Does the purchasing power parity theory still hold ? The UK as the case study

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Does the purchasing power parity theory still hold ? The UK as the case study

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Abstract

The purchasing power parity (PPP) theory is an integral part of international finance. The PPP examines the relationship between the inflation rate differential between two countries and their exchange rate movements. The purpose of this study is to investigate whether the PPP still holds or not. The UK is taken as a case study. The standard time series techniques are employed to address the issue. Our findings tend to indicate that the PPP theory does hold in the long run as evidenced in the cointegration (or comovement) of the exchange rate and price ratio variable. Furthermore, the Granger-causality analysis unveils that an exogenous shock to the US-UK exchange rate disturbs the long run equilibrium and the domestic-foreign price ratio variable bears the brunt of short-run adjustment to bring about the long run PPP equilibrium. The exchange rate is found to be the exogenous leading variable and the price ratio variable is found to play the role of a follower in terms of endogenous adjustment. The findings have strong policy implications for international trade and investment.

Keywords: exchange rate, domestic price, foreign price, cointegration, VECM, VDC

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1. Introduction: Objective and motivation

The purpose of this research is to see if Purchasing Power Parity theory holds for predicting currency movements. In today's internationally integrated financial and economic system even the smallest firm is impacted by changes around the globe. Therefore, it is important to many decision makers to be able to have a view on currency movement and the basis of the currency movements.

In this regards we have selected Purchasing Power Parity theory as it is an established theory that is used as a standard in economic data. Our focus of research is in using the most recent data that includes several incredible historical events to see if there is still value in using PPP by policy makers. These events are:

- The 2008 global financial crisis brought by the collapse of Lehman Brothers
- The Eurozone crisis that is continuing
- The global 'Currency Wars' whereby nations intentionally seek to inhibit rises in currency value i.e. Japan, Switzerland, and Brazil amongst others
- The United States Debt Ceiling Crisis and the subsequent lowering of the United States credit rating by S&P to below AAA
- The United States and United Kingdom economies entering a period of sustained recession as argued by Krugman and others

Although we are not interested on the impact of each event individually, as a whole we desire to examine the impact on the variables involved in PPP theory and the direction of causality to see what variable should policy makers be focusing on manipulating and decision makers focus on watching to determine future trends in this era of unprecedented global integration and upheaval. PPP theory was established in 1918 and has been an economic benchmark for generations of economists and it has been through several drastic changes in currency. What can we learn about PPP from this most recent portion of economic history?

2. The Purchasing Power Parity (PPP)Theory

Purchasing power parity theory specifies a precise relationship between relative inflation rates of two countries and their exchange rate. PPP theory suggests that the equilibrium exchange rate will adjust by the same magnitude as the differential in inflation rates between the two countries.

PPP theory focuses on the relationship between the inflation rate differential and future exchange rate movements.

According to Purchasing power parity (PPP) is a currency trading economic theory, the exchange rates between currencies should be in equilibrium when the their purchasing power is the same in each of the two countries. This states that the exchange rate between two countries is equal to the ratio of the two countries' price level of a fixed basket of goods and services. When a country's domestic price level is increasing (i.e., a country experiences inflation), that country's exchange rate must depreciate in order to return to PPP. The basis for PPP is the "law of one price". In the absence of transportation and other transaction costs, competitive markets will equalize the price of an identical good in two countries when the prices are expressed in the same currency.

3. LITERATURE REVIEW

The short time frame does not allow for an exhaustive literature review of cointegration application to PPP however the author would like to direct the reader to a paper by the Royal Swedish Academy of Sciences entitled "Time-series Econometrics: Cointegration and Autoregressive Conditional Heteroskedasticity" (2003) which relates to the awarding of the Nobel Prize to Engel and Granger on cointegration and ARCH. A rich and detailed history on the application and limitation of regression to PPP is related. It continues to explain how cointegration brought new ways of looking at and solving old problems. It is not fitting to reproduce the entire narrative here, however the author does recommend readers to view the section of the paper regarding PPP. As a summary we will only pose that OLS results did not provide consistent results for the PPP theory and it was only after the introduction of cointegration to the analysis that did results finally produce results acceptable to theory.

Background and application of Purchasing Power Parity Theory
PPP was fist stated in a rigorous manner by the Swedish economist Gustav Cassel in 1918. He used it as the basis for recommending a new set of official exchange rates at the end of World War I that would allow for the resumption of normal trade relations. Since then, PPP has been widely used by central banks as a guide to establishing new par values for their currencies when the old ones were clearly in disequilibrium. From a management standpoint, PPP is often used to forecast future exchange rates, for purposes ranging from deciding on the currency denomination of long-term debt issues to determining in which countries to build plants.

3.1. EQUATION FORM

We are using the form described by the Nobel Prize paper mentioned above. Early empirical studies of the PPP hypothesis initially focused on Cassel's (1922) simple formulation. PPP was tested by using regression models of the form:

$s_t = a + b(p_t - p_t^*) + \varepsilon_t$

Where s_t is the logarithm of the exchange rate between the home and foreign currency, and p_t and p_t^* are the logarithms of the price levels of home and foreign goods, respectively. The assumption taken is that a=0 and b=1 for long term modeling.

4. RESEARCH METHODOLOGY, RESULTS AND INTERPRETATION

A time series approach will be used in order to find empirical evidence of PPP. As discussed previously OLS was not able to generate successful results and cointegration provides for new ways of looking at this problem. We aim to reproduce the results using the latest data, which includes periods of increased volatility due to recent economic events. The data used is monthly data for 41 years starting from January of 1971.

4.1. TESTING STATIONARITY OF VARIABLES

In this part, we will test if the variables used are stationary or non-stationary. Indeed, to apply co-integration on later stage, we need to find our variables to be non-stationary in their original form and in their first differenced form, they are stationary. The differenced form for each variable is the difference of the log form. We then apply the Augmented Dickey-Fuller (ADF) test on each variable in the level and differenced form. The table below summarizes the results.

Variables in Level form	Test Statistic	Critical Value	Implications, the variable is:
LGBPUSD	-2.3636	-3.4211	Non-stationary
LUKCPI	-3.0941 (AIC)	-3.4211	Non-stationary
	-3.0941(SBC)	-3.4211	Non-Stationary
LUSCPI	-2.7533 (AIC)	-3.4211	Non-stationary
	2.6110 (SBC)	-3.4211	Non-stationary

Variables in differenced form	Test Statistic	Critical Value	Implications, the variable is:
DGBPUSD	-19.6139(SBC)	-2.8678	Stationary
	-11.3449(AIC)	-2.8678	Stationary
DUKCPI	-3.6750	-2.8678	Stationary
DUSCPI	-11.6320(SBC)	-2.8678	Stationary
	-5.5566 (AIC)	-2.8678	Stationary

Where:

- GBPUSD is the GBP exchange rate in USD
- UKCPI is the United Kingdom Consumer Price Index
- USCPI is the United States Consumer Price Index

4.2. DETERMINATION OF ORDER OF THE VAR MODEL

Before proceeding with the test for cointegration we need to determine the order of the VAR. In other words, we are trying to determine the optimum number of lags for the equation. To do so, we will use AIC and SBC methods, which both give optimum number of lags, except that AIC maximizes it whereas SBC minimizes it.

	AIC Criteria	SBC Criteria
Optimal order	6	1

To solve this conflict between AIC results and SBC results, we have to look at the data we have used. First we check for serial correlation of each variable.

IT is evident that autocorrelation is present in some variables. If we proceed with the lower order there is a chance of encountering the effects of serial correlation. Proceeding with the higher order would risk over-parameterization however our long time series of over 400 observations negates this trend. Based on the judgment of the researcher and considering the tradeoffs we opt for a **VAR of 1**.

4.3. TESTING COINTEGRATION

The previous steps served to determine the stationarity or not of our variables, and the optimum VAR order. Now that we have clarified that all our variables are non-stationary and that the optimum VAR order is 5, we can test the co-integration.

In this step, we are testing the co-integration of the variables by looking at the results of Eigen value test, and trace test. Co-integration will indicate whether the variables are moving together in the long run or not.

Eigen value Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	64.9598	25.4200	23.100
r<= 1	r>= 2	18.4228	19.2200	17.1800

Testing the co-integration is a test that allows us to see the relationship between the variables in the long run. In the results showed above, we can see that for r=0, the statistical value is higher than both critical values, at 95% and 90% confidence intervals. As such, we can reject the null hypothesis that is, there is no co-integration.

In the second case, when r=1, the statistical value is lower than the critical value. We can then accept the null hypothesis, which is in that case, that there is one co-integration at the 95% confidence level. Trace test provides for two co-integrations at the 95% confidence level.

Trace Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	92.1367	42.3400	39.3400
r<= 1	r>= 2	27.1770	25.7700	23.0800

Further, SBC gives a result of 1 co-integration while AIC results in 2. Although there is enough evidence to support cointegrating of both 1 and 2 vectors based on our judgment and previous work, we choose 1 co-integration and r value of 1.

4.4. LONG RUN STRUCTURAL MODELLING (LRSM)

At this stage, we are willing to understand how the variables are moving together in the long run. Indeed, testing the co-integration, did only tell us whether or not the variables are co-integrated. We know now that our variables are co-integrated, so moving together in the long run. However, it is important to keep the theory in our research. This is what we are aiming to do in the Long Run Structuring Model. We are now testing our theory on the results we previously got. This step allows us to establish the fact that our results are not only scientific, but also supporting and supported by a theory.

We have run the LRSM test with the restriction a1=1, or GBPUSD=1. Our main objective is to evaluate the impact foreign and domestic price changes on the exchange rate between the two countries. We then have computed the chi-square p-value of our variables, to test whether our variables are significant or not

Variables	Vector 1	Vector 2
LGBPUSD	1.0000 (*NONE*)	1.0000 (*NONE*)
LUKCPI	-1.5200* (.41796)	-1.000 (*NONE*)
LUSCPI	2.7643* (.84241)	1.7612* (.16752)
Trend	-.0018320 (.0011124)	-.5977E-3 (.4906E-3)
CHSQ(1)=		1.6379[.201]

We have found all variables to be significant in Vector 1 and this supports our data in relation to the theory. This is a well-tested hypothesis so we did not expect any surprises in this step nor did we receive any. Vector 2 represents the over identification step. We have decided to test the hypothesis based on our theory and therefore selected UKCPI to be -1. We found a p-value of .201, meaning there is a high probability that our null hypothesis is right in that **our restriction is correct**.

Although the null hypothesis for vector 2 is accepted and this means that empirically the restriction is correct the author feels that this restriction would remove some valuable information on the relationship between the variables and we therefore revert back to the exact identifying vector 1.

Our equation becomes then:

$$GBPUSD - \underset{(0.41796)}{1.52UKCPI} + \underset{(0.84241)}{2.7643USCPI} \rightarrow I(0)$$

We must note that the signs are in accordance with the general trend of our theory. Our ideal vector would be [1,-1,1] and our cointegrating equation vector being [1,-1.52,2.764] does provide acceptance of the theory in general.

4.5. VECTOR ERROR CORRECTION MODEL

However, we do not know which of our variables are exogenous or endogenous. We need now to evaluate which variables are the leading ones. To find out about it, we need to test with the vector error correction model.

Co-integration tells us that in the long run, our variables are going together. The error correction term in the equation will be able to determine leading variables and follower variables.

The principle in action here is that of Granger-causality, a form of temporal causality where we determine the extent to which the change in one variable is caused by another variable in a previous period.

Dependent Variables	DGBPUSD	DUKCPI	DUSCPI
ECM(-1)	-.0062183* (.0046050)	-.011332* (.8833E-3)	-.0062721 (.0021779)
Chi-sq SC(1)	[.027]	[.000]	[.000]
Chi-sq FF(1)	[.229]	[.012]	[.288]
Chi-sq N	[.000]	[.000]	[.000]
Chi-sq HS	[.135]	[.000]	[.126]

Variable	ECM (-1) t-ratio p-value	Implications
GBPUSD	[.178]	Variable is exogenous

UKCPI	[.000]	Variable is endogenous
USCPI	[.000]	Variable is endogenous

The implication of this result is that policy makers should attempt to influence exchange rate through some means other than prices as prices are a follower variable. This is opposite to our theory which would have expected US prices, USCPI, to be exogenous. We discuss later in our conclusion that despite the theory, these are very encouraging results and policy makers in actual practice have resorted to influencing exchange rate directly through various market operations.

We also note that we are missing some information due to Microfit 5.1 not providing dependent variable relationship information upon selecting a lag order of 1. The result was attempted with a lag order of 2 however, LRSM step showed that no variables were significant. Therefore it was decided that it was more appropriate to accept the limitations of the software and proceed with a lag order of 1 rather than have variables which returned as insignificant in the LRSM step.

The coefficient of e_{t-1} tells us how long it will take to get back to long-term equilibrium if that variable is shocked. The coefficient represents proportion of imbalance corrected in each period. We note that some p values for the tests are below .05 indicating that the null is rejected and we suffer from the problems in the test. However we are not overly concerned due to previously completing ADF to reduce autocorrelation and the long time series in reducing heteroskedasticity, our two main concerns.

4.6. VARIANCE DECOMPOSITIONS

Vector error correction model told us which variable is endogenous, and which one is exogenous. However, we do not know exactly which one is the most leading variable. For this reason, we go through variance decomposition. This stage allows us to see how much a variable responds to its own shock. The one with the highest percentage is the most exogenous variable.

	GBPUSD	UKCPI	USCPI
GBPUSD	0.969205	0.0006	0.030196
UKCPI	0.544813	0.452988	0.002199
USCPI	0.689483	0.092693	0.217824

	GBPUSD	UKCPI	USCPI
GBPUSD	0.949995	0.0039	0.046105
UKCPI	0.710487	0.285003	0.00451
USCPI	0.84192	0.092288	0.065792

The table shows us that the most leading variable in our equation is the exchange rate GBPUSD. It is explained by its own past at over 90% for both horizons. In the table, rows are the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in columns), including its own. The columns are the percentage in which that variable contributes to other variables in explaining observed changes. The diagonal line of the matrix represents the relative exogeneity.

Now traditionally theory has regarded USCPI as the exogenous variable. This is because the US economy has long been considered the driver of the global economy as it is the largest single contributor to GDP. The sheer size and importance of its economy for almost all of the 20th century has lead for researchers to automatically assume that it is exogenous in nature and not affected by other economies and events. This is why traditionally when testing PPP the home country is compared against the United States. Also it helps that the US Dollar is the worlds global currency for precisely the same reasons.

However, recent events such as the global financial crisis of 2008 while not having disproven this view but have at least shaken these assumptions. Especially when coupled with the rise of China and the continuing US recession it can no longer be a given to accept the hypothesis that the US economy is 'like the rainfall', meaning exogenous.

4.7. IMPULSE RESPONSE FUNCTIONS (IRF)

We have seen in VDC which variable is the most endogenous and the most exogenous. The IRF only shows us the results in a graphical form. It does not bring any new information to us.

It does however give an appreciation as to the general movements of the variables over time.
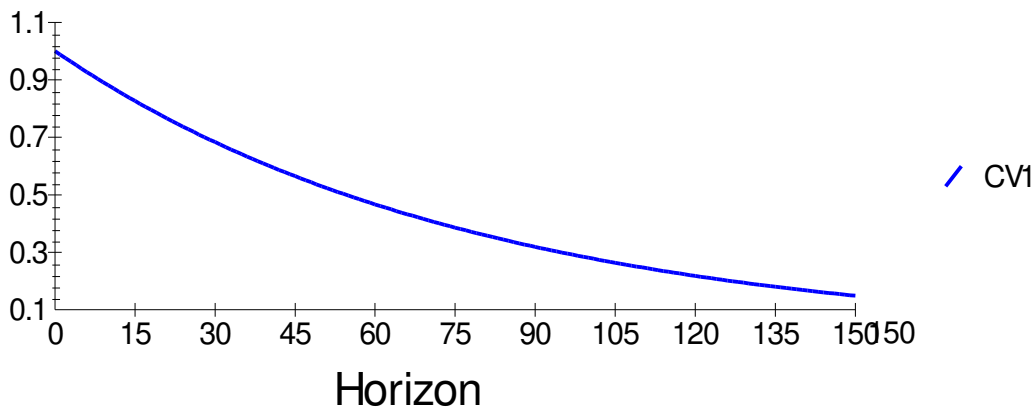
Generalized Forecast Error Variance Decomposition for variable LUSCPI

Legend: LGBPUSD, LUKCPI, LUSCPI
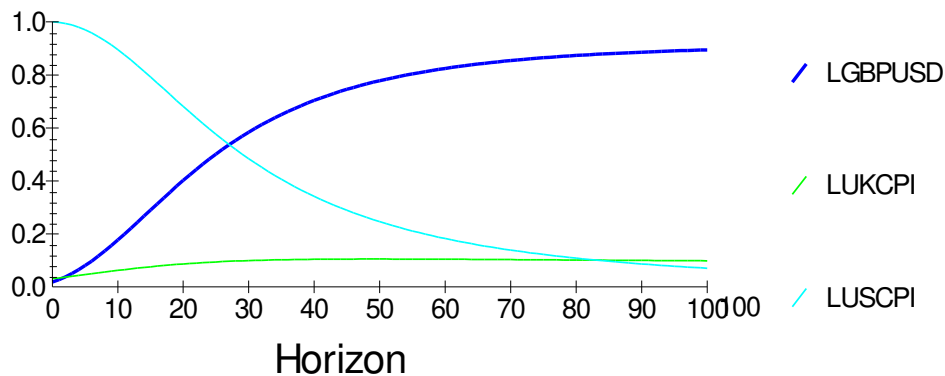
All the other results are as expected and can be found in the appendices.

4.8. PERSISTENCE PROFILE

Persistence Profile of the effect of a system-wide shock to CV'(s)

Legend: CV1

The chart above shoes the persistence profile for the cointegrating equation for this study. Persistence Profile shows us how long does it take to the whole system to come back to equilibrium after a shock. In the present graph, we can see that it takes around 150 months to do so. This would indicate over 15 years.

As is the case when utilizing real world results there are often complexities that are not captured in the model which may lead to unpredictable results such as the above. In the above case it is the authors humble attempt at explanation that short term information is being

captured in the long term portion which we are examining. This is leading to a dampening effect that is elongating the time to equilibrium. In other words, every period the system moves to equilibrium in the long term, short term effects may slightly adjust it one way or another, which then elongates the time needed to reach equilibrium.

5. Conclusion

In our paper we found that exchange rate was overwhelmingly the leader variable

The PPP theory was developed in 1918. A lot has changed in the world since that time. We have been through several currency regimes. Among important recent development there has been the so called 'Currency Wars' alluded to by even the leaders of the largest nations in the world such as Germany and France. The situation nowdays is that countries ensure that their exchange rate stays favorable to the country such that the country's export market is increased by lowering the exchange rate of its currency as compared to other currencies. China has long been accused as the most notorious culprit in keeping its currency artificially low in order to boost exports.

The direct result of this has been unprecedented intervention into the markets by central banks to 'guide' the currency. This year we have seen Japan and Switzerland intervene to put an end to an abrupt appreciation of the currency visa vis others. Some nations have been content with the rise in its currency and have not intervened such as, Australia.

Nonetheless what is key here is that it in today's environment it is not unreasonable to view exchange rate as exogenous because policy makers themselves have resorted to treating it as the leading variable. Therefore, although the results are not entirely in line with PPP theory the author is pleased with the results. They are still valuable and sufficient explanation exists to support them.

Another important implication is that traditionally the United States economy and therefore the US consumer price index has typically been taken as foreign price to compare against. This is why typically all countries are compared against the United States as it leads to ease in selecting the US consumer price index as the exogenous variable in the theory. What we are seeing is that this may no longer be an acceptable assumption for researchers to rely on , especially given the impact of the recent events on the United States economy mentioned earlier.

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