Sub-Sahara's Experience with the Purchasing Power Parity Hypothesis

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For a panel of 19 Sub-Sahara African countries, annual data are used to carry out an empirical investigation of the main tenet of the Purchasing Power (PPP) Hypothesis. After a brief examination of recent inflation and direction of trade data, OLS techniques are used to establish an initial link between inflation differentials (for the panel with the five primary industrialized countries) and changes in the bilateral nominal exchange rates. Following an ADF unit root test, the Johansen cointegration technique is used to search for a stable long term relationship for these variables that would provide support for the PPP. There is at best modest support for the premise that aggressive fiscal and monetary policies aimed at combating high inflation can guarantee a stable currency.

INTRODUCTION

Despite being around for many decades the Purchasing Power Parity theory provides one of the most useful perspectives from which to analyze economic policies bearing on the potential misalignment of a country's exchange rate. Thus it is important to have a firm read on the long run relationship between national price level changes and currency values. For the last two decades both the level and volatility of inflation rates in African countries have been higher than those experienced by countries in the other two developing country continents of Asia and Latin America.[1] The establishment of an equilibrium or steady-state theoretical exchange-rate level serves the policy function of identifying and correcting potentially destabilizing deviations from this desired level.

A Statement of the PPP

Following the Law of One Price, the absolute version of the PPP states the number of the units of one currency that would exchange for a unit of another currency to ensure that these quantities of both currencies would provide identical purchasing power in both economies. The relative version stipulates the percentage change in the nominal exchange rate necessary to account for a given relative price change. This version implies that price changes in one country will create a temporary fluctuation in the purchasing power of that currency leading to profit-seeking arbitrage activities which ultimately restore purchasing power. For one country the spirit of either version can be expressed in this equation:

$$S_{it} = \beta_i (P_{it} - P_{it}^*) + \mu_t \qquad (1)$$

Where, S_{it} is the nominal exchange rate

P_{it} is the domestic price level

P^*_{it} is the foreign price level.

For purposes of regression analysis, Equation 1 can be formatted as follows:

$$S_{it} = \beta o + \beta_1 Pt + \beta_1 P^*_t + \mu_t \quad (2)$$

Empirical investigation into the PPP over the last three decades has been at best mixed. While Frenkel (1981) finds little support for the PPP for countries experiencing real economic shocks, his 1978 paper gets estimates for β_1 and β_2 in the above equation to be close to positive and negative one respectively for countries burdened with high rates of inflation. Lui (1992) replicates Fenkel's 1978 findings while Sarno and Taylor (2002) confirms Frenkel's 1981 conclusion that traditional OLS techniques fail to support the PPP hypothesis in a general setting. The work of Engle and Granger (1987) highlights the fact that since many macroeconomic variables are nonstationary in nature, regression analysis could produce spurious results. Their work suggested that if variables could be shown to be nonstationary then this paves the way to investigate whether they are cointegrated with the implication of an underlying long-term relationship between them.

This paper seeks to use annual data from 19 Sub-Saharan African countries to investigate whether there is such an underlying long-term relationship between the nominal exchange rate and the domestic and foreign price levels. This is accomplished by using data reflecting the bilateral exchange rates between members of the panel and each of five major industrial countries; the US, the UK, France, Germany and Japan. In the following section there is a brief analysis of the inflation figures and the trading experience of the panel members with these DC's, as well as some further explanations of the data used in this study. After a cursive examination of the preliminary OLS results for Equation 1, the paper moves on to unit root and cointegration tests. A concluding section analyzes the implication of these results for the validity of the PPP

BASIC DATA

Table 1 presents the average annual rate of inflation for the period1960 2006, and also for the last available 10 year period ending in 2011. For the sake of analysis we can think in the African context of low or controlled inflation as being less than 5%, moderate 5 to 10%, and high inflation as above 10%[2] Only four countries (Mali, Central African Republic, the Republic of the Congo and Burkino Faso) managed to keep inflation low in both periods, with the good news being that in the latter time period inflation was kept below its long-term average. Three countries: Ethiopia, Ghana and Senegal were in the moderate group and also experienced falling rates in the more recent time period. Every other African country experienced high inflation in at least one of the two periods with most performing poorly in both, and with the Democratic Republic of the Congo averaging above 800% in both time periods. Zimbabwe's record of over 4,000,000% in the last 10 years was a result of the economic dislocation associated with the traumatic election and near civil war, with these massive increases occurring between 2004 and 2007. This record of high inflation and especially long-term inflation should provide an excellent testing ground for the long run PPP in as much as it was noted earlier that the consensus points to the validation of the PPP in cases where high inflation persists into the long run.

Table 2 shows the percentage of total trade [exports plus imports] between each panel member and each of the five developed countries (DC's) in this study for two individual years, 1980 and 2011. Several salient observations can be made from these data. Between these two years there is a noticeable drop in the share of panel country trade with these five DC's, with the drop being steeper in imports than exports. Second, of the five DC's the percentage of panel trade is highest with France and lowest with Japan. Third, individual DC's appear to maintain strong trading relationships specific panel countries. For example France, not too surprisingly, maintains a strong trading profile with the handful of Francophone

countries included in the panel. This is not merely because these are former French colonies, but primarily because unlike the UK and her former colonies, France maintains various binding preferential trading ties as well as special monetary arrangements with these countries. The implication of a shift from LDC-DC trade to South-South trade is borne out by the fact that by 2010 China and South Africa had become big players in Sub-Sahara Africa; hence the diversion of trade to these two giants.

PANEL TEST CONSTRUCTS

For a single country series a variable Y is regressed on a lagged version of itself and other regresses X_i with the residual error term E.

$$Y_t = \rho Y_{t-1} + \delta X_t + E_t \quad (3)$$

Where X_t represents regressors such as a constant or a time trend, ρ and δ represent the parameters and E_t the white noise,

If the coefficient, ρ on the lagged term Y takes on the value absolute one, it can be concluded that the series Y is nonstationary i.e. has a unit root. Extending this to panel data to allow for multiple cross-sections, and to the augmented Dickey Fuller test, to accommodate higher order lagged series, the unit root specification becomes:

$$\Delta Y_t = \propto Y_{t-1} + \beta_1 \Delta Y_{t-2} \ldots\ldots \beta 1\, \Delta Y_{t-p} + \delta X_t + V_t \quad (4)$$

Where $\propto = \rho - 1$,
And where they are i=1-----n series and t=1-----T_i periods. The condition for the finding of a unit root remains essentially unchanged: $\propto = 0$

With a unit root affirmed, Equation 3 is rewritten with the residual cast as the dependent variable:

$$u_t = Y_t - \beta_0 - \beta_1 x \quad (5)$$

Next a unit root test is conducted on this construct. If this test confirms that it is stationary i.e. integrated of order zero, then Y and X are cointegrated meaning that there is a long-term relationship between them. Pedroni [2004, 1999] and Maddala [1999] provide appropriate extensions of this equation to panel data constructs.

OLS RESULTS

Table 3 provides the results for the regression analysis following Equation 2. For the US, UK and France the signs on the contemporaneous domestic and foreign price levels are correct [positive and negative respectively]. Further these coefficients β_1 and β_2 are all significant at the 1% level, with reasonably high coefficients of determination. In the case of Germany and Japan the domestic price level carries the correct sign and is significant at the 1% level while for Germany the foreign country price level coefficient has an unexpected positive sign and is insignificant at the 5% level.[3] When one period lags are introduced the results do not appear to change noticeably. The panel's domestic price level remains positive and significant for all countries while again the developed country's price level remains negative and significant only for the US, the UK and France. For the most part the one period lagged

price variables [foreign and domestic] reverse signs and are almost always insignificant at the 5% level. This suggests that almost all of the response of the nominal exchange rate to both price levels had not only been accomplished by the end of the first year but also that any overshooting of this exchange rate was corrected 12 to 24 months out.

In two areas these results are somewhat week. First, consider the symmetry and proportionality conditions.[4] While it is true that for the most part the coefficients on these price variables range from close to positive one to negative approximately .5 (the US, the UK and France), only Germany carries the value of approximately 1for both, though with the incorrect sign on the German price variable. Second, the Durbin Watson statistic is infinitesimal (instead of the expected approximately 2.0), suggesting the presence of positive first order autocorrelation. Further, the fact that the Durbin Watson is generally dwarfed by the R^2 raises the specter (not the confirmation) of spurious regression, (Gujarati and Porter, 2009). The logical next step is to examine the stationary nature of these variables.

PANEL UNIT ROOT TEST

These results for the unit root test (both level and first difference) are presented in table 4. These follow the ADF Fisher form of the test using the Schwartz Information automatic lag length.[5] Also for both stages of the test the null hypothesis is the existence of a unit root.

For the most part the results do indicate the existence of a unit root, as the level ρ values are quite high, while the low ρ values for the first difference test will cause us to reject the null hypothesis of the existence more than one root. The only level tests that give us some pause are the domestic price variables for German and Japan, where we cannot definitively accept the unit root hypothesis.

However there does appear to be strong evidence to support the notion that most of the variables in our study and especially the crucial ones namely the panel's domestic price variable and all of the bilateral exchange rates are nonstationary. This in turn suggests the likelihood of a long-term underlying relationship between the two sets of price levels and the nominal exchange rate. A cointegration test will either confirm or deny the existence of such a relationship, and lay the groundwork for the exploration of the nature of such a relationship.

PANEL COINTEGRATION TEST

The specific form of the cointegration test we choose to use is the Johansen-Fisher construct. We make this choice because in addition to a determination or lack thereof of overall cointegration, it allows us to investigate the cointegration for individual panel members. Table 5 displays both the Trace and Maximum Eigenvalue results of cointegration. For each of the developed countries the test follows Equation 1, i.e. the panel's domestic price level, the bilateral exchange rate and the developed country price level. The first column shows the number of hypothesized cointegrating relations assumed by the null hypothesis. This is followed by the ρ values for the null corresponding to the number of cointegrating equations shown in the previous column. Finally the single number that follows in the next column represents the actual number of cointegrating equations proven to exist, using the 1% confidence level.

Both the Trace and Maximum Eigenvalue test clearly point to the existence of two cointegrating equations for France, Germany and Japan and the UK, and differ as to whether there are one or two for the US. Even with this letter disagreement, the obvious implication has to be that the differentials in national price levels between the panel and each of the developed countries play some role in the determination of the relevant bilateral exchange rate.

Table 6 presents the results of the Trace cointegration tests for individual countries from the panel of African countries with each developed country. [For brevity the Maximum EigenValue results were omitted given that both results are fairly similar.[6] Most panel countries have at least one cointegrating relationship with one or more of the DC's, with the strongest case of multiple cointegrating equations being established in the case of Cameroon, Republic of Congo and Sierra Leone and Ghana. In fact the

only country for which no cointegrating relations found were the Gambia and the Democratic Republic of the Congo.

Inasmuch as the thrust of the PPP is that inflation is a driver of the nominal exchange rate changes[7], it would be worthwhile to see if the results from the cointegration test bear out this idea. In the last column of Table 1, the total of all cases of discovered cointegration cases for each panel member is matched with the average annual inflation numbers. As it is, the results are not clear-cut as two of the low inflation countries, Mali and the Republic of Congo have a higher than average number of cointegrating equations. Meanwhile the only two countries with no cointegrating equations are the Gambia which is in the moderate inflation group and the Democratic Republic of Congo which by a wide margin sports the highest average annual inflation over the 47 year period.

The results for the remaining 19 countries display no identifiable correlation between the variables in question. This outcome raises considerable doubt about the main tenet of the PPP. Perhaps a more in-depth study would be needed to determine whether government policies such as generalized or sectorial price controls, or exchange-rate setting could be fracturing the link between domestic prices and the nominal exchange rate.

CONCLUSION

The long run version of the PPP dictates that a country's nominal exchange rate with the rest of the world is determined by fluctuations of its inflation differentials with the rest of the world. This paper has attempted to test that hypothesis for a panel of 19 Sub-Saharan African countries against the five major industrial countries. A review of price levels in these 19 Sub-Saharan countries over the period 1962-2006 and a more recent period 2001 to 2011, paints a clear picture of high and volatile inflation for most countries. A comparison of the panel's trading patterns with these developed countries for two individual years, 1980 and 2011, shows a more distinct reduction in imports from than exports to, the developed countries. It is speculated that a not insignificant reason for this shift can be attributed to growing trade links with both China and South Africa.

And OLS regression analysis of the main PPP hypothesis does provide some support for the notion that price differentials impact the nominal exchange rate, though with some technical questions left unresolved. Panel unit root tests do confirm the existence of a unit root especially for the most significant variable, the panel's domestic price level. Based on this conclusion two cointegration tests are conducted. First, both the Trace and the Eigenvalue results of the Johansen- Fisher construct point to the existence of cointegration for the basic PPP equation for the panel with most of the developed countries. However when cointegration tests are done for individual panel countries with each developed country, there is no clear pattern of an association of discovered cointegration equation with the rate of inflation for that country.

This latter finding calls into question the validity of the long run PPP for sub-Saharan Africa and would appear to suggest the need to broaden the research to include individual country economic policies relating not only two practiced monetary policy, but also regulations governing resource use in the broadest sense.

END NOTES

1. It must be noted that for most LDCs there is a limited extent to which a central bank can influence the trading range of its currency if it operates a reasonably flexible exchange rate regime.
2. Please see http://www.inflation.eu.
3. It must also be noted that while the quarterly data sample size averages about 155 for the other four DCs, for Germany there are only 72 observations.
4. The symmetry and proportionality conditions are supposed measures of the accuracy of the empirical results from an **OLS** regression as provided by the coefficients on the domestic and foreign price variables β_1 and β_2. The symmetry condition requires that these be both equal and of opposite sign, while the proportionality condition (the more binding of the two) requires that $\beta_1=1$ and $\beta_2 = -1$.

5. In about two of the cases for the CPI, the lag length was fixed at 4 by the author.
6. These Trace results are available from the author.
7. As we have maintained throughout the paper it is the inflation differential that matters l. But since the price levels in the DC's have been stable for the past three decades especially when compared with our panels volatile price levels, isolating the panels price level and comparing it with the number of cointegrating equations sets up as a useful exercise.

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