | Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
          lm |  -.0012355   .0012365    -1.00   0.318     -.003659    .0011879
         lxr |  -.0031661   .0041577    -0.76   0.446     -.011315    .0049828
        lgep |    .005667   .0012543     4.52   0.000     .0032086    .0081255
       _cons |   .0112128   .0200629     0.56   0.576    -.0281097    .0505354
-------------+----------------------------------------------------------------
     sigma_u |  .00222592
     sigma_e |  .00727819
         rho |  .08553384   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```