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ECON 4027 UNUK: Financial Macroeconometrics

A Long-Run Structural Model of the UK Economy

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1 Introduction

Before the turn of the 21st century, there was increased research that aimed to produce macroeconomic models consisting of flexible dynamics which could accurately fit historical time series data. The paper published by Garratt et al. (2003), presented a modelling framework which built on previous studies. They described a long-run framework which was appropriate for modelling small open macroeconomies, they also presented a novel approach which incorporated long-run structural relationships in an unrestricted vector autoregressive (VAR) model. In doing so, they were one of the first to apply such techniques to an applied context, thereby presenting a practical case study of the importance of macroeconomic modelling using a quarterly macroeconometric model.

In their paper, Garrat et al. (2003) developed a long-run theoretical framework for the macroeconomic modelling of small open economies, using the United Kingdom as their example, and found the testable restrictions for the long-run relationship. They also described how to use long-run relations in Vector Error Correction Models, allowing them to compare long run structural macroeconomic modelling against the previous structural approaches. Most important to this paper, the empirical analysis of the core model tests the long-run properties. Under the assumption that there are long- run relations, the consequent model was determined to be both theory and data consistent. By producing this reliable estimated model, they were able to analyse the impacts of exogenous oil price shock and could identify monetary policy shocks

In our paper, we first replicated Table 3, the cointegration rank statistics for the core model, of the Garratt et al. (2003) study. In reproducing Table 3 we carried out the initial stage of the modelling sequence which allowed us to determine the underlying VAR in the variables. We then replicated Table 4 of the same study, from which we obtained the estimates of the long-run relations and reduced form error correction specification by producing values for the reduced form error correction specification for the core model. These tasks were carried out under the assumption that were five cointegrating variables between the variables. To then build on Garratt et al. (2003), we estimated the cointegrating VAR, but this time assuming 3 cointegrating relations instead of 5.

The structure of this paper is as follows; we first discuss the relevant literature. We then provide an overview of the data – describing the relevant variables and providing summary statistics and plots of the data. The next section then describes the basic replication of results followed by our work to extend the findings of Garratt et al. (2003). The final section provides some concluding remarks.

Literature review

When looking at the empirical papers we can see that the UK macroeconomy is explored from different aspects. We can look at the macroeconomy from a long run standpoint which does not impact the short-run variables to a significant degree. On the other hand, we can look at the short-run dynamics of past shocks without the emphasis on the long run. Garratt et al. explore this concept whilst stating that the above property holds without regard to the structural or reduced form. It also explores the dynamics of cointegrating models using the reduced error correction model.

When we look at Garratt et al. (2003) along with Gali (1992), Mellander et al. (1992) and Crowder et al. (1999) we can see that the concept is to explain the structure of the long run macroeconometric model. The main way in which Garratt et al. accomplish improvements within this field is the exploration of a small open economy of the UK. A small open economy allows international trade with other economies but the world prices, interest rates and incomes are not altered accordingly.

This allows capital to flow within the country at the equivalent world interest rate that the other countries operate at. From the papers mentioned a closed economy operates differently as there is a lack of imports and exports which would thus have different fluctuates in the long run economy. The Garratt et al. paper highlights the long run macroeconomy and builds upon the previous papers explored.

The extension that we adapt to the Garratt et al empirical paper is an adaptation to the number of error correction terms. This was an important factor as it explores the last periods' deviations from the long run macroeconomy and how it influences the short run dynamics. Many empirical papers such as Pesaran (2004), Dungey (2000), Pesaran (2002) and Cologni (2008) all use this along with the impulse response functions to explain the effect of their variables. The literature is a good way to contrast these against each other to see different techniques in which they took to explain their hypothesis. As a collective, we decided that the model may be improved if there were fewer error-correction terms and whether this would simplify the analysis as well as continue showing the importance of the long run structural macroeconometric model. We would then be able to contrast the two datasets whilst keeping the rest of the variables consistent within the model. Although the papers above vary the number of variables we have seen a lack of the incorporation of both a low number of error correction terms along with a high number of error correction terms. This could be due to the academic specifically choosing the appropriate number of terms to support their hypothesis and strengthen their argument along with it.

2 Data Analysis

This paper uses quarterly time series data with the dates ranging from 1965 to 1999. The dates in the project are labelled with the letter q with either 1,2,3 or 4 after it. This indicates that the period being examined is under one of the four quarters, e.g., 1965q1. There are a total of 140 observations. In this section the paper will provide summary statistics and data plots to give the reader an understanding of the variables used.

The variables that are used in this data have been put into a coded name which is then computed into Stata. The variables with foreign written in the name indicate that this is the respective variable in the foreign country. $'e_t'$ is the effective exchange rate, defined as the domestic price of a unit of a foreign currency at the beginning of period t, so that an increase in the exchange rate represents a depreciation of the home country currency. 'y'_t is the natural logarithm of the UK GDP real per capita at market prices. $'p^{'}$ is the natural logarithm of the UK producer price index. 'r ' is the 90-day treasury tt bill average discount rate per annum. $'\mathrm{h}_t y$ ' is the natural logarithm of the UK real per capita M0 money stock minus the natural logarithm of the UK real GDP per capita at market prices. $'P$ ' is the price of oil and 'ChangeinPo' is the difference in the price of oil in this time t minus the price of oil in t-1. 'Priceinflation' is the natural logarithm of the UK retail price index which is a measure of the domestic price inflation. Finally 'pps' is the difference between the natural logarithm of the UK producer price index and the natural logarithm of the foreign producer price index.

Table 1 displays the summary statistics of all the variables in the paper, showing the mean, standard deviations, and min/ max values of the respective variable. The table shows that all the variables apart from 'DateQ' have a low standard deviation, demonstrating that the data for each variable are clustered around the respective mean. The min/ max value shows the respective smallest and largest number under that variable.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
DateQ	140	89.5	40.5586	20	159
yt	140	4.355573	0.2002384	4.012434	4.708576
ytForeign	140	4.393324	0.1933172	3.974747	4.698656
rt	140	0.0210718	0.0069093	0.0105493	0.0377077
rtForeign	140	0.0152634	0.005159	0.0071177	0.030821
et	140	-4.964504	0.2575177	-5.467597	-4.589139
hty	140	-1.644274	0.3752986	-2.079252	0.9955616
Po	140	4.160374	0.9750999	2.509032	5.434078
ChangeinPo	140	0.0172891	0.1648515	-0.477943	1.370257
priceinfla~n	140	0.0174878	0.0140425	0.0036694	0.0825771
pps	140	0.1027834	0.1518764	0.3595225	0.044102

Table 2 shows the numerical output of each variable when put into first differenced form with up to four lag lengths. The results in this table suggest that it is reasonable to treat the variables in testing as I(1) variables. Under the first differencing there is evidence to be able to reject the unit roots hypothesis. The table displays the use of four different lag lengths used when completing the Augmented Dicky-Fuller unit root testing. In the original paper Garrett et al (2015) their unit root testing found that both domestic and foreign prices were I(2) variables, in which Haldrup (1998) suggested that it may be better transform these variables into I(1) rather than dealing with both I(1) and I(2) variables. Therefore, the original paper has used the relative prices of (p_t– $p_t foreign$) rather than two separate price levels.

Table 2: Augmented Dicky-Fuller Unit Root Test

		1965q1 - 1999q4			
Variable	ADF(0)	ADF(1)	ADF(2)	ADF(3)	ADF(4)
(i) For the first differences					
d.yt	-11.762	-7.872	-5.211	-4.995	-4.567
d.ytforeign	-7.484	-5.339	-4.737	-4.568	-4.322
d.rt	-10.346	-7.516	-7.253	-5.837	-6.02
d.rtforeign	-7.007	-6.105	-4.764	-4.718	-4.4
d.et	-9.745	-7.805	-6.36	-5.424	-5.282
d.ht-y	-12.25	-7.964	-5.654	-4.698	-3.166
d.pps	-6.357	-4.612	-3.524	-3.41	-3.268

Figure 1a shows an increasing trend in both the domestic and foreign GDP per capita, however, there is a dip in the data in the early 1990's, this may be because of the recession that hit the UK in this period. Despite this, the graph displays an increasing trend before and after this dip in the early 1990's, therefore allowing the paper to assume that this is a non-stationary process. The graph presents this by the dip to around 4.55, which then accelerates in an increasing trend to 4.72. Figure 1b shows the same two variables but now in first differenced form creating evidence that the variables of UK and foreign GDP per capita Is now stationary as it is reverting to the zero mean.

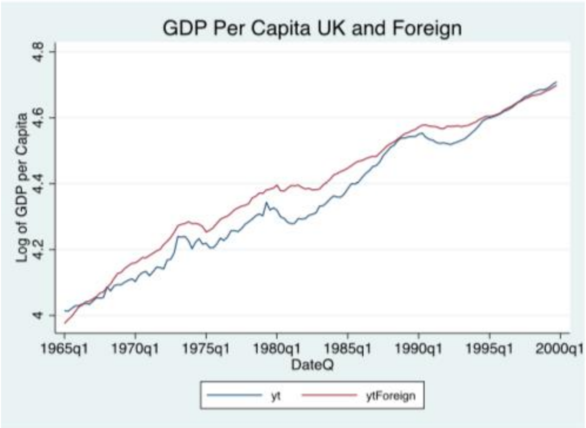

Figure 1a

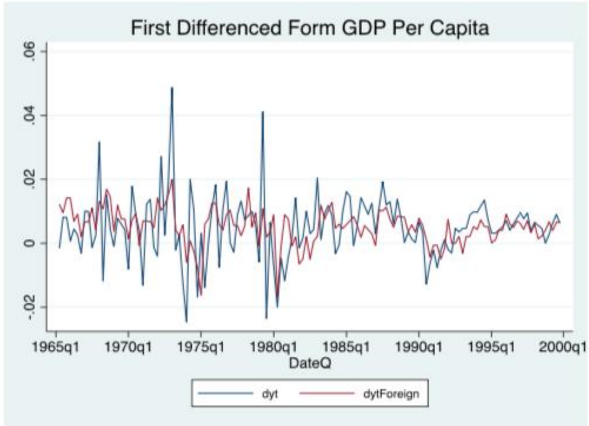

Figure 1b

Figure 2a and 2b displays the data of both the price of oil and the change in the price of oil. The data may be slightly skewed as shown by the graphs below. In the quarters before 1970q4 the data for the change in the price of oil is 0, this is because the price of oil stayed the same for roughly 5 years. Figure 2b shows that there was a big shock in the price in 1973 which may have been because of OPEC imposing an embargo against the United States over war disagreements.

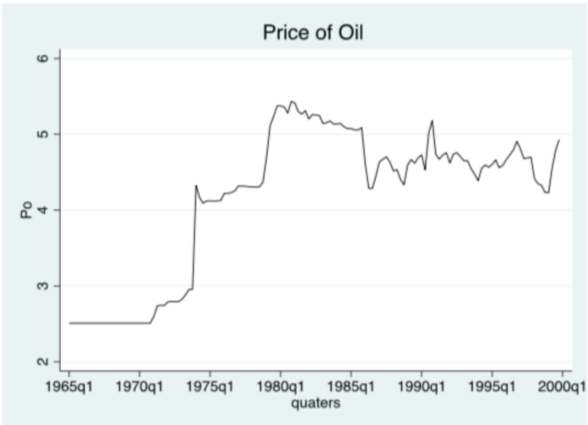

Figure 2a

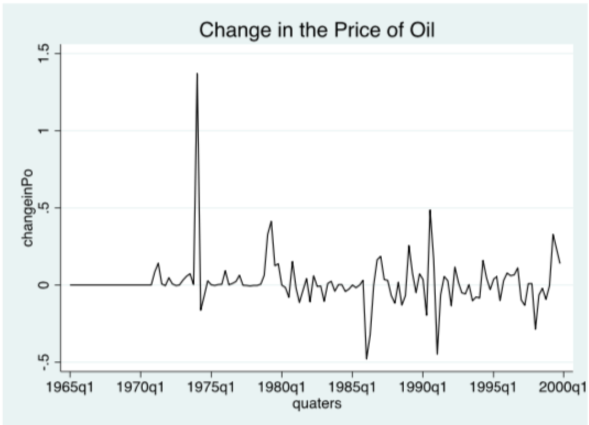

Figure 2b

Testing and Estimating the Long-Run Relations

The first step in our modelling deployment was to choose the order of the underlying VAR in these variables. As per Garratt et al. (2003), using the AIC as the model selection criterion shows that suing a VAR of order two was the most appropriate, despite a VAR of order one being the most appropriate when using SBC as the model of selection criterion. This decision is due to the comparative consequences of using the VAR of different orders, models underestimating the order of the VAR are likely to be subject to much more serious consequences (Kilian, 1997).

We then computed Johansen's 'trace' and 'maximal eigenvalue' statistics using a VAR (2) model with unrestricted intercepts, restricted trend coefficients and treating the oil price variable as weakly exogenous for the long-run parameters. Table 3 shows these statistics with their associated 95% critical values.

Table 3: Cointegration Rank Statistics for the Core Model

pto ; et; rt*; rt; D pt; yt; pt pt*; ht yt*; yt

H0	H1	Test statistic	95% critical values
(a) Trace Statistic			
r=0	$r \geq 1$	304.7176	192.89
$r \leq 1$	$r \geq 2$	219.754	156
$r \leq 2$	$r \geq 3$	154.7332	124.24
$r \leq 3$	$r \geq 4$	106.3315	94.15
$r \leq 4$	$r \geq 5$	69.3136	68.52
$r \leq 5$	$r \geq 6$	42.9273*	47.21
$r \leq 6$	$r \geq 7$	23.5883	29.68
$r \leq 7$	r = 8	10.0473	15.41
(b) Maximum eigenvalue statistics			
r = 0	r=1	84.9636	57.12
$r \leq 2$	r=2	65.0208	51.42
$r \leq 3$	r=3	48.4017	45.28
$r \leq 4$	r=4	37.0178	39.37
$r \leq 5$	r=5	26.3863	33.46
$r \leq 6$	r=6	19.339	27.07
$r \leq 7$	r=7	13.541	20.97
$r \leq 2$	r=8	6.4199	14.07

Garrat et al. (2003)'s assumption of five cointegrating vectors is somewhat contradicted by the maximal eigenvalue statistic that our VAR (2) model yields. Instead, our results imply that there are only two cointegrating relationships at the 95% significance level. However, been suggested in previous studies that the trace tests, when compared to the maximal eigenvalue tests, are less vulnerable to the presence of skewness and excess kurtosis in the errors *(Cheung and Lai)*.

As a result of the non-normality of the VAR model's residuals used in calculating the test statistics, the cointegration tests are based on the trace statistics. These trace statistics reject the null hypothesis that r = 0, 1, 2, 3, 4 at the 5% level of significance but we cannot reject the null hypothesis that r = 5. This inference concurs with our *a priori* assumption based on the long-run theory discussed in Garratt et al. (2003), and means we are able to continue under the assumption that there are five cointegrating vectors.

Five cointegrating relations needs five restrictions on each relationship to accurately identify them. Taking into consideration the long-run theory, we applied the 25 exact-identifying restrictions below on the cointegrating matrix which corresponds to the nine variables in the model:

$$\boldsymbol{\beta}' = \begin{pmatrix} \beta_{11} & \beta_{12} & 0 & 0 & \beta_{15} & 0 & 1 & \beta_{18} & 0 \\ \beta_{21} & 0 & \beta_{23} & 1 & \beta_{25} & 0 & 0 & 0 & \beta_{29} \\ \beta_{31} & 0 & 0 & 0 & 0 & 1 & \beta_{37} & \beta_{38} & \beta_{39} \\ \beta_{41} & 0 & 0 & \beta_{44} & \beta_{45} & \beta_{46} & 0 & 1 & 0 \\ \beta_{51} & 0 & 0 & \beta_{54} & -1 & 0 & 0 & \beta_{58} & \beta_{59} \end{pmatrix} \qquad \text{(A)}$$

In this cointegrating matrix, the first vector corresponds with the PPP relationship. The second vector corresponds to the IRP relationship, the third to the 'output gap', the fourth is the MME condition and finally, the fifth is the real interest rate relationship.

There are 20 unrestricted parameters in (A), and as per Garratt et al. (2003), this yields 18 overidentifying restrictions which we then tested. Due to our using of a cointegrating VAR, with restricted trend coefficients, there could be five further parameters on the trend terms in the five cointegrating relationships. There is no implication that we should have applied a time trend in the IRP, FIP or output gap relationships, which paired with imposing zeros on the relationship's trend coefficients, produces an additional three over-identifying restrictions. These restrictions, and the restriction that β_{46} = 0 because of the PPP relationship exhibiting no trend, result in there being only two parameters that can be freely estimated in the cointegrating relationships, meaning we had to base the core model on 23 overidentifying restrictions.

3 Reduced Form Error Correction Model

When we performed the reduced form error correction model, we observed very similar results to the Garratt et al. (2003) paper, as seen in Table 4. With the aim of this paper to replicate the work completed in the original paper, we have obtained similar results in both tables 3 and 4. This continues to prove that the papers clearly explained its procedure in getting the values stated in the table. There were many statistics that were calculated within the model which slightly differed but resulted in our R2 term changing. The majority of our R2 terms were close to 1 (as they were generally over 90%) The model also includes the Chi-squared distribution which can show whether two variables are independent of one another. Most of the values are the same however the most important indication is that they follow the same trend. If the estimated increases in the original values, we also found a correlation when we ran our results whereby the estimates also increased. When completing the R^2 benchmark, we used the ARMA testing on the differences in which we came across issues due to the fact that there are sometimes convergence issues when estimating the maximum likelihood models.

When running the commands for table 4, we tend to see a similar trend and relation to the results obtained in Garrett et al (2003). However, we haven't got the exact results, our coefficients are slightly different, with the significant levels also being different. When computing the chi-squared statistics we found that a significant amount of the coefficients were under the 10% significance level.

Table 4 : Reduced Form Error Correction Specification for the Core Model

Equation	pps		et		rt		rtForeign		yt		ytForeign		hty		priceinflation	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
correction1	-0.027803*	0.01	0.0090851	0.05	0.0023416	0.00	0.0006263	0.00	0.0076145	0.01	0.0094084	0.01	-0.0311447**	0.02	-0.0225556	0.01
correction2	-0.335154*	0.29	2.769925*	1.23	-0.0177576	0.10	0.0692797*	0.03	1.68045*	0.34	1.002935*	0.17	-0.7873746	0.59	-0.7007874*	0.28
Correction3	-0.00131	0.04	-0.4461949*	0.17	-0.0064435	0.01	-0.0076157	0.00	-0.1673963*	0.03	-0.0489198*	0.02	0.0893282	0.07	0.0384375	0.03
Correction4	0.010876*	0.00	-0.0420975*	0.02	-0.0010192	0.00	0.000331	0.00	-0.0296547*	0.00	-0.0154435*	0.00	-0.002315	0.01	0.0123195*	0.00
Correction5	-0.036498	0.09	-0.2683161	0.36	-0.0573997**	0.03	-0.0136457	0.01	-0.1004179	0.10	-0.1042146*	0.05	0.3710825*	0.18	0.2865583	0.26
pps-1	0.397282*	0.10	0.1328907	0.41	-0.0342198	0.03	-0.0311842*	0.01	-0.2401198*	0.12	-0.0701728	0.06	0.0084656	0.19	0.3670105*	0.09
et-1	0.043004**	0.02	0.2175695*	0.09	-0.0038093	0.01	-0.0020701	0.00	0.014754	0.03	0.0020945	0.01	-0.0066641	0.04	-0.0470093*	0.02
rt-1	0.024145	0.29	-1.858914	1.19	0.132201	0.10	-0.0613722	0.04	0.3385637	0.33	0.1385753	0.17	-0.3679492	0.56	0.9464346*	0.27
rtForeign-1	-0.467449	0.59	3.749052	2.45	0.5324857*	0.20	0.3992875*	0.08	0.6425132	0.70	0.6812517**	0.35	-0.3432062	1.14	0.0627057	0.55
yt-1	0.087929	0.09	0.2828783	0.36	0.0163799	0.03	0.0085867	0.01	-0.0004581	0.10	0.0400789	0.05	-0.2025261*	0.17	0.3533355*	0.08
ytForeign-1	-0.225949	0.15	-1.000026	0.62	-0.0170229	0.05	0.0429899*	0.02	-0.2382242	0.18	0.0158072	0.09	0.6809024	0.30	-0.1439499	0.15
hty-1	0.116431**	0.05	0.3746278**	0.22	0.0300649	0.02	0.0082099	0.01	0.0870963	0.06	-0.0103984	0.03	-0.2686978*	0.11	0.1146802*	0.05
Priceinflation-1	-0.13029**	0.07	0.3170641	0.30	0.0160819	0.02	0.0142621	0.01	0.1306555	0.08	-0.0635288	0.04	0.0467684	0.14	-0.1893277*	0.07
Po	0.007163	0.00	-0.0169659	0.02	-0.0019946	0.00	-0.0006245	0.00	0.0031981	0.01	0.0005031	0.00	-0.0118022	0.01	0.0133256*	0.00
Po-1	-0.000759	0.00	-0.0067842	0.02	0.0004778	0.00	0.0017128*	0.00	0.006141	0.00	0.0010509	0.00	0.0032602	0.01	-0.0075966*	0.00
R^2	0.7838		0.923		0.9115		0.8421		0.905		0.8955		0.9029		0.9788	
Benchmark R^2																
Sigma	0.0059511		0.0275586		0.015012		0.0010199		0.0070954		0.0070954		0.01135		0.0081717	
Chi^2 (SC)	2.038197		1.959967		2.018497		2.113556		2.05756		1.914704		2.010677		1.960929	
Chi^2 (FF)	16.46**		5.73**		1.57		2.94**		2.68**		1.84		3.74**		2.27**	
Chi^2 (N)	58.41**		14.62**		12.52**		11.82**		35.48**		13.12**		144.70**		44.27**	
Chi^2 (H)	0.29		7.25**		11.14**		19.26**		0.2		0.03		2.39		6.26**	

* = 5% critical value ** = 10% critical value

The first error correction term is the PPP relationship. Previous PPP evidence shows how the changes to rates and prices could affect this dramatically. There are many ways in which using a unit root test or rejecting it within the hypothesis would change the analysis. Within table 4 we explored the cointegrating model which is very similar and follows the same trends as the original empirical paper. This shows that the explanations for transforming the data were clearly explained and could be replicated. This, therefore, supports the original argument that PPP is a useful contribution to the model and supports that the relationship is stronger in a complete model of the macroeconomy.

The second error correction term was the IRP condition. This explored the $rt{-}rt{*}$ variable within the model. This was related to the risk premia with bonds and foreign exchange. As with the original literature, we found the IRP condition such that $rt{-}rt{*}{\sim}I(0)$ which complies with the previous literature mentioned. The close estimates within the data support the analysis that was originally explored in the paper. Alongside this the third long run relationship is the output gap ($yt{-}yt{*}$). As with the original data we received a coefficient, but it was very close to zero. However, this means that the co-trending hypothesis cannot be rejected as the output gap equation is not zero. We can find that the growth rate trend for the UK is very close to that of the original data. Thus, yt and $yt{*}$ are cointegrated in our model.

The next error correction term was the money market equilibrium (MME). The hypothesis states to reject the hypothesis that the elasticity of real money is zero. The trend showed a downwards trend. Garratt et al. exploration within the dataset was up to a high standard as this also was easily reproduced within our findings. We found ourselves unable to reject this hypothesis which led us to the last cointegrating equation. The final FIP relationship has a constant which implied an annual real rate of return. The results we obtained also supported the original output within the model. The relationship in the model combined interactions between variables which further emphasises that the output within our model followed the same trend as the original data published in the empirical paper. To get the exact dataset there would have needed to be more adjustments not to the coding process itself but more to the statistical programme we used. This would have enabled us to use the exact precision and accuracy as the method that has been undertaken by the software may differ slightly. We can therefore interpret the same conclusion that the short run dynamics of the model are characterised by the error correction from Table 4 as stated from the Garratt et al. paper.

4 Reduced Form Error Correction Model Assuming; 3 Cointegrating Relations

To build on from the work done by Garratt et al. (2003), we estimated the cointegrating VAR, but this time assuming 3 cointegrating relations instead of 5. The table 5 is an important extension in the literature obtained by Garrett et al. (2013) since we are able to show the long-run relations in the equations and that the three error correction terms provide useful statistical feedback across the different markets observed: commodity, money and foreign exchange markets

Our results, as seen in Table 5 below shows that this was somewhat harmful to the overall quality of the model. The R^2 Values that we obtained assuming 3 cointegrating relations were reduced for each variable, in comparison to the corresponding values in the earlier model. While the extent to which the R^2 value varies, the results imply assuming 3 cointegrating relations produces an inferior model. The statistics obtained by running different types of commands to obtain chi squared, whether this be functional form, serial correlation, heteroskedasticity and normality are of satisfaction. However, in nearly all cases bar the price inflation variable, we would reject the heteroskedasticity testing all bar one fell outside the confidence interval. This contrary to the results found in table 4 where four out of the eight terms were found at a minimum 10% significance level. Therefore, it may be argued that the original table 4 appears to capture the time series properties of the main macroeconomic aggregates in the UK better than the extension has.

Table 5: Reduced Form Error Correction Specification for the Core Model (3 error correction terms)

Equation	pps		et		rt		rtForeign		yt		ytForeign		hty		priceinflation	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
correction1	-0.011472**	0.01	-0.0072111	0.05	0.0005673	0.00	0.0013483**	0.00	-0.0141924	0.01	-0.0033287	0.01	-0.0204594	0.02	0.0072995	0.01
correction2	0.295534	0.18	0.1860821	0.75	-0.0099601	0.10	0.0753886*	0.02	-0.0343677	0.22	0.0893696	0.11	-0.8239251*	0.34	0.0804277	0.17
Correction3	-0.079784*	0.03	-0.1649973	0.12	-0.0107474	0.01	-0.0084022**	0.00	-0.0615968**	0.03	0.0289891**	0.02	0.1157122*	0.05	-0.0201507	0.03
pps-1	0.488988*	0.08	0.0230865	0.35	-0.0090547	0.03	-0.017045	0.01	-0.2749971*	0.11	-0.0598261	0.06	-0.1608407	0.18	0.420326*	0.10
et-1	0.04752*	0.02	0.1935872*	0.09	-0.0053205	0.01	-0.0013573	0.00	0.010728	0.03	-0.0011211	0.01	0.0022809	0.04	-0.024645	0.02
rt-1	0.094162	0.29	-2.19221**	1.21	0.116418	0.10	-0.0573155	0.04	0.1036658	0.37	0.0088888	0.19	-0.2718331	0.56	1.127067*	0.28
rtForeign-1	0.277272	0.54	0.9772226	2.24	0.5544864*	0.19	0.4260144*	0.08	-1.425032*	0.69	-0.3786634	0.35	-0.4899837	1.04	1.078373	0.54
yt-1	0.082168	0.09	0.2366534	0.37	0.0042673	0.03	0.0052243	0.01	0.0345641	0.11	0.048084	0.06	-0.1242797	0.17	0.3516342*	0.09
ytForeign-1	-0.225949*	0.15	-0.4086523	0.60	-0.0163733	0.05	0.047615*	0.02	0.2310386	0.19	0.2702627*	0.10	0.669348*	0.28	-0.2993304	0.14
hty-1	0.088487**	0.05	0.4223943**	0.22	0.0197528	0.02	0.0056	0.01	0.1368439*	0.07	0.0077617	0.03	-0.2025413*	0.10	0.1019862**	0.05
Priceinflation-1	-0.13979*	0.07	0.459527	0.29	0.0322401	0.02	0.0166482**	0.01	0.1849984*	0.09	-0.0211962	0.05	-0.0566519	0.13	-0.2615119*	0.07
Po	0.009645*	0.00	-0.0209211	0.02	-0.0014851	0.00	-0.0002003	0.00	0.0006772	0.01	-0.0001287	0.00	-0.0153406*	0.01	0.0165026*	0.00
Po-1	0.000464	0.00	-0.0093044	0.02	0.0007393	0.00	0.0018881*	0.00	0.002716	0.01	-0.000416	0.00	0.0014915	0.01	-0.005799	0.00
R^2	0.6275		0.8673		0.856		0.743		0.8116		0.7927		0.7712		0.7386	
Benchmark R^2																
Sigma	0.0065926		0.0286529		0.0153214		0.0010824		0.0072334		0.0043941		0.0120187		0.0081895	
Chi^2 (SC)	2.077445		1.980041		1.972292		2.091403		2.185465		2.083904		2.014122		2.021147	
Chi^2 (FF)	9.44*		3.72*		2.61**		1.76		1.9		2.87*		1.66		15.87*	
Chi^2 (N)	58.41**		14.62**		12.52**		11.82**		35.48**		13.12**		144.70**		44.27**	
Chi^2 (H)	0.34		2.32		1.95		10.07*		0.47		0.44		0.00		16.46*	

*=5% critical value ** = 10% critical value

5 Conclusion

This paper provides a statistical explanation of how a cointegrating vector auto regression can be used to outline a long-run macro economy. The paper introduces the theory based long-run relationships as a base of the models used, in which tools such as VAR and a cointegrating VAR were used to present approximations of a core macro econometric economy. The variables of interest consisted of, money markets, foreign exchange markets, exchange rates and commodity markets. The dataset estimated was between the period of 1965q1-1999q4.

The paper started off by running regressions and estimations to see whether the chosen variables were I(1) variables, in which the results suggested for GDP per capita and the price of oil were both I(1) variables. Knowing this allowed the paper use further testing to understand the macroeconomy under this model.

With the considerations of the economic theory applied empirically, it was suggested that there were five long-run cointegrating relationships among the core variables used in this paper. The statistical tests used in this paper was the Johansen's cointegrating rank statistics, which is used to find any potential cointegrating relationships, of which we also found five, in line with the theory. Implying that the estimated model and theory are consistent.

A cointegrating VAR was used in this table where we regressed the first differenced variables against the model, including the five error correction terms. When running the cointegrating VAR tests we found that our results were in line with the work completed by Garrett et al. (2003) since our results were following a similar trend to this piece of work. To extend this piece of work from Garrett et al. (2003), we removed the last two error correction terms, implying that there were only three cointegrating variables in our dataset rather than five which we found in the Johansen's cointegrating test. We found that is change in the model altered our results significantly, seeing a change from the results we found in table 4. The paper found a major difference in results under the heteroskedastic chi squared variable. However, throughout this paper we have been able demonstrate how the use of Johansen's cointegrating rank, VAR and cointegrating VAR can be very useful when trying to model the macroeconomy.

6 References

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7 Appendix Do file

set more 1 clear

cd "/Users/thomasbaseley/Desktop/4year/Financial Macro "
/Users/thomasbaseley/Desktop/4year/Financial Macro
import excel "/Users/thomasbaseley/Desktop/4year/Financial Macro /Dataset project 1 .xlsx", sheet("Sheet1") firstrow clear

gen quaters = tq(1965q1)+_n-1 browse
format %tq quaters
browse

tsset quaters

rename quaters DateQ
rename consumerpriceinflation priceinflation rename C ytForeign
rename E rtForeign
rename Rt rt
rename pp pps

***** this variable above is the differene between the UK producer price and the foreign producer price

label var Po "Price of oil"
label var ChangeinPo "change in the price of oil "
label var et "exchange rate"
label var DateQ "Date in quaterly time series"
label var pp "p-ps difference of UK and foreign producer index"

drop Date

gen dPo = d.Po
gen dpps = d.pps
gen dpriceinflation = d.priceinflation gen drtforeign = d.rtForeign
gen det = d.et
gen drt = d.rt
gen dytForeign = d.ytForeign
gen dyt = d.yt
gen dhty = d.hty

***** Below is the data analysis. Where the commands are for summary stats and plots of the data
describe
*** provides information about the current data file, including the number of variables and observations and a listing of the variables in a data file

codebook

*** Produce codebook like information for the current data file
summarize DateQ yt ytForeign rt rtForeign et hty Po ChangeinPo priceinflation pps

// then use graph editting tool to get the right measurements of labelling sizing
twoway (tsline yt) (tsline DateQ), legend(label(1 EURO/USD) label (2 GBP/USD)) xtitle("Date", size(Medium)) xlabel(,ang(60)) ytitle("Exchange Rates ", size(Medium))
saving(exchrate_1.jpg, replace)

** need to edit this previois command to make a better graph, including titles and axis title etc - for domestic and foreign gdp per capita

** this command can also be used to show that these variables are upward trending, so could potentially put to first differenced form to test this
line yt ytForeign DateQ, legend(size(small))
line dyt dytForeign DateQ, legend(size(small))

** for the exchange rate showing first differenced stationarity line et DateQ, legend(size(small))
line det DateQ, legend(size(small))

** for the price of oil showing first differenced stationarity line Po DateQ, legend(size(small))
line dPo DateQ, legend(size(small))

** graph showing the change in oil prices by quater and year twoway (tsline ChangeinPo)

**** table 3 command johansen cointegration
vecrank yt ytForeign rt rtForeign et hty Po priceinflation pps

**
vecrank yt ytForeign rt rtForeign et hty Po ChangeinPo priceinflation pps, trend(constant) max levela

****eigen values
vecrank yt ytForeign rt rtForeign et hty Po priceinflation pps, lags(2) max levela notrace gen ppsLag = pps[_n-1]
gen PoLag = Po[_n-1]

**** this mihgt be part of the coding for cointegrating var gen correc1 = pps - et - 4.588
gen correct2 = rt - rtForeign - 0.0058
gen correct3 = yt - ytForeign - 0.0377

gen correct4 = hty + 56.0975*rt + 0.0073 + 0.05379 gen correct5 = rt - priceinflation - 0.0036

*** the correc terms are what kevin has put at the bottom of table 4. where it says "the five error correction terms are given by"

constraint define 1 pps - et - 4.588 constraint define 2 rt - rtForeign - 0.0058 constraint define 3 yt - ytForeign - 0.0377

constraint define 4 hty + 56.0975*rt + 0.0073 + 0.05379
constraint define 5 rt - priceinflation - 0.0036
*** constraints have been made here because im not sure whether we used te correct terms in the code, or we run these constraints before doing VAR and then leave the correct terms out of the code

*** in the table the first 4 and the last 7 are not in differenced form. whereas the variables we have used are. is this something to think about? potentially separate coding var pps correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po ld.Po, lag(1)

*** or use this code below they get similar results
var pps correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var et correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var rt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var rtForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var yt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var ytForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var hty correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var priceinflation correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)

*** need to check the commmands above whether i should use differenced for the dependant variables or not. Havent used them for the coding atm and for the excel output document

*** generating R^2
regress pps correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress et correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress rt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress rtForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress yt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress ytForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress hty correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress priceinflation correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag

***

*** to find the sigma
arima d.pps correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)

arima d.et correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, ar(1) ma(1) arima d.rt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)

arima d.rtForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.yt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.ytForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.hty correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.priceinflation correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation d.Po d.PoLag, ar(1) ma(1)

***Chi^2 serial correlation
var pps correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var et correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var rt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var rtForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var yt correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var ytForeign correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var hty correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var priceinflation correc1 correct2 correct3 correct4 correct5 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat
*test this above need to see whether this works for all the variables or not

*** Chi^2 functional form

regress pps correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress et correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag

ovtest
regress rt correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign

```
ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress rtForeign correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress yt correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign
ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress ytForeign correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress hty correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress priceinflation correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest

***chi^2 normaility
sktest et correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest et correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest rt correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty priceinflation
Po PoLag
sktest rtForeign correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest yt correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest ytForeign correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest hty correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag
sktest priceinflation correc1 correct2 correct3 correct4 correct5 pps et rt rtForeign yt ytForeign hty
priceinflation Po PoLag

*** chi^2 heteroskedasticty
regress pps correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest
regress et correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign
ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest

regress rt correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign
ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest
regress rtForeign correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt
ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
```

estat hettest
regress yt correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest
regress ytForeign correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest
regress hty correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest
regress priceinflation correc1 correct2 correct3 correct4 correct5 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
estat hettest

** need to keep my commands consistant so am i using d. before the depedant variable or am i not ???

****
************************ extension *********************
****

****
var pps correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var et correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var rt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var rtForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var yt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var ytForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var hty correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
var priceinflation correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
*** need to check the commmands above whether i should use differenced for the dependant variables or not. Havent used them for the coding atm and for the excel output document

*** generating R^2
regress pps correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag

regress et correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag
regress rt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag

```
regress rtForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag
regress yt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation
d.Po d.PoLag
regress ytForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag
regress hty correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag
regress priceinflation correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag

*** to find the sigma
arima d.pps correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.et correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.rt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation
d.Po d.PoLag, ar(1) ma(1)
arima d.rtForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.yt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty d.priceinflation
d.Po d.PoLag, ar(1) ma(1)
arima d.ytForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.hty correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)
arima d.priceinflation correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d. hty
d.priceinflation d.Po d.PoLag, ar(1) ma(1)

***Chi^2 serial correlation
var pps correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation
d.Po d.PoLag, lag(1)
dwstat
var et correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation
d.Po d.PoLag, lag(1)
dwstat
var rt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po
d.PoLag, lag(1)
dwstat
var rtForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag, lag(1)
dwstat
var yt correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po
d.PoLag, lag(1)
dwstat
```



```
var ytForeign correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty
d.priceinflation d.Po d.PoLag, lag(1)
dwstat
```

var hty correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)

dwstat
var priceinflation correc1 correct2 correct3 d.pps d.et d.rt d.rtForeign d.yt d.ytForeign d.hty d.priceinflation d.Po d.PoLag, lag(1)
dwstat

*test this above need to see whether this works for all the variables or not

*** Chi^2 functional form
regress pps correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress et correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress rt correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtes
regress rtForeign correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress yt correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress ytForeign correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress hty correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty ld.priceinflation ld.Po ld.PoLag
ovtest
regress priceinflation correc1 correct2 correct3
ld.priceinflation ld.Po ld.PoLag
ovtest

***chi^2 normaility

sktest sktest sktest sktest sktest sktest PoLag sktest

ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty

pps correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag
et correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag
rt correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag rtForeign correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag yt correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag ytForeign correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po

hty correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po PoLag

Student ID’s 14304274 20402443 20412804

```
sktest priceinflation correc1 correct2 correct3 pps et rt rtForeign yt ytForeign hty priceinflation Po
PoLag

*** chi^2 heteroskedasticty
regress pps correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress et correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress rt correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress rtForeign correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress yt correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress ytForeign correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettes
regress hty correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
regress priceinflation correc1 correct2 correct3 ld.pps ld.et ld.rt ld.rtForeign ld.yt ld.ytForeign ld.hty
ld.priceinflation ld.Po ld.PoLag
estat hettest
```