Pursuing the Phillips curve in an African monarchy: The Swazi case

Phiri, Andrew

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PURSUING THE PHILLIPS CURVE IN AN AFRICAN MONARCHY: A SWAZI CASE STUDY

Andrew Phiri
Department of Economics, Faculty of Business and Economic Studies, Nelson Mandela University, Port Elizabeth, South Africa, 6031.

ABSTRACT: The purpose of this study is to examine whether we can identify a Philips curve fit for the Kingdom of Swaziland as a low middle income Sub-Saharan Africa monarchy using data collected between 1991 and 2016. In our approach we rely on the recently introduced nonlinear autoregressive distributive lag (N-ARDL) model to a variety of Phillips curve specifications. For robustness sake, we further employ three filters (one-sided HP, two-sided HP and Corbae-Oularis filters) to extract the gap variables necessary for empirical analysis. Our findings point to a linear, short-run traditional Philips curve whereas we find strong support for concave shaped unemployment-gap and output –gap based Phillips curve specifications. Given the specific form of concavity discovered in the Phillips curves, the low inflation rate experienced over the last couple of decades can be attributed to a worsening labour and goods markets. Moreover, our evidence also cautions Swazi policymakers of 'overheating' of the economy during economic booms in which stabilization tools are required to implemented in such instances. Given the overall absence of empirical studies establishing the Philips curve for the Swazi economy our study makes a valid contribution to the literature.

Keywords: Inflation; Unemployment; Phillips curve; Central Bank of Swaziland (CBS); Hodrick-Prescott (HP) filter; Corbae-Oularis (C-O) filter; Emerging Economies.

JEL Classification Code: C22; C32; C52; E24; E31.

1 INTRODUCTION

The Kingdom of Swaziland, popularly known for being the Africa's last monarchy, is a small, land-locked country situated in the South East region of the African continent being largely linked to the South African economy, not only on account of geographic encompassment, but more so in terms of economic dependence, primarily in the areas of trade, finance, tourism, electricity usage and monetary policy. Despite being richly endowed with natural resources as well as boasting a favourable subtropical climate, the economy suffers from severe socio-economic problems such as i) extremely high levels of HIV prevalence, which are reported to be the highest in the world; ii) high levels of poverty and unemployment, more especially amongst the youth and iii) unacceptably high levels of income inequality and distribution, which leads to other social ills such as crime, high mortality rates and low life expectancies.

In addition to Swaziland's poor socio-economic repertoire, the country's problems were further exacerbated during a severe budget crisis in 2011 which is strongly believed to resonate as a delayed reaction to the infamous global financial crisis of 2007 and the subsequent global recessionary period of 2010. Whereas many industrialized or emerging economies were affected by the crisis primarily through financial markets, the most adverse effects of the crisis on the Swazi economy occurred via decreased revenues received from the Southern African Customs Union (i.e. SACU). As SACU revenues collapsed, the budget deficit widened to historically high levels and with limited access to alternative forms of financing, the Swazi government was faced with severe liquidity constraints whose adverse effects were channelled to households via the labour market (Brixiova et al., 2013). The resulting Swazi budget crisis of 2011 received immediate attention from the global community, and particularly from the International Monetary Fund (IMF), who in conjunction with the Ministry of Economic Planning and Development devised an Economic Recovery Strategy (ERS) as part of the Fiscal Adjustment Roadmap (FAR), which has an ultimate mandate of curbing economic recovery through improved fiscal management.

Notwithstanding these positive developments in pursuing economic recovery and development, one major point of concern is the lack of focus on monetary policy conduct as a means towards ensuring a stable financial environment. In turn, financial stability may be considered a catalyst to foster higher growth, lower unemployment and attract much required FDI inflows to the kingdom. By virtue, monetary policy in Swaziland is directly linked to that of South Africa via her affiliation to the Common Monetary Area (CMA). In this regard, Swaziland CMA membership places major constraints on domestic monetary policy in terms of being devoid of independent monetary and exchange rate policies. This is certainly of concern since the South African Reserve Bank (SARB) does not take economic fundamentals of Swaziland into consideration when making monetary decisions hence rendering the Bank of Swaziland as an institution which 'leans against the wind' in the sense of closely emulating actions of the SARB. Moreover, the financial sector, and specifically the capital market, in Swaziland is not as developed nor as large as that of her South African counterpart. Therefore, in contrast to South African authorities, Swazi policymakers are not offered the luxury exploiting these financial sectors in improving growth and reducing unemployment and have had to rely more on traditional fiscal policies methods such as encouraging small and medium business development, as a means of addressing the country's socio-economic problems.

In this current research, we argue for the role of Central Bank of Swaziland in influencing the macroeconomy. To this end, we exploit the simple but fundamentally important relationship between inflation and unemployment or demand deficit, which has been academically coined the 'Phillips curve'. Having being first brought into existence by the seminal contribution of Williams Phillips (1958) and further developed in the works of Phelps (1967) and Friedman (1968), the much celebrated 'Phillips curve' has remained at the heart of many macroeconomic policy models, most notably the MPS-MCM models used by the US Federal Reserve Bank during the 1960's and 1970's which were eventually replaced with FRB/US, FRB/MCM and FRB/WORLD models. The simple yet powerful notion of the existence of a relationship between inflation and unemployment or demand pressure, has had far reaching ramifications for policymakers as it assumes that Central Banks are offered a trade-off between two macroeconomic evils; inflation and unemployment. The failure to identify a correct functional form of the Phillips curve has proven to be costly to policymakers, and in previous times has been primarily responsible for the destabilizing of many macroeconomies with periods of stagflation experienced worldwide in the 1970's serving as a classic example.

The primary motivation for this study is that no previous academic attempts have been formally made in estimating a Philips curve specification for the Swazi economy. In our study, we bridge this empirical hiatus by employing the recently introduced nonlinear autoregressive distributive (N-ARDL) model of Shin et al. (2014) to examine the possibility of an existing Philips curve for the Swazi economy using data collected between 1991 and 2016. Our choice of empirical modelling provides us with some useful advantages in conducting our empirical analysis. For instance, unlike other cointegration models, the N-ARDL is functional with a combination of stationary and difference stationary variables, hence relieving the pressure on econometricians to only use time series variables that are integrated of similar order. Moreover, the N-ARDL model, on account of being an asymmetric extension of the ARDL model Pesaran et al. (2001), allows us to explore the possibility of convexities and concavities frequently claimed to exist within the Phillips curve (Turner (1995), Clark et al. (1996), Stiglitz (1997), Eisner (1997), Debelle and Laxton (1997), Laxton et al. (1999) and Nell (2006, 2018)). Another point of departure in our study concerns the extraction of the 'gap variables' used as proxies for demand pressures, in which we go beyond the conventional use of a two-sided Hodrick-Prescott (HP) filter by employing the more advanced one-sided HP and the Corbae-Oularis (C-O) filters. As is demonstrated through our empirical analysis our choice of extracting the gap variables is paramount to establishing significant Phillips curve specifications for the Swazi economy.

It is against this background that the rest of the paper is structured as follows. The following section of the paper outlines the empirical Phillips curve specifications and the N-ARDL model used to estimate these empirical specifications is presented in the third section.

The data and empirical results are presented in the fourth section of the paper whereas the study is concluded in the fifth section primarily in the form of policy recommendations.

2 EMPIRICAL SPECIFICATIONS

In his 1977 Nobel lecture, Milton Friedman conveniently described two main phases of development and amendment of the Phillips curve specification. The first phase of development can be traced to the seminal contribution of Phillips (1958) who investigated the relationship between unemployment and nominal money wage rates for the United Kingdom using extensive data covering the period 1861 to 1957. The author hypothesizes on a negative, non-monotonic relationship between the two variables on the basis of money wage rates being dependent on three factors namely; i) the prices of labour ii) the rate of change in labour demand and iii) changes in domestic prices as operating through costs of living. Nevertheless, Phillips (1958) relaxed the last assumption in his analysis since he argued that the costs of living adjustments are only correlated with domestic prices via import price pass-through effects which only occurs during period of war (i.e. the American civil war (1961–1865), World War I (1914–1918), World War II (1939–1945) and the Korean War (1950–1953)). In order to validate his hypothesis, Phillips (1958) formulates the following nonlinear regression function:

$$W_N = f(U) \quad (1)$$

Where W_N is the nominal wage rate and U represents the unemployment rate. In log-linearizing equation (1) and denoting α as a regression intercept, the following equation was also fitted to the data:

$$\log W_N = \log \alpha - \beta \log U \quad (2)$$

In fitting these regressions to three sub periods (i.e. 1861–1913, 1913–1948 and 1948–1958), Phillips (1958) was able to validate a negative, nonlinear trade-off between unemployment and wage rates for the United Kingdom at which the relationship is more sensitive at higher wage rates in comparison to that found at lower wage rates. Lipsey (1960) expounded upon Phillips (1958) contribution by extending the empirical findings into a formal theoretical workhorse with the derived model reflecting gradual disequilibrium adjustment in the labour market where excess labour demand leads to nominal wage inflation whilst excess labour supply causes nominal wage deflation (Palley, 2012). Further Lipsey (1960) assumed that unemployment can be used as proxy for excess labour demand or supply, such that the Phillips curve should be considered a relationship between price level and imbalances in the labour market. The Philips-Lipsey synthesis was then re-cast as a useful policy guidance tool for monetary authorities in the seminal paper of Samuelson and Solow (1960) which was initially presented at the American Economic Association (AEA) annual meetings in 1959. However, when Bhatia (1961) tested the Philips curve on United Sates data ranging from 1900 to 1958, the author was unable to find such a trade-off in the periods subsequent to the second-World War. Moreover, extended periods of stagflation as experienced worldwide in the 1970's cast a lot of doubt on the existence of a long-run Phillips curve and hence fostered the need for the reformation of the original Philips curve hypothesis.

The second phase of development of the Phillips curve came about when mainstream neoclassical economists began to vouch for a vertical long-run Phillips curve in which a trade-off between inflation and demand deficiencies is only permitted over the short-run. The chief contributions to this neoclassical paradigm arose as a courtesy of Phelps (1967, 1968) microeconomic foundations for wage and price settings as well as Friedman's (1968) much celebrated presidential address in 1968. Their works can be collectively summarized in three important contributions. The first of their contributions, was to distinguish between nominal and real wage rates and in denoting W_R as the real wage rate and π as the inflation rate the following identify can be used to distinguish between the two variables:

$$W_R = W_N - \pi \quad (3)$$

Therefore in re-specifying the Philips curve in terms of real wages i.e.

$$W_R = f(U) \qquad (4)$$

And substituting equation (3) into (4) and further re-arranging the outcome yields the following alternative Phillips curve specification:

$$W_N = f(U) + \pi \qquad (5)$$

The second contribution of the Friedman-Phelps synthesis was being able to distinguish between the long-run and short-run effects of an unanticipated change in aggregate nominal demand. By effect this allows the incorporation of inflation expectations (i.e. π^e) into the nominal wage adjustment process such that resulting expectations based Phillips curve can be specified as:

$$W_N = f(U) + \pi^e \qquad (6)$$

In further assuming that labour is the only production cost and there is no productivity growth, then natural inflation can be equated to nominal wages (i.e. $W_N = \pi$) and hence the 'expectations-based', 'inflation-unemployment' Phillips curve can be derived as (Palley, 2012):

$$\pi = f(U) + \pi^e \qquad (7)$$

The third contribution attributed to the Friedman-Phelps synthesis concerns the assumption of no stable inflation-unemployment trade-off yet Friedman (1968) particularly argues for the existence of a 'natural rate of unemployment' (NRU), of which unemployment can be kept below the NRU (i.e. $U < NRU$) at the expense of accelerated inflation, or above it (i.e. $U > NRU$) by accelerated deflation. The resulting 'accelerationist', 'expectations-based' Philips curve can be specified as:

$$\pi = f(U - NRU) + \pi^e \quad (8)$$

And in further making use of Okun's (1962) law which postulates a positive relationship between the 'unemployment-gap' and the 'output-gap', we can re-specify equation (8) as:

$$\pi = f(GDP - GDP^{pot}) + \pi^e \quad (9)$$

Where GDP is output growth and GDP^{pot} represents a measure of potential output. The consecutive seminal papers presented by Gordon (1989, 1990) proposed the extension of the Philips curve to that of a triangular function consisting of inertia, demand pressure and supply shocks. Whilst the first two of these variables are already incorporated in both the unemployment-gap and the output-gap versions of the Phillips curve, the third variable, being supply shocks, needs to be proxied and included in the estimation regressions. We opt for the exchange rate as such a proxy since, as previously argued by Gordon (1990), WHAT. We therefore, specify the triangular form of the unemployment-gap Phillips curve inclusive of supply shocks, SS, as:

$$\pi = f(U - NRU) + \pi^e + SS \quad (10)$$

Whereas the triangular form output-gap Phillips curve takes the following specification:

$$\pi = f(GDP - GDP^{pot}) + \pi^e + SS \quad (11)$$

In summarizing this synopsis on the development of the Phillips curve we employ equations (4), (8), (9), (10) and (11) as our empirical representatives of the traditional Phillips curve specification, the 'unemployment-gap' base Philips curve specification and the 'output-gap based' Phillips curve specification, the triangular form of the unemployment-gap Phillips curve and the triangular form of the output-gap Phillips curve, respectively. The N-ARDL model used to estimate these Philips curve model specifications are outlined in the next sub-section of the paper.

3 ECONOMETRIC METHODOLOGY

As a baseline econometric model, we consider the following long-run asymmetric model regression:

$$\pi_t = \beta_0 + \alpha^{+}X_{it}^{+} + \alpha^{+}X + error, X_t = X_0 + X_t^{+} + X_t^{-} \quad (12)$$

Where, π_t is the inflation rate, X_t is a K × 1 vector of demand pressure proxies, β^+ and β^- are asymmetric long-run parameters and X^+ and X^- are partial sum processes of positive and negative changes in X_t which are specifically defined as:

$$X_{it}^{pos} = \sum_{j=1}^{i} \Delta X_{it}^{pos} = \sum_{j=1}^{i} \max(\Delta X_j) \quad (13)$$

$$X_{it}^{neg} = \sum_{j=1}^{i} \Delta X_{it}^{neg} = \sum_{j=1}^{i} \min(\Delta X_j) \quad (14)$$

Shin et al. (2014) demonstrate that the model regression (10) can be transformed into the following error correction representation:

$$\Delta\pi_{t_t} = \rho X_{t-1} + \lambda^{neg} X_{it}^{neg} + \lambda^{pos} X_{it}^{pos} + \sum_{j=1}^{\rho-1} \psi_i \Delta GDP_{t-j} + \sum_{j=1}^{\rho-1} (\eta_j^{pos} \Delta x_{t-j}^{pos} + \eta_j^{neg} \Delta x_{t-j}^{neg}) + error \quad (15)$$

The traverse between short-run disequilibrium and the new long-run steady state of the system can be estimated through the following cumulative dynamic multipliers:

$$M_h^{pos} = \sum_{j=0}^{n} \frac{\partial y_{t+j}}{\partial X_i^{pos}}, M_h^{neg} = \sum_{j=0}^{n} \frac{\partial y_{t+j}}{\partial X_i^{neg}}, \qquad h = 0, 1, 2 \ldots. \quad (16)$$

Where M_h^{pos} and $M_h^{neg} \rightarrow \beta^+$ and β^-, respectively as $h \rightarrow \infty$. Note that the long-run coefficients are computed as $\beta^{pos} = -(\lambda^{pos}/\rho)$ and $\beta^{neg} = -(\lambda^{neg}/\rho)$, respectively, with the nonlinear error correction term is computed as $\xi_{t-1} = GDP_t - \beta^{pos'} X_h^{pos} - \beta^{neg} X_h^{neg}$. Moreover, Shin et al. (2014) suggest the testing of three hypothesis in order to validate asymmetric cointegration effects within the specified N-ARDL model. The first is an extension of the non-standard bounds based F-test of Pesaran et al. (2001) which is used to test for overall asymmetric cointegration relations i.e.

$$H_{01}: \rho = \lambda^+ = \lambda^- = 0 \quad (17)$$

The second hypothesis tests for long-run asymmetric effects in which the null hypothesis of no long-run asymmetric effects is tested as:

$$H_{02}: \rho = \beta^+ = \beta^- \quad (18)$$

The empirical final hypothesis which is formulated concerns short-run asymmetric effects whereby the null hypothesis of no short-run asymmetric effects is tested as:

$$H_{03}: \eta^+ = \eta^- \quad (19)$$

Note that the latter two null hypotheses of 'no long-run' and 'no short-run' asymmetric effects can be evaluated by relying on standard Wald tests. Furthermore, conventional diagnostic tests are to be performed on the regression residuals such as test for normality, serial correlation, heteroscedasticity and functional form.

4 DATA AND EMPIRICAL RESULTS

4.1 Empirical data, descriptive statistics and unit root tests

The data used in our study has been retrieved from the World Bank online statistical database on an annual basis over the period 1991 to 2016 and consists of the inflation in consumer prices (i.e. π), unemployment as a percentage of total labour force (i.e. U), GDP growth rates (i.e. gdp) and the Rand/Dollar nominal exchange rate (i.e. ER) which is used to proxy supply shocks as in Phiri (2016). Further note that since the Swazi Lilangeni is pegged one-for-one with the South African Rand hence further justifying the use of our proxy. Also recall that in order to estimate our empirical Phillips curve specifications requires the construction of two additional variables, namely, the 'unemployment-gap' (i.e. U_gap) and 'output-gap' (i.e. Y_gap) variables. The extraction of these 'gap' variables has been the subject of much contention, and to ensure robustness of our analysis we employ three filters to this end. The first two filter are the one-sided and two-sided HP filters, respectively, with the later providing ex post estimates of the 'gap' based on all information and the former providing real estimates of the gap. However, these HP filters have been severely criticized on the premise of suffering from 'end-point problems' hence prompting us to employ the frequency-domain (FD) filtering process discussed in Corbae and Oularis (2006) which overcomes these deficiencies by minimizing distortions in the data generating process (DGP) of the series.

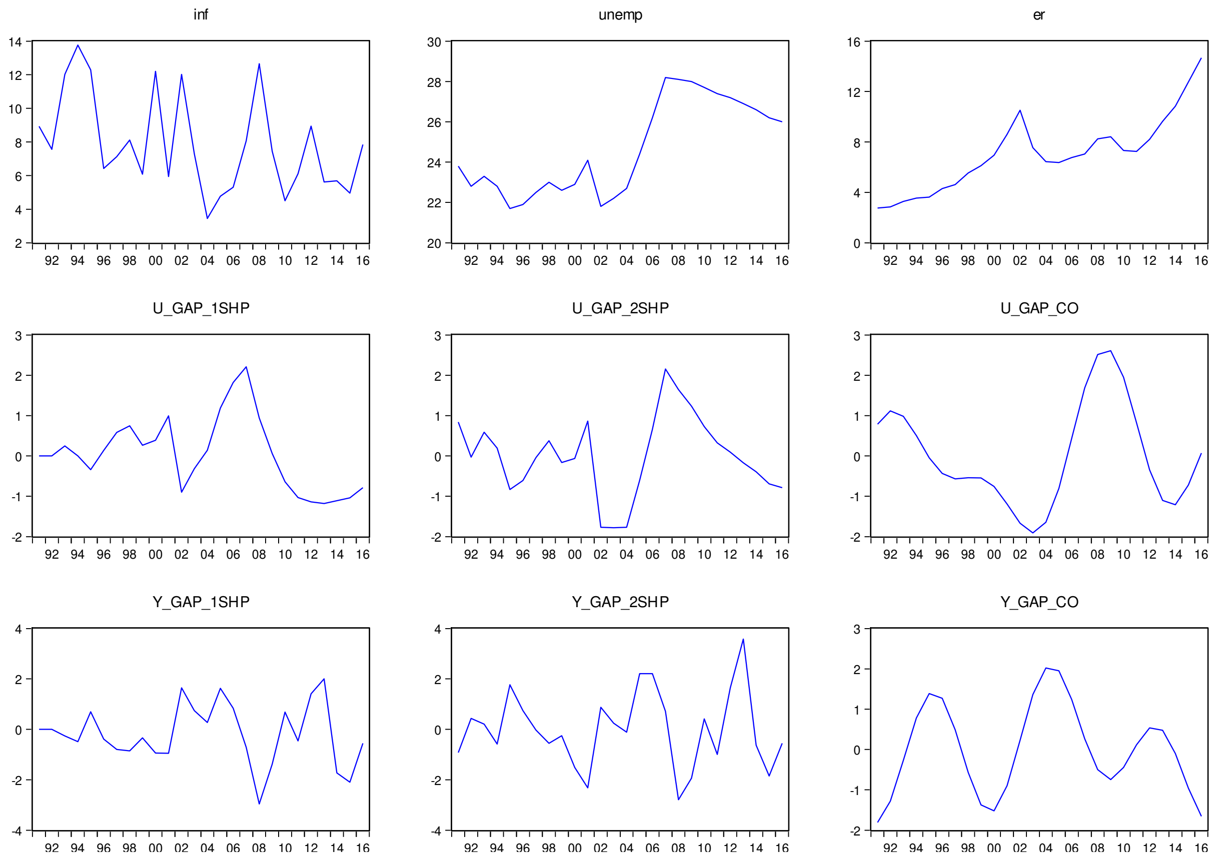
The descriptive statistic of the utilized time series are reported in Panel A of Table 1, whilst their time series plots are provided in Figure 1. Panel B of Table 1 reports the outcome of the ADF, PP and DF-GLS unit root tests as performed on the levels and first difference transformations of the time series variables. Collectively, these results indicate that the observed inflation, unemployment, unemployment-gap and output gap series are both levels stationary process whereas the unemployment and unemployment gap variables are first difference stationary variables. The realization of the time series data being a mixture of I(0) and I(1) variables implies that conventional cointegration methods such as the Engle-Granger (1987) and Johansen (1991) approaches would not methodologically suffice in modelling cointegration relations amongst the time series. Hence our decision to rely on the N-ARDL framework is well justified.

Table 1: Descriptive statistics, correlation matrix and unit root tests

				1-sided HP filter		2-sided HP filter		Corbae-Oularis filter	
Panel A: Descriptive statistics	π	unemp	ER	unemp_gap	gdp_gap	unemp_gap	gdp_gap	unemp_gap	gdp_gap
Mean	7.89	24.65	7.09	0.05	-0.19	3.07E-16	-9.27E-15	3.75E-16	-1.71E-16
Std. dev.	2.91	2.31	2.98	0.91	1.19	0.98	1.50	1.26	1.12
J-B (p-value)	0.31	0.24	0.44	0.53	0.95	0.98	0.81	0.44	0.56
Panel B: Unit root tests									
ADF	-3.71**	-0.93	0.44	-1.68	-4.03***	-2.29	-4.32***	-7.40***	-10.14***
(intercept)	(-6.69)***	(-3.97)***	(-3.19)**	(-4.20)***	(-4.93)***	(-4.61)***	(-5.79)***	(-9.69)***	(-22.9)***
ADF	-4.31**	-1.79	-1.99	-1.93	-3.86**	-2.25	-4.17**	-8.49***	-9.93***
(trend)	(-6.54)***	(-3.86)**	(-3.25)*	(-4.15)***	(-4.69)***	(-4.51)***	(-5.58)***	(-9.45)***	(-27.7)***
PP	-3.71**	-1.11	0.44	-1.84	-3.27**	-2.43	-3.83***	-1.97	-2.18
(intercept)	(-10.44)***	(-3.98)***	(-3.16)**	(-4.21)***	(-10.7)***	(-4.62)***	(-11.85)***	(-2.09)	(-2.44)
PP	-4.15**	-2.06	-1.37	-2.07	-3.18	-2.39	-3.63**	-1.95	-2.28
(trend)	(-10.03)***	(-3.86)**	(-3.22)	(-4.15)***	(-10.4)***	(-4.52)***	(-11.33)***	(-2.09)	(-2.30)
DF-GLS	-3.76***	-0.93	0.64	-1.74	-4.16***	-2.23	-4.05***	-9.38	-6.03***
(intercept)	(-6.83)***	(-3.65)***	(-3.27)***	(-4.30)***	(-4.38)***	(-4.38)***	(-5.00)***	(-16.47)***	(-18.1)***
DF-GLS	-4.47***	-1.72	-2.34	-1.99	-4.14***	-2.29	-4.42***	-7.14***	-9.19***
(trend)	(-6.74)***	(-3.92)***	(-3.42)**	(-4.34)***	(-4.74)***	(-4.60)***	(-5.76)***	(-9.82)***	(-14.5)***

Note: Notes: significance codes *** – 1%, ** – 5% and * – 10%. Unit root test statistics for first differences reported in parentheses (). Optimal lag selection of models determined by minimization of Schwarz information criterion.

Figure 1: Time series plots of variables



4.2 Empirical results from traditional Phillips curve specification

Table 2 presents the results form estimating the tradition Phillips curve and for control purposes, we also report estimates from the linear ARDL specification. As can be observed from panel A, the results obtained from the linear ARDL model are quite encouraging, in the sense of finding a theoretically-correct negative and significant coefficient estimate in the short-run although the obtained long-run coefficient is insignificant. However, as is demonstrated in Panel B, the linear short-run trade-off is not translated into the long-run steady state as the coefficient on the long-run parameter is insignificant. We deem these results as plausible since they are consistent with traditional theory as suggested by Gordon (1997) as well as with the empirical evidence recently presented in the study of Khumalo and Eita (2015) for similar Swazi time series. Moreover, the bounds test statistic for cointegration effects and the diagnostic tests reported in Panels C and D, respectively, provide sufficient evidence for linear cointegration amongst the series and vouch for well-behaved error terms, correct functionality and regression stability.

On the other hand, the regression estimates obtained from the N-ARDL regression estimates are less optimistic as none of the obtained short-run or long-run estimates reported in Panels A and B are statistically significant. Moreover, the Wald test for long-run asymmetry reported in Panel C is insignificant hence ruling out the possibility of any long-run asymmetries in the traditional Phillips curve. And even though the F-test for asymmetric cointegration, the Wald test for short-run asymmetric effects, as well as the diagnostic tests and stability analysis from Panel D all produce favourable findings, the regressions are meaningless in the absence of significant coefficient estimates. Collectively, our results in Table 1 infer at least a linear, short-run trade-off between inflation and unemployment for the Swazi Kingdom.

Table 2: Traditional Phillips curve estimates

	Linear ARDL ARDL(1,0)		Nonlinear ARDL N-ARDL(2,1,1)	
Panel A: Long-run estimates	Coefficient	p-value	Coefficient	p-value
U	-0.29	0.37		
U+			0.12	0.74
U-			0.87	0.25
Panel B: Short- run estimates				
ΔU	-1.16	0.07*		
ΔU+			-0.91	0.20
ΔU-			-1.21	0.17
ectt-1	-0.81***	0.00	-1.08***	0.00
Panel C: Cointegration tests				
F-test	5.04**		4.53**	
Wald-LR			0.13	
Wald-SR			3.77**	
Panel D: Diagnostic tests				
χ^2_{NORM}	1.89	0.39	0.27	0.87

χ^2_{SC}	2.09	0.15	0.77	0.48
χ^2_{HET}	0.50	0.62	0.95	0.49
χ^2_{FF}	0.25	0.80	0.47	0.65

Notes: significance codes *** – 1%, ** – 5% and * – 10%. P-values are reported in parentheses (). The regression have been estimated using Newey-West coefficients. Optimal lag selection of models determined by minimization of Schwarz information criterion.

4.3 Empirical results from New Classical Phillips curve specifications

Tables 4 and 5 report the empirical results for the unemployment-gap and the output-gap based Phillips curve and as before, we report both the linear ARDL and N-ARDL regression estimates. Further note that we present a total of six estimated regressions in each of the Tables, which are representative of the linear ARDL and N-ARDL models performed for the three filters (i.e. one-sided HP, two-sided HP and C-O filters) used to extract the 'gap' variables. Focusing on Panel A, we find the correct negative and statistically significant coefficients for three models. The first two are the linear and nonlinear ARDL models estimated with gap variables extracted from the one-sided HP filter and the third is the nonlinear ARDL model with gap variables derived from the conventional two-sided HP filter. Note that concerning the N-ARDL results, the model based on the one-sided HP filter argues for a traditional convex, unemployment-based Phillips curve in the short-run (i.e. U_gap+ > U_gap-) as found in Turner (1995), Clark et al. (1996), Debelle and Laxton (1997), Laxton et al. (1999) and Nell (2006, 2018) whilst the two-sided HP filter argues for a concave, short-run Phillips curve as found in Stiglitz (1997) and Eisner (1997). However, judging from the long-run estimates recorded in Panel B, only the N-ARDL model with gap variables derived from the one-sided HP filter produces a significant negative coefficient on the U_gap+ variable. This result implies that over the long-run, the Phillips curve is of a concave shape which is in line with the findings presented by Stiglitz (1997) and Eisner (1997).

The results obtained from the out-put gap specification are not as concrete as those found for the unemployment-gap version and can be summarized by two relevant findings.

The first is from the short-run coefficients reported in Panel A, in which the Y_gap+ variable extracted from the two-sided HP filter for the N-ARDL model produces the correct positive and statistically significant estimate. The second is from the long-run coefficients reported in Panel B, in which the Y_gap+ series extracted from the one-sided HP filter similarly produces a positive and significant estimate. Both these results argue for a concave output-gap based Phillips curve specification which is consistent with argument for stabilization policies to be implemented during expansionary cycles to prevent the overheating of the economy. These arguments are re-iterated in the works of Turner (1995), Clark et al. (1996), Debelle and Laxton (1997), Laxton et al. (1999) and Nell (2006, 2018). Further re-enforcing the validity of our findings are the positive statistics obtained for corresponding tests for asymmetries, regression diagnostics and stability analysis presented in Panels C and D.

Table 3: Unemployment-gap based Phillips curve estimates

	one-sided HP		Two-sided HP		C-O	
	ARDL	N-ARDL	ARDL	N-ARDL	ARDL	N-ARDL
	(1,0)	(2,0,1)	(1,1)	(1,1,1)	(1,0)	(1,1,0)
Panel A: Long-run estimates						
U_gap	0.92		1.19		0.64	
	(0.02)**		(0.12)		(0.37)	
U_gap+		-1.03		0.51		0.39
		(0.03)*		(0.10)		(0.45)
U_gap-		-0.28		1.13		0.94
		(0.38)		(0.00)***		(0.10)
Panel B: Short run estimates						
Δπ		0.49				
		(0.01)**				
ΔU_gap	-1.60		-0.59		0.49	
	(0.04)*		(0.36)		(0.29)	
ΔU_gap+		-1.56		-2.05		0.35
		(0.05)*		(0.09)*		(0.45)
ΔU_gap-		-3.75		-1.02		0.85
		(0.00)***		(0.07)*		(0.11)
ect(-1)	-0.79	-1.51	-0.83	-1.52	-0.76	-0.91
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***

Panel C: Cointegration tests						
F-test	4.99*	5.83**	6.22**	5.83**	7.01**	6.11**
Wald-LR		5.94**		0.58		2.64
Wald-SR		8.48***		12.85***		0.20
						(0.66)
Panel D: Diagnostic tests						
χ^2_{NORM}	0.97	0.28	1.02	4.09	2.30	1.94
	(0.62)	(0.87)	(0.60)	(0.10)	(0.32)	(0.38)
χ^2_{SC}	0.30	0.66	0.31	0.40	0.02	0.91
	(0.74)	(0.53)	(0.74)	(0.68)	(0.98)	(0.42)
χ^2_{HET}	0.41	1.64	0.87	1.09	0.14	0.84
	(0.75)	(0.20)	(0.47)	(0.41)	(0.87)	(0.49)
χ^2_{FF}	0.01	0.57	0.05	0.06	0.02	1.21
	(0.99)	(0.58)	(0.96)	(0.95)	(0.98)	(0.24)
CUSUM	S	S	S	S	S	S
CUSUMSQ	S	S	S	U	S	U

Notes: significance codes *** – 1%, ** – 5% and * – 10%. P-values are reported in parentheses (). The regression have been estimated using Newey-West coefficients. Optimal lag selection of models determined by minimization of Schwarz information criterion.

Table 4: Output-gap based Phillips curve estimates

	one-sided HP		two-sided HP		C-O	
	ARDL	N-ARDL	ARDL	N-ARDL	ARDL	N-ARDL
	(1,0)	(1,1,0,0)	(1,0)	(2,1,1)		
Panel A: Long-run estimates						
Y_gap	-0.41		-0.35		-0.63	
	(0.56)		(0.40)		(0.32)	
Y_gap+		1.21		-0.80		-0.84
		(0.06)*		(0.01)**		(0.17)
Y_gap-		-0.82		-0.43		-0.28
		(0.14)		(0.21)		(0.63)
Panel B: Short run estimates						
Δπ(-1)			0.24			
			(0.32)			
ΔY_gap	-0.31		-0.17		0.64	

	(0.55)		(0.59)		(0.44)	
ΔY_gap+		0.35		0.84		0.72
		(0.66)		(0.04)*		(0.49)
ΔY_gap-		-0.80		-1.51		0.14
		(0.12)		(0.00)***		(0.90)
Ect(-1)	-0.75	-0.97	-0.77	-0.97	-0.85	-1.03
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Panel C: Cointegration tests						
F-test	6.64**	5.51**	4.60*	3.83*	4.43**	4.48**
Wald-LR		7.12***		6.54**		0.20
Wald-SR		10.89***		7.65***		0.22
Panel D: Diagnostic tests						
χ^2_{NORM}	2.44	1.72	2.18	1.07	2.56	1.94
	(0.30)	(0.42)	(0.34)	(0.58)	(0.28)	(0.38)
χ^2_{SC}	0.06	0.99	0.01	0.96	0.38	2.41
	(0.94)	(0.39)	(0.99)	(0.40)	(0.69)	(0.12)
χ^2_{HET}	0.31	1.77	1.29	0.41	0.99	0.92
	(0.74)	(0.18)	(0.29)	(0.84)	(0.39)	(0.45)
χ^2_{FF}	0.03	1.43	0.77	2.29	1.38	1.23
	(0.98)	(0.17)	(0.45)	(0.04)*	(0.18)	(0.23)
CUSUM	S	S	S	S	S	S
CUSUMSQ	S	S	S	S	S	S

Notes: significance codes *** – 1%, ** – 5% and * – 10%. P-values are reported in parentheses (). The regression have been estimated using Newey-West coefficients. Optimal lag selection of models determined by minimization of Schwarz information criterion.

4.4 Empirical results from the triangular Philips curve specifications

As a final empirical exercise, we estimate Gordon's (1989, 1990, 1997) triangular Phillips curve version for both the unemployment-gap and output gap specifications. Starting with the results from the triangular, unemployment-gap version reported in Table 5, the short-run estimates found in Panel A point to correct negative and significant estimates for both ARDL and N-ARDL models estimated with gap variables extracted from the one-sided HP filter as well as the linear ARDL model estimated with two-sided HP gap variables. Note that the significant coefficient for the N-ARDL model is on the U_gap+ variable hence arguing for a concave unemployment-gap based Philips curve specification. However, we also note that none of the estimated coefficients on the supply shock variable is significant over the short-run. And even though the supply shock variable for the long-run reported in Panel B produces the correct positive and significant estimate for the N-ARDL with two-sided HP filter gap variables, the remaining long-run coefficients are either statistically insignificant or produce the wrong sign throughout all estimated regressions. And with the exception of the models estimated with the C-O filter-based gap variables, the associated Wald tests for short-run and long-run asymmetries fail to find significant asymmetries, which further cast doubt on the validity of these estimates.

In turning to the empirical results of the triangular, output gap Phillips curve specification reported in Table 6, we are quick to note that only the N-ARDL model estimated with gap variables derived from the C-O filter produce encouraging findings. As can be observed from the short-run and long-run estimates reported in Panels A and B, respectively, all variables including the supply-shock variables produce the correct positive estimates which are all significant at the 1 percent critical level. Upon closer inspection of our results, we note that the Y_gap+ estimates are of larger value than the Y_gap- counterparts, hence implying a form of concavity within the output-gap based Phillips curve. Recall that these findings imply that policymakers should be cautious of overheating the economy during economic expansions and should not test the limits of expansionary policies. This is clearly a counterargument to that proposed by Stiglitz (1997) and Eisner (1997). Further strengthening the validity of our findings are the significant test-statistics for asymmetric cointegration as well as for short-run and long-run asymmetries found in Panel C. Similarly, the failure to detect non-normality, serial correlation, heteroscedasticity and incorrect functional form, as reflected in the diagnostic tests reported in Panel C of Table 5, also validates the reliability of our empirical results.

Table 5: Unemployment-gap based Phillips curve augmented with supply shocks

	one-sided HP		two-sided HP		C-O	
	ARDL	N-ARDL	ARDL	N-ARDL	ARDL	N-ARDL

	(1,1,0)	(1,1,0,0)	(2,1,1)	(1,1,1,0)	(1,0,0)	(1,0,2,0)
Panel A: Long-run estimates						
U_gap	0.46		0.21		0.52	
	(0.19)		(0.63)		(0.42)	
U_gap+		0.32		1.03		0.434
		(0.13)		(0.03)*		(0.48)
U_gap-		1.16		1.88		1.55
		(0.13)		(0.00)***		(0.07)*
ER	-0.29	0.18	-0.55	1.88	-0.19	0.48
	(0.27)	(0.38)	(0.00)***	(0.00)***	(0.42)	(0.21)
Panel B: Short run estimates						
Δπ(-1)			0.39			
			(0.07)*			
ΔU_gap	-2.01		-2.06		0.43	
	(0.02)**		(0.02)**		(0.36)	
ΔU_gap+		-6.47		-1.21		0.39
		(0.00)***		(0.30)		(0.32)
ΔU_gap+(-1)				-0.05		
				(0.94)		
ΔU_gap-		1.19				1.40
		(0.11)				(0.04)*
ΔER	-0.26	0.18	0.15	0.22	-0.15	0.43
	(0.26)	(0.38)	(0.73)	(0.44)	(0.41)	(0.22)
ect(-1)	-0.89		-1.33	-1.11	-0.81	-0.90
	(0.00)***		(0.00)***	(0.00)***	(0.00)****	(0.00)***
Panel C: Cointegration tests						
F-test	4.05*	4.15*	4.67**	5.06**	5.01*	4.70**
Wald-LR		9.20***		1.16		3.81*
Wald-SR		8.17***		9.91***		0.16
Panel D: Diagnostic tests						
χ^2_{NORM}	0.57	0.76	1.52	1.05	2.23	1.93
	(0.75)	(0.83)	(0.77)	(0.59)	(0.33)	(0.38)
χ^2_{SC}	0.14	0.04	0.41	0.10	0.59	0.23
	(0.87)	(0.97)	(0.67)	(0.91)	(0.56)	(0.80)
χ^2_{HET}	0.44	0.72	0.31	0.95	0.01	0.88
	(0.78)	(0.61)	(0.92)	(0.49)	(0.99)	(0.50)
χ^2_{FF}	1.59	1.07	1.66	1.84	1.51	1.59

	(0.13)	(0.30)	(0.12)	(0.08)*	(0.15)	(0.13)
CUSUM	S	S	S	S	S	S
CUSUMSQ	U	S	S	S	S	S

Notes: significance codes *** – 1%, ** – 5% and * – 10%. P-values are reported in parentheses (). The regression have been estimated using Newey-West coefficients. Optimal lag selection of models determined by minimization of Schwarz information criterion.

Table 6: Output-gap based Phillips curve augmented with supply shocks

	one-sided HP		two-sided HP		C-O	
	ARDL	N-ARDL	ARDL	N-ARDL	ARDL	N-ARDL
	(1,0,0)	(1,1,0,0)	(1,0,0)	(1,0,0,0)	(1,0,0)	(1,1,2,2)
Panel A: Long-run estimates						
Y_gap	-0.47		-0.45		-0.84	
	(0.50)		(0.27)		(0.16)	
Y_gap+		-1.22		-0.44		1.64
		(0.07)*		(0.32)		(0.00)***
Y_gap-		-0.83		-0.11		1.16
		(0.17)		(0.83)		(0.00)***
ER	-0.26	-0.01	-0.29	0.26	0.34	0.96
	(0.30)	(0.97)	(0.24)	(0.43)	(0.13)	(0.00)***
Panel B: Short run estimates						
ΔY_gap	-0.39		-0.22		0.71	
	(0.48)		(0.48)		(0.37)	
ΔY_gap+		0.36		-0.04		7.69
		(0.69)		(0.93)		(0.00)***
ΔY_gap-		-0.80		-0.27		5.38
		(0.13)		(0.57)		(0.00)***
ΔER	-0.22	-0.01	0.48	0.62	0.53	0.98
	(0.27)	(0.97)	(0.33)	(0.26)	(0.29)	(0.01)**
Ect(-1)	-0.83	-0.97	-0.83	-0.90	-0.90	-1.29
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Panel C: Cointegration tests						
F-test	5.08**	3.96*	3.97**	3.43*	3.79*	5.80***
Wald-LR		1.54		0.10		6.08***
Wald-SR		2.84		0.12		37.11***
Panel D:						

Diagnostic tests						
χ^2_{NORM}	2.36	1.73	1.94	1.29	2.39	0.70
	(0.31)	(0.42)	(0.38)	(0.52)	(0.30)	(0.71)
χ^2_{SC}	1.25	0.94	1.08	0.06	3.44	0.31
	(0.31)	(0.41)	(0.36)	(0.94)	(0.05)*	(0.90)
χ^2_{HET}	0.09	1.54	0.26	1.49	0.32	1.38
	(0.97)	(0.23)	(0.86)	(0.24)	(0.81)	(0.29)
χ^2_{FF}	2.76	1.41	2.11	0.16	0.56	0.50
	(0.01)	(0.18)	(0.05)*	(0.87)	(0.58)	(0.62)
CUSUM	S	S	S	S	S	S
CUSUMSQ	S	S	S	S	S	S

Notes: significance codes *** – 1%, ** – 5% and * – 10%. P-values are reported in parentheses (). The regression have been estimated using Newey-West coefficients. Optimal lag selection of models determined by minimization of Schwarz information criterion.

5 CONCLUSION

Against the lack of empirical evidence on the possibility of a Phillips curve trade-off for the Swazi kingdom, our study sought to fill this empirical hiatus. To this end we estimate i) traditional ii) new classical and iii) triangular versions of the Philips curve using the nonlinear ARDL model applied to data collected between 1991 and 2016. For control purposes we also provide estimates from the linear ARDL model. We are able to find evidence of linear short-run Phillips curve for the traditional specification whilst for the New Classical and triangular forms of the Phillips curve, we find that nonlinear specifications bests describes the time series data. What is particular interesting is our discovery of 'concave-type' nonlinearity for both the unemployment-gap and output-gap specifications and these findings have different yet interconnected policy implications. In our case, the concave unemployment-gap implies that a worsening of the economy reflected by a positive deviation of unemployment from it's natural rate will be met with reduced inflation whilst a countermovement of unemployment below its natural rate bears no impact on the inflation rate. On the other hand, the dynamics from the concave output-gap Phillips curve implies that changes in the output-gap move in the same direction as inflation, more so when economic growth exceeds its potential. This latter finding highlights the need for policymakers to be forwarded looking and act accordingly upon inflationary pressures.

In assembling policy recommendations for Swazi policymakers, we come up with the following. Firstly, we advise Swazi monetary authorities to be concerned with stabilizing policies and judging from the concavity observed in the output-gap based Phillips curve policymakers should particularly caution against the overheating of the economy during upswings of the business cycle. In the event that the economy recovers from it's current recessionary period, policymakers should proceed cautiously as the economy reaches and surpasses its potential output level. In further contextualizing our findings, our concave unemployment-gap Phillips curve accounts for the decrease in Swazi inflation experienced over the last decades which were an outcome of worsening labour markets as reflected by the widening of the unemployment gap above its natural rather than a deliberate effort of policymakers. Therefore, over the medium-to-long term we encourage Swazi policymakers to develop the necessary institutions necessary to conduct a more independent, a more credible and a more transparent monetary policy. These monetary developments can be coupled with microeconomic structural reforms which can include adopting less stringent laws on minimum wage or for insider-outsider or efficiency wage bargaining. However, given the significance of supply shocks through the exchange rate as well as the Kingdoms dependency on South Africa for trade revenues, monetary authorities are not advised to cease their currency dependence of the Swazi Lilangeni on the South African Rand.

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