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Sources of Inflation in Sub-Saharan Africa

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This paper explores the sources of inflation in Sub-Saharan Africa by examining the relationship between inflation, the output gap and the real money gap. Using heterogeneous panel co-integration estimation techniques, we estimate co-integrating vectors for the production function and the real money demand function to recover the structural output and money gaps for 17 African countries. The central finding is that both gaps contain significant information regarding the evolution of inflation, albeit with a larger role played by the money gap. There is no significant evidence of asymmetry in the relationship.

JEL classification: *E3, E5, O4*

1. Introduction

An important relationship relatively undocumented for Sub-Saharan African (SSA) countries is the Phillips curve, which represents the trade-off between inflation and excess demand in the economy. The evaluation of excess demand is notoriously difficult, especially for developing economies where commonly used measures such as NAIRU (non-accelerating inflation rate of unemployment) are unavailable. We close this gap by constructing measures of inflationary pressures due to excess demand. We also construct a measure of the real money gap and test its information regarding future inflation. Our measures could be important not only for forecasting inflation, but also for building basic macroeconomic models for policy analysis, including financial programming

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models used by the International Monetary Fund (IMF) (see Mikkelsen, 1998).

A number of authors have attempted to identify the sources of inflation in SSA, but they have generally taken a reduced-form VAR approach (e.g. Fielding *et al.*, 2004; Mikkelsen and Peiris, 2005). These authors have not attempted to estimate the short-term tradeoffs between inflation and excess demand due to insufficient data. Money demand in SSA has been more thoroughly investigated [e.g. Nachega (2001) on Uganda, Rother (1999) on the West African monetary union, or Jenkins (1999) on Zimbabwe], but studies have rarely directly related monetary aggregates to inflation dynamics.

In this paper, we will analyze the determination of inflation in SSA, particularly the role of output gap and real money gap. There are two basic methodologies for recovering unobserved components such as potential output: statistical detrending or estimation of structural relationships (see Coe and McDermott, 1997; Cerra and Saxena, 2000). In this paper, we recover the unobserved structural (output and money) gaps for a sample of SSA countries by using a panel co-integration approach and economic theory to isolate the effects of structural and cyclical influences. In this way, we attempt to mitigate the problem of small sample biases that have prevented the reliable estimation of these structural gaps in most SSA countries. We then use a panel GMM estimator to test the role of output and money gaps in determining the inflation in SSA. Since SSA countries present considerable variations in their average level of inflation, we estimate a Phillips curve for SSA as a whole as well as for CFA Franc zone countries and non-CFA Franc zone countries. Dividing the sample based on the average inflation rate broadly coincides with the CFA Franc/non-CFA Franc grouping, with low inflation countries part of the monetary union. To preview our results, we find that our two measured gaps both contain robust and considerable information regarding the evolution of inflation across SSA with the money gap playing a large role in non-CFA Zone economies.

The paper is organized as follows: Section 2 takes a short look at the sources of inflation and the Phillips curve in theory; Section 3 describes the procedure followed to estimate the output and real money gaps; Section 4 describes the data and Section V presents the panel data estimations of the structural gaps and augmented-Phillips curves for SSA.

2. Inflation Determination

In developing countries, there are four frequently cited sources of inflation:[1]

- Demand pressures: a standard measure of the relative pace of economic activity is the output gap, the difference between output and potential output.
- Fiscal and monetary policies: fiscal imbalances in developing countries with scarce resources often lead to monetization of the fiscal deficit. To capture inflationary pressures stemming from 'excess' money supply, we consider the real money gap, the difference between real money stock and equilibrium real money stock (the level equal to real money demand).
- Supply shocks: changes in the terms of trade, drought, or conflict can lead to persistent changes in the price level.
- Inertia: inflation may have an inertial dynamic component arising from the sluggish adjustment of expectations or the existence of staggered wage contracts.

Therefore, we will consider an augmented-Phillips curve of the general form:[2]

$$\begin{aligned}\pi_{i,t+1} = \pi_{i,t+1}^{e(t)} + \alpha_y\left(y_{i,t} - y_{i,t}^*\right) + \alpha_m\left(m_{i,t+1} - m_{i,t+1}^*\right)\\ + \alpha_z z_{i,t+1} + \alpha_i + \alpha + \varepsilon_{i,t+1}.\end{aligned} \quad (1)$$

where $\pi_{i,t+1}$ is the annualized inflation rate at date $t+1$ in country i, $\pi_{i,t+1}^{e(t)}$ is expected future inflation at date t, $y_{i,t}$ is output, $y_{i,t}^*$ potential output, $m_{i,t+1}$ is real balances, $m_{i,t+1}^*$ is long-run equilibrium real balances, $z_{i,t+1}$ is an exogenous variable or shift factor like a supply shock, α_i denotes unobserved country-specific heterogeneity and α is the intercept. Given that African data are available on an annual basis, we assume that the real money gap can have an

[1] See, for example, Loungani and Swagel (2001).
[2] The new-Keynesian Phillips curve is a relation between inflation and marginal cost as opposed to inflation and the output gap. Since there are no data on unit labor cost in SSA, we will focus only on the traditional Phillips curve.

'immediate' impact on inflation while the output gap enters only the Phillips curve with a lag.

We will proxy expected inflation by lagged inflation, assume $\pi^{e(t)}_{i,t+1} = \alpha_\pi \pi_{i,t}$ and estimate α_π in equation (1).

3. Measuring the Output and Real Money Gaps

The output and real money gaps are the two crucial variables measuring demand pressures that generate inflation. Measuring them is nevertheless notoriously difficult because we need to isolate long-run movements from short-run fluctuations capturing demand variations.

Our general approach in this paper is to identify long-run trends through co-integration relationships. For the output gap, provided that there is co-integration, we are able to estimate a co-integrating vector (β_K, β_L) by postulating a simple two-factor Cobb–Douglas production function:

$$\ln\left[Y_{i,t}\right] = \beta_K \ln\left(K_{i,t}\right) + \beta_L \ln\left(L_{i,t}\right) + tfp_{i,t} + c + \varepsilon^{y}_{i,t}. \tag{2}$$

where $tfp_{i,t}$ is total factor productivity. Provided that $\varepsilon^{y}_{i,t}$ is stationary, we can interpret the short-term deviation around the estimated long-term output as the output gap. For comparison, we will also use statistical detrending and estimate potential output with the Hodrick–Prescott filter.

To define the real money gap, we must specify the long-run money demand m^*_t. Because of a lack of reliable data and absence of market-determined interest rates in many SSA countries, at least until recently, we assume a simple specification for money demand that disregards the opportunity cost of holding money:[3]

$$m^*_t = \ln\left[\frac{M_{i,t}}{P_{i,t}}\right] = \kappa_y \ln\left(Y_{i,t}\right) + \kappa_{i,t} + \kappa + \varepsilon^{m}_{i,t}. \tag{3}$$

[3] In one specification from 1970 until 2003, we included the opportunity cost of holding money proxied by deposit interest rates, but did not find any significant effect. The expected inflation was not included as a potential determinant of money demand, as we intend to use the money gap to explain inflationary processes in subsequent sections.

where $\kappa_{i,t}$ is a country-specific trend that allows for changes in the financial technology that affects money demand independent of income. $\varepsilon^{m}_{i,t}$ will be interpreted as the real money gap.

4. Data and Methodology

The paper uses annual data on a panel of African countries covering a maximum time span from 1960 to 2003 with a few countries missing data for a few years. Because of data limitations for the investment time series, we consider only a subset of 19 countries. All data are taken from the World Development Indicators (WDIs) except the capital stock, rainfall and the war index. Inflation is the change in the log of the consumer price index, labor is proxied by population and money is defined as 'money plus quasi-money'. The real capital stock is taken from the Nehru and Dhareshwar (1993) dataset. Since data are available only from 1960 until 1990, the time series are extended using gross-fixed capital formation from the WDI and a depreciation rate of 10% using the last available entry in the Nehru and Dhareshwar capital series (1990 or less). Rainfall data are taken from the FAO Clim 2.0 dataset, which uses gauge data from 1960 to 1998 to estimate total yearly rainfall in meters. Following Miguel *et al.* (2004), a war index is built from 1960 until 2003 using the PRIO database. All country–year observations with a civil conflict in progress with at least 25 battle deaths per year are coded as ones, and other observations are coded as zeros.

5. Panel Estimation

5.1. Estimation Technique

A key point in estimating a Phillips curve is the accurate measurement of the economy's excess demand. We focus on two indicators: the output gap and the real money gap. The two main challenges in estimating long-term relationships in SSA are the short data time span and the frequent structural changes related to natural and man-made disasters and changes in institutions. This makes single country co-integration tests very sensitive to the different test specifications and rarely provides robust estimates of long-run relationships, which are required for computing the output and real money gaps.

As an alternative approach to single country analyses, we use heterogeneous panel co-integration techniques introduced by Pedroni (2000, 2004) to determine the long-run properties of output and real money demand. The interest in this approach is 2-fold. First, the existence of co-integrating relationships for output and the real money demand in SSA has not been documented and is interesting in its own right. Secondly, the group-mean FMOLS[4] estimator from Pedroni (2000) allows heterogeneous dynamics, heterogeneous co-integrating vectors and complete endogeneity. Intuitively, it pools the long-run information contained in the panel (thus bringing additional information to bear upon a particular co-integration hypothesis), while permitting short-run dynamics and fixed effects to be heterogeneous across different members of the panel enabling us to estimate the long-run production function and long-run real money demand operating across different SSA countries. Moreover, the technique helps to avoid producing inconsistent estimates of standard errors when regressors are endogenous, as would be the case under panel OLS methods.

The systematic estimation of the production function and money demand function allow us to derive output gaps and money gaps for SSA. Using the pooled dataset of a large sample of SSA countries, we estimate equations (2) and (3), and assume that the unique co-integrating vectors estimated correspond to a stable production function (constant factor shares) and long-run money demand function (constant elasticity of money demand), respectively.[5] We view this method as a good first-approximation given the strong theoretical underpinnings and simple specification employed. In the case of the output equation, this approach allows us to conduct a simple growth accounting exercise without imposing arbitrary assumptions regarding the production

[4] Each FMOLS estimator corrects for endogeneity and for serial correlation by estimating long-run covariance directly.

[5] The sample of SSA countries include Botswana, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Uganda, Zambia and Zimbabwe.

process.[6] However, to determine potential output, we still need to derive total factor productivity. This is done by smoothing the residuals of the co-integrating equation by fitting a polynomial. Indeed, robust estimates of TFP growth should be based on information for a sufficiently long period of time, as TFP reflects inherent advancements of knowledge about the production process, as well as reallocation of resources from low-productivity sectors (such as agriculture) to high productivity sectors (such as manufacturing).[7] The choice of a polynomial allows richer idiosyncratic behavior through time and is no-more *ad hoc* than a deterministic trend. As emphasized by Pritchett (2000), the growth patterns in developing countries have been far from similar. 'While some countries have [had] steady growth, others have [had] rapid growth followed by stagnation, rapid growth followed by decline or even catastrophic falls, continuous stagnation, or steady declines'. The output gap is then defined as the difference between the actual and potential output.[8] For the long-run money demand, we allow for deregulation or changes in the financial technology that affects money demand independently of income. For the same reasons as before, we fit a higher-order polynomial instead of a simple linear trend. Similarly, the real money gap is the difference between actual and long-run money demand.

5.2. Data Properties

Before testing for panel co-integration, we need to make sure that the variables of interest have unit roots. We take advantage of the panel structure and, rather than using time series unit root tests, and report the more efficient panel unit root tests from Im *et al.* (2002) for output, capital, labor and real money. In accordance

[6] This is usually the case in Growth Accounting exercises in SSA: a plausible capital share is imposed given data limitation and difficulties in estimating a robust long-run relationship (see, for example, Tahari *et al.*, 2004).

[7] Most other studies of the sources of growth estimate TFP by the residual of output not explained by changes in factor inputs. Thereby, typically very large short-term output fluctuations, which are caused by a host of other circumstances, are attributed to changes in TFP. Tahari *et al.* (2004) provide a good overview of past studies and provides estimates of TFP growth for countries in SSA.

[8] Note that output gap estimates remain similar if we estimate the production function in one-step, with factor inputs and time trends entered simultaneously. The same is true for money gap estimates.

with previous studies, Table A3 shows that we cannot reject the null of unit-root for these variables.

5.3. Measuring the Output Gap

In order to test for the null of no panel co-integration, we use the seven statistics developed by Pedroni.[9] These statistics all aim at rejecting the absence of panel co-integration, but the power of each statistic varies with the sample size and the data-generating process. In Table 1 we report these statistics for the null of no panel co-integration between output, capital and labor under the assumption of a constant return-to-scale (CRS) production function. The evidence seems mixed because only three out of the seven tests can accept panel co-integration. However, our panel is small in N and T, and in that case, the two most powerful tests are the panel ADF-stat and group ADF-stat. Since these two strongly reject the null, this is encouraging for the existence of panel co-integration. Moreover, when we test for co-integration in first-difference in Table A5 (output and capital per capita are indeed borderline I(2)), we find evidence of co-integration in six out of seven cases. Hence, we conclude that output, capital and labor are panel co-integrated and proceed to the estimation of the co-integrating vector.

The result for the panel co-integration regression is shown in the first column of Table 2. The panel group FMOLS estimate[10] for the capital share is 0.28 and varies little when we change the sample size in the time or country dimensions. This is remarkably close to the usual capital share of one-third usually found for developed economies. Note that the results do not hinge on the CRS assumption. Table A5 reports FMOLS estimates when we do not impose

[9] Under the alternative hypothesis, panel ν statistic diverges to positive infinity. Therefore, it is a one-sided test where large positive values reject the null of no panel cointegration. The remaining statistics diverge to negative infinity, which means that large negative values reject the null. Pedroni (2004) showed with Monte-Carlo simulations that with small N and T, the two tests with the most power are the panel ADF-stat and group ADF-stat while the group ρ-test has the least power of the seven tests and under-reject the null of no cointegration.

[10] Since the data are panel co-integrated but not necessarily co-integrated at the country level, we do not report estimates for individual countries. However, it is interesting to note that all the significant capital share estimates have realistic values ranging from 0.18 to 0.62.

Table 1: *Panel Co-integration Tests*

Test	CRS Production function 1960–2004, $n = 17$	Real money demand 1970–2004, $n = 19$
panel v-statistic	16.64*	5.71*
panel ρ-statistic	−1.81	−1.35*
panel pp-statistic	−1.73	−2.60*
panel adf-statistic	−4.8*	−2.28*
group ρ-statistic	−0.53	−0.61
Group pp-statistic	−1.17	−2.64*
group adf-statistic	−4.42*	−2.71*

Note: Heterogeneous third-order polynomial allowed for production function, heterogeneous trend allowed for real money demand, no common time trend.
H_0, no heterogeneous panel co-integration.
*Significance at 5% level.

Table 2: *Cointegration Regressions*

Country FMOLS estimates	CRS production function capital share 1960–2004	Real money demand income elasticity 1970–2004
Panel group FMOLS	0.28* (21.62)	1.02* (30.36)

Note: No common time trend, all reported values are distributed $N(0,1)$.
H_0, no cointegration for most countries.
*Significance at 5% level.

a CRS production function. The capital share is then 0.27 and the labor share 0.78, thereby indicating that the CRS hypothesis is reasonable.

Finally, we evaluate the potential output series by imposing the capital share estimate of 0.28 for each country, thereby making the assumption that co-integrating vectors are the same across countries. The output gaps are defined as the difference between

Table 3: *Stationarity Tests for Measured Gaps*

		Without trend	Without/with trend
Y_gap	Im, Pesaran and Shin *W*-statistic	−10.54*	−7.14*
	Hadri *Z*-statistic	−2.79	0.10
Y_gapHP	Im, Pesaran and Shin *W*-statistic	−11.55*	−9.67*
	Hadri *Z*-statistic	−1.89	1.17
M_gap	Im, Pesaran and Shin *W*-statistic	−10.65*	−7.82*
	Hadri *Z*-statistic	−2.89	−0.45

Note: H_0 *W*-statistic: individual unit root, H_0 *Z*-statistic: no common unit root.
*Significance at 5% level.

true and potential output. They are typically in the range of ± 0.5 percent of GDP.[11] This is smaller than other output gap measures such as Coe and McDermott's (1997) for Asian economies, but of the same magnitude as the output gaps estimated using HP filtering, thereby strengthening confidence in our panel co-integration approach estimates. In Table 3, we verify that the gaps are stationary using the Im, Pesaran and Shin *Z*-stat and the Hadri *W*-stat tests.

5.4. *Measuring the Real Money Gap*

To estimate the real money gap, we follow the same procedure. First, we test for panel co-integration and, as above, find that the evidence in favor of panel co-integration is strong. As shown in Table 1, we can reject the null in six out of seven cases and the remaining case, the group ρ-test, has the least power. The money demand income elasticities are shown in the second column of Table 2. They are significant in 16 out of 17 cases and range from 0.44 to 2.16. The group mean FMOLS is 1.02. This estimate is broadly in line with the findings from Nachega (2001), Jenkins

[11] Note that using a different capital stock series (e.g. Penn Table) or assuming a different depreciation rate does not modify substantially the results.

(1999) and Rother (1999) who report income elasticities around unity for Uganda, Zimbabwe and the West African monetary union.

We recover the real money gap by imposing a money demand elasticity of 1.02 for each country. Compared with the output gap, it is economically larger and fluctuates around $\pm 1.5\%$ of GDP. We verify that it is stationary by running standard stationarity tests in Table 3.

5.5. *Phillips Curve Estimates*

Now that we have recovered the output gap and the real money gap, we are ready to estimate the expectation-augmented Phillips curve [equation (1)] for SSA. However, our sample contains countries with low inflation as well as countries with a long history of high inflation, and this heterogeneity could be of importance for the existence of an Africa-wide Phillips curve. In addition, some countries are members of a monetary union with a fixed exchange rate regime (the CFA Franc zone) whereas others pursue their own monetary policy. We could expect to find differences in inflationary processes depending on the exchange rate regime. Hence, we estimate our augmented expectations Phillips curve for different country groupings, and we divide our sample based on two criteria: (i) the average level of inflation during the sample period and (ii) whether the country is part of the CFA Franc Zone or not. As it turns out, dividing the sample based on the average inflation rate broadly coincides with the CFA Franc/non-CFA Franc grouping, with low inflation countries part of the monetary union. Therefore, we report separate Philips curves' estimates only for CFA Franc Zone countries and non-CFA Franc Zone countries.

The estimation of expectation-augmented Phillips curves [equation (1)] across the entire sample of SSA countries, as well as sub-samples of CFA Franc Zone and non-CFA Zone countries needs to take into account country-specific effects and the dynamic nature of the panel. With dynamic panels, the fixed effects estimator is biased and inconsistent when N tends to infinity and T is fixed (Nickell, 1981). To solve the inconsistency problem, however, we can use the Arellano and Bond (1991) generalized method of moments (GMMs) estimator. First, differencing equation (1) removes any country-specific effects, and produces an equation that is estimable by instrumental variables. Table 4 shows the results using the Arellano and Bond one-step GMM estimator.[12]

The output gap and money gaps estimated play an economically and statistically significant role in inflationary processes in SSA. Several conclusions are worth noting. The coefficient on lagged inflation is always significant with a value around 0.50. Regression equation (1) considers only the output gap whereas equation (2) considers only the real money gap. In both cases, the gap coefficients are significant. To answer the question of their relative importance in explaining inflation movements, we enter both variables simultaneously in equation (3). The structural output and real money gaps have a significant predictive power on inflation. The elasticities are, respectively, 0.28 and 0.34. Using an HP-filtered measure of the output gap does not change the main conclusions; the elasticities from equation (4) are 0.26 and 0.34. Recall that real money gap fluctuations were found to be more than twice as large as output gap variations. This means that for Sub-Saharan countries, the real money gap plays a larger role in the inflation process. This is not surprising as demand stimuli are often financed through 'excess' money printing.

One possible criticism of a Phillips curve for developing countries is the fact that potential output is less meaningful when a large proportion of output is accounted for by primary commodities whose production is supply-determined. Hence, our output gap measure could be a measure of supply shocks and not demand fluctuations. In regression equation (5), we control for exogenous shocks likely to have an impact on inflation: changes in the terms of trade, rainfall, war and the CFA Franc devaluation. The conclusions remain unaltered, indicating further that our gap measures do capture demand fluctuations and not purely supply shocks.[13] Although the estimate for the terms of trade is not

[12] For the Arellano and Bond estimates to be consistent, it is crucial that we first accept the null no second-order autocorrelation in the first-differenced idiosyncratic errors. Using the Arellano and Bond tests of autocorrelation of order 1 and 2, we can see in Table 4 that we accept the null of no second-order autocorrelation and reject the presence of first-order autocorrelation for all regressions. Moreover, the acceptance of the null of the Sargan test in the one-step estimator makes us prefer the one-step estimator over the two-step estimator, especially given the size of our sample.

[13] The elasticities are slightly bigger, but this is partly due to the shorter sample size (1970–1998) due to missing rainfall data.

Table 4: *Phillips Curve Panel GMM Estimates*

Dependent variable	Π	Π	Π	Π	Π	Π	Π	Π
Sample	1970–2004	1970–2004	1970–2003	1970–2003	1970–1998	1980–2003	1970–1998 Non-CFA Franc	1970–1998 CFA Franc
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimation	GMM	GMM	GMM	GMM	GMM	GMM	GMM	GMM
Π_{-1}	0.54*** (8.30)	0.54*** (4.66)	0.54*** (4.50)	0.55*** (4.62)	0.38*** (5.37)	0.38*** (4.33)	0.42*** (6.73)	0.32*** (6.19)
Y_gap$_{-1}$	0.27** (2.61)	–	0.28*** (3.29)		0.25*** (4.78)	0.33*** (3.43)	0.23*** (3.33)	0.07 (1.05)
Y_gapHP$_{-1}$	–	–	–	0.26*** (2.79)	–	–		
M_gap	–	0.34*** (3.97)	0.34*** (3.98)	0.34*** (4.05)	0.37*** (3.59)	0.41*** (3.10)	0.37*** (3.24)	0.15*** (3.35)
Δ(rainfall)	–	–	–	–	−0.12* (1.93)	−0.13** (2.45)	−0.12* (1.86)	−0.04 (0.03)
Intercept	−0.002* (1.89)	−0.001 (0.97)	−0.001* (1.32)	−0.001 (1.20)	−0.001 (0.07)	−0.032 (0.73)	0.002** (2.12)	−0.003** (2.54)
Controls	No	No	No	No	Yes	Yes	Yes	Yes
SE of regression	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15
AB test of first-order serial correlation (*P*-value)	0.01***	0.03**	0.03**	0.03**	0.03**	0.04**	0.05**	0.04**
AB test of second-order serial correlation (*P*-value)	0.65	0.91	0.75	0.75	0.62	0.49	0.52	0.76
Sargan test (*P*-value)	0.99	0.20	0.28	0.30	0.73	0.93	1	1

Note: The dependent variable is the change in the log of the consumer price index. First difference(AB 1-step) GMM procedure, White-SE, *t*-stat in parentheses. Sargan test H_0: instruments are not correlated with the residuals. Rainfall is measured in meters per year.
*Significance at 10% level.
**Significance at 5% level.
**Significance at 1% level.

significant, rainfall has a significant negative impact on inflation.[14] Finally, as emphasized by Faal (2005) for the case of Mexico, it is important to verify the stability of the relationship when testing for a Phillips curve. We made the implicit assumption that the relationship between the gaps and inflation was stable during the sample period but SSA countries could have experienced sharp structural changes or shifting expectations since 1970s. Encouragingly restricting our sample to 1980–2003 in equation (6) does not change the results.[15]

In equation (7), estimates for non-CFA Franc zone countries remain similar to the ones for the whole SSA sample. For the CFA-Franc zone, regression (8) shows that, as expected, money plays less of a role with the elasticity of the real money gap decreasing to 0.15. This is probably because pegging the nominal exchange rate to a low-inflation currency (French franc and more recently the Euro) imports credibility and anchors inflationary expectations providing less of a role for monetary control. An interesting difference is that the point estimate for the output gap in the CFA-Franc zone is low and insignificant, which is an area for further research.

To discuss the economic significance of our estimates, it is interesting to calculate the cumulative effect that a positive output gap or real money gap has on inflation. Using the estimates from regression [equation (5)], we find that a 1% increase in the output gap will contribute to a total excess inflation of 0.4% points over the future. A 1% increase in the real money gap will increase future inflation by a total 0.6% points. Since the output and real money gaps are in the order of magnitude of 1% of GDP, a 1% increase in the gap is only a minor fluctuation in GDP but this fluctuation has a far from negligible impact on inflation.[16]

[14] Indeed, for most African countries, the agricultural sector represents roughly 40% of GDP. A drought would lead to an increase in prices independent of demand inflationary pressures.

[15] This remains true if we restrict our sample to 1990–2003.

[16] With seemingly large standard errors for the Phillips curve regressions (about 0.14), one could wonder whether the gaps are economically significant. However, multiplying the standard deviations of the output gap and the real money gap (respectively, 0.06 and 0.15) with their respective point estimates of 0.25 and 0.37 [from equation (5)], we obtain values of about 0.02 and 0.06 (ignoring the cumulative effect) indicating that both gaps are not of minor importance.

5.6. Symmetry in the Phillips curve

A final policy question is whether there is any asymmetry in the Sub-Saharan Phillips curve. For example, in the case of a positive asymmetry in which inflation responds more to a positive gap than to a negative gap, allowing the economy to produce in excess of its potential will be more costly because a larger negative gap (whether output or money) will be needed to rein in inflationary pressures.

To test for asymmetry, we specify a simple asymmetric Phillips curve as follows:

$$\begin{aligned}\pi_{i,t+1} = {} & \alpha_\pi \pi_{i,t} + \alpha_y y_{\text{gap}\,i,t} + \alpha_{y\text{pos}} y^{\text{pos}}_{\text{gap}\,i,t} + \alpha_m m_{\text{gap}\,i,t+1} \\ & + \alpha_{\text{mpos}} m^{\text{pos}}_{\text{gap}\,i,t+1} + \alpha_i + \alpha + \varepsilon_{i,t+1}.\end{aligned} \tag{4}$$

where y^{pos} and m^{pos} represent the positive values of the output and the real money gaps.

As can be seen in Table 5, we do not find any significant evidence of asymmetry as the point estimates for y^{pos} and m^{pos} are never significant.

6. Conclusion

In this paper, we provide a first estimate of an augmented Phillips curve for SSA. We examine the determination of inflation in SSA, particularly the role of output gap and real money gap. The short data time span imposed by African data severely limit the single country analysis, and we use panel co-integration techniques to estimate the structural gaps. This also allows us to conduct a consistent growth accounting exercise across SSA giving a capital share of 0.28, which is remarkably close to the capital share of one-third usually found for developed economies. In addition, the panel money demand estimations report money demand elasticities around unity, confirming previous single country studies in SSA.

We present strong evidence that the structural gaps contain considerable information regarding the evolution of inflation. Interestingly, the real money gap plays a larger role in inflation processes than the output gap in SSA, highlighting the importance of the money gap as an indicator of inflationary pressures rather

Table 5: *A simple Asymmetric Model*

Dependent variable	Π	Π	Π
Sample	1970–2003	1970–2003	1970–2003
Regression	(9)	(10)	(11)
Estimation	GMM	GMM	GMM
Π_{-1}	0.54*** (8.42)	0.55*** (5.16)	0.54** (4.93)
Y_gap_{-1}	0.42** (2.00)	–	0.40** (1.96)
$Y\_gap_{-1}pos$	−0.35 (1.19)	–	−0.24 (0.70)
M_gap	–	0.33*** (2.21)	0.34*** (2.20)
M_gappos	–	−0.003 (0.01)	0.005 (0.02)
Intercept	−0.012* (1.94)	−0.001 (1.04)	−0.001 (1.49)
AB test of first-order serial correlation (p-value)	0.01***	0.03**	0.03**
AB test of second-order serial correlation (p-value)	0.65	0.91	0.73
Sargan test (p-value)	0.99	0.21	0.27

Note: The dependent variable is the change in the log of the consumer price index. First difference (AB 1-step) GMM procedure, White-period SE (d.f. corrected), *t*-stat in parentheses. Sargan test.
H_0: instruments are not correlated with the residuals.
*Significance at 10% level.
**Significance at 5% level.
***Significance at 1% level.

than focusing purely on output gaps as done in most developed countries. Moreover, the evidence suggests that targeting monetary aggregates can provide an effective anchor to control inflation in SSA as practiced by a number of countries in the region, especially in the context of IMF-supported programs. Estimates of a Phillips curve for non-CFA Franc zone countries remain in line with the results for the whole SSA sample. Money plays less of a role in inflationary dynamics in CFA franc zone countries than non-CFA franc zone countries, as expected, but the impact of the output gap in CFA franc zone countries is even less discernible. We do not find any significant evidence of an asymmetric Phillips curve relationship.

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