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A pipeline between producer and consumer prices in Ghana: A Policy Issue

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ABSTRACT

As prices have grown at their fastest pace in recent times, inflation has become a key concern for the macro-policy environment. In many jurisdictions, consumer prices have typically formed the basis for price stability policies. Notwithstanding, producer prices remain an important channel and must be closely watched. We utilise data on Ghana and investigate the causal links between consumer and producer inflation and assess the necessity to include producer inflation target in the monetary policy rule. Our VECM and Granger causality analyses show that consumer and producer prices exhibit very stable long-term relationship and short-term gaps between the two tend to normalise over time. The relationship between consumer and producer prices has not been a one-sided lag structure, even though producer prices lead more than lag consumer prices. We conclude that Bank of Ghana's monetary policy design that does not distinguish between consumer and producer inflation is less problematic at the moment.

KEYWORDS

Inflation; Monetary policy; Granger causality; VECM; CPI; PPI

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1. Introduction

Inflation has increased rapidly all over the world since 2021 as the strong post-pandemic recovery measures spurred on demand pressures and the presence of global value chain bottlenecks, food prices and energy crisis ignited significant supply side restrictions and cost-push shocks. The widespread inflation has stirred a synchronised monetary tightening by many central banks as many countries grapple with inflation well above their monetary policy targets.

The analysis of inflation requires more than one index, and it is essential to know exactly how the producer prices relate to the consumer prices. Understanding the pipeline between consumer and producer prices is important in ensuring that policy responses to rising prices are well calibrated to safeguard speedy and less-damaging disinflation. In this paper, we investigate the pipeline between consumer and producer prices and assess if rising producer prices signal consumer price changes early in the pipeline.

In Ghana, the Bank of Ghana has formally adopted the CPI as the basis for its inflation target. Notwithstanding, the PPI remains an important channel and must be closely watched. Economic policy analysts have observed a strong correlation between the two inflation indicators. The PPI has also been considered as reflecting upstream price changes that could signal future shifts in the downstream consumer prices (O'Trakoun and Ramachandran, 2022).

Inflation remains a central variable in macroeconomic policy and there have been calls for the PPI inflation to be directly included in the central bank's monetary policy rule. Recent research¹ shows that for an open economy and even for a closed economy, it is better to include PPI inflation rather than CPI inflation in the monetary policy rule. In their contribution, Wei and Xie (2022) emphasise that the necessity to include the PPI inflation target in the monetary policy rule depends in part on whether the CPI and the PPI co-move strongly. In this paper, we assess the correlation between the two series and ascertain whether the Bank of Ghana's practice of targeting the CPI alone has been less harmful.

We also investigate the causal links between the inflation indicators. Cushing and McGarvey, (1990) note that the PPI can cause the CPI in a supply side development. In this process, the production of final goods uses primary goods as input, so that supply side disturbances in the primary goods market affect the factory gate prices, wholesale prices and ultimately consumer prices. Wholesale/factory gate prices will Granger cause consumer prices independently from the other exogenous transformation of inflation as long as primary goods are used with a lag as input in the production of consumption goods. The causality from CPI to PPI is explained in the derived demand analysis framework (Caporale, Katsimi and Pittis, 2002). In this setup, the demand for final goods via the price of inputs affects the cost of production. Causality from CPI to PPI may also reflect the fact that the wage-setting process in the production/wholesale sector ignites wage increases when there is an increase in consumer prices.

Our contributions to the existing literature are twofold: First, we employ causality and correlation testing procedures to provide evidence on the empirical relationship between consumer and producer prices in Ghana. Second, our analysis is data driven and seeks to evaluate whether the current practice of CPI inflation targeting alone in the policy designs is appropriate. Our empirical analysis utilises monthly inflation data gleaned from the Ghana Statistical Services (GSS) and spans from January 2019 to December 2022.

The layout of the rest of this paper is as follows: Section 2 surveys the existing literature while Section 3 provides an overview of the recent developments in the inflation realisations. Section 4 discusses the test of correlation between the two inflation indicators. Section 5 presents the empirical results of the causal links between producer and consumer prices. Section 6 offers some concluding remarks and policy recommendations.

¹ See for example, Huang and Liu (2005) and Wei and Xie (2020).

2. Related literature

Inflation has become a key concern for the macro-policy environment, particularly monetary policy, as prices have grown at their fastest pace in recent times. Economic analysis has varying ways of measuring the general price level of an economy. Two major price indices include the Consumer Price Index (CPI) and the Producer Price Index (PPI). The CPI measures price changes in goods and services consumed by individuals and households. It refers to a single index that includes the prices of goods and services purchased by the consumer. PPI measures the average change over time in the selling prices received by domestic producers for their output. It is used to measure changes in input prices of crude materials, intermediate goods, and finished goods. Producer prices capture the prices of goods at the time when these goods leave factory gates while consumer prices include taxes and levies, as well as the costs and markups of the distribution and retail sectors (Rubene, 2023).

Li et al (2019) indicate that the two price indices form an industrial chain connecting from upstream production to downstream consumption. The CPI reflects prices in downstream consumption while the PPI reflects prices in upstream production. According to Jongwanich, Park and Wongcharoen (2019), the two prices indices are differently determined. Demand-pull factors are reflected in consumer prices and external cost-push and supply factors are transmitted to producer prices.

From the perspective of supply-side developments, price fluctuations are generally transmitted from upstream to downstream. Thus, according to the supply-side approach, the fluctuation of PPI will cause CPI changes, but there will be a certain lag period (Cushing and McGarvey, 1990; Li et al., 2019). Therefore, the traditional approach shows that the dynamics of price transmission is from producer process to consumer prices (Ozpolat, 2020).

Li et al (2019) explain that the goal of all economic activities is to provide goods and services to consumers as dictated by the demand decision theory. The demand-side approach stresses that consumer prices are the cause of producer prices. Under the demand-side development, CPI affects PPI in two ways: First, consumer prices depend on the current demand and demand expectations. The dynamics of current demand affect producer prices as well. Thus, consumer prices transmit to the producer prices through demand dynamics (Cushing and McGarvey, 1990). Finally, the causality from consumer prices to producer prices is explained by labour supply. Caporale, Katsimi and Pittis (2002) explain that in the presence of high consumer inflation, wage earners in the production sector would bid for higher wages to maintain the purchasing power of their labour income. This would cause changes in producer prices as labour and production cost soar.

Empirical analyses affirm the existence of both the demand approach and supply-side propositions. Akçay (2011) indicated that a unidirectional causality exists from PPI to CPI in Finland and France. In another study, Martinez, Caicedo and Tique (2013) showed that producer prices have significant impacts on consumer prices. Su et al. (2016) studied the relationship between the PPI and the CPI in Slovakia and found that PPI has a positive impact on CPI. Khan et al (2018) conducted Granger causality analysis and reported that the PPI influences CPI in five Central and Eastern European (CEE) countries including Latvia, Lithuania, Romania, Slovakia and Slovenia. In a recent study, Nilcan (2023) showed that there is a causal relationship from PPI to CPI in Indonesia.

Existing studies have reported results in favour of the demand-side explanation as well. For instance, Hamid, Thirunnavukkarasu and Rajamanickam (2006) utilised data on the US in a VAR and Granger causality analysis and found a strong causality from the CPI to the PPI. In China, Gang, Liping and Jiani (2009) found that CPI has an impact on PPI. Also, Ulke and Ergun (2014) employed a Vector Error Correction Model and found a unidirectional causality from CPI to PPI in Turkey. In Hungary, Khan et al (2018) found that the CPI has a significant impact on the PPI. Likewise in South Africa, Nilcan (2023) indicated that causality runs from the CPI to PPI.

In some instances, however, causality runs in both directions. Ozpolat (2020) argues that in these cases, the demand side and supply side of prices move together and affect each other. In their study of Pakistan, Shahbaz, Wahid and Haider (2010) concluded that there exists bidirectional causality between Wholesale Prices and

Consumer Prices over the period 1992 to 2007. Also, Akçay (2011) and Nilcan (2023) found a bidirectional causality among the two price indices for Germany and Turkey respectively.

Finally, some studies established no causality between the PPI and CPI. For example, Akçay (2011) studied the relationship between the price indices in Netherlands and Sweden for the period 1995 to 2005 and reported no causality. Also, Nilcan (2023) indicated that there was no asymmetrical relationship between the CPI and PPI for Brazil and India.

This current contribution analyses further the pipeline between the CPI and PPI in Ghana and determines whether price stability policies should be calibrated using both price indices.

3. Recent trends in the inflation realisations

Recent inflation readings have recoded levels that are about the highest in the last three decades. Figure 1 shows the recent year-on-year inflation rates for consumer and producer price indices. The data shows that both consumer and producer inflation have been largely stable around 10% until the third quarter of 2021. By December 2022, the CPI inflation registered 54.1% on a year-on-year basis, more than six (6) times the Bank of Ghana's long-run average target of 8%. The producer inflation rose to a year-on-year rate of 78.1% in November 2022. Though the PPI inflation exhibits greater volatility, the level of producer inflation appeared to move reasonably closely with the level of consumer inflation. The two inflation measures started to diverge by January 2022, with the rise in PPI inflation outpacing the rise in CPI inflation. However, the gap between the two closed relatively quickly by December 2022. This evidence suggests a stable relationship between the inflation measures, where any gap that opens up between the two tends to close over time.

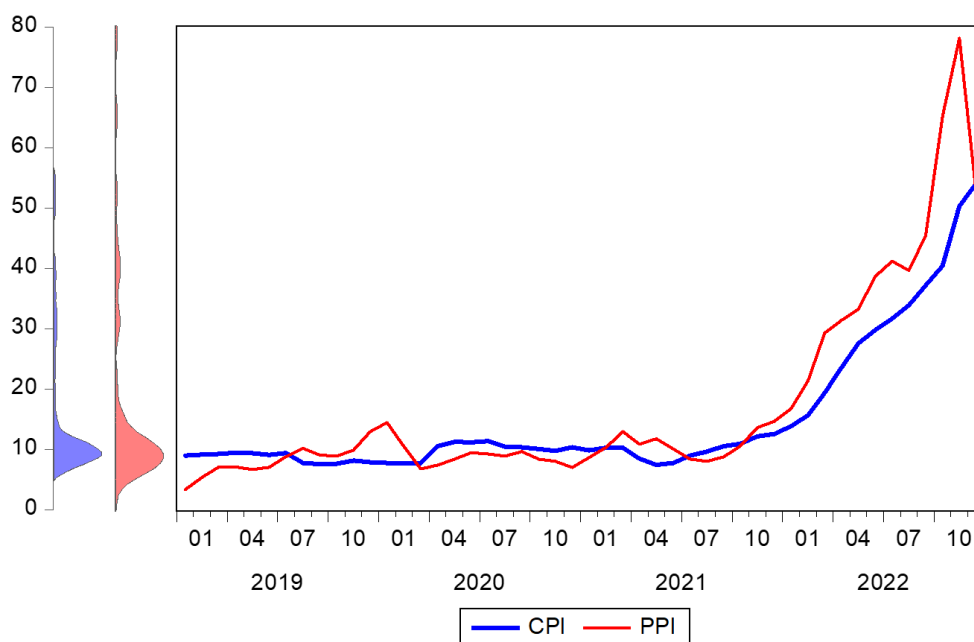


Figure 1. Monthly Inflation Readings, 2019–2022.

Both food and non-food component of the CPI experienced a similar trend as the overall consumer inflation (see Figure 2). At the height of the inflation spiral, the wedge between the two widened. Food inflation rose to 59.7% while non-food inflation increased to 49.9% in December 2022. This reflects general sharp increases in food prices in 2022 and is consistent with the global hikes in food prices in 2022. Indeed, the Food and Agriculture

Organization's (FAO) food price index² averaged 143.7 points in 2022, up 14.3% from 2021, and the highest since records started in 1990.

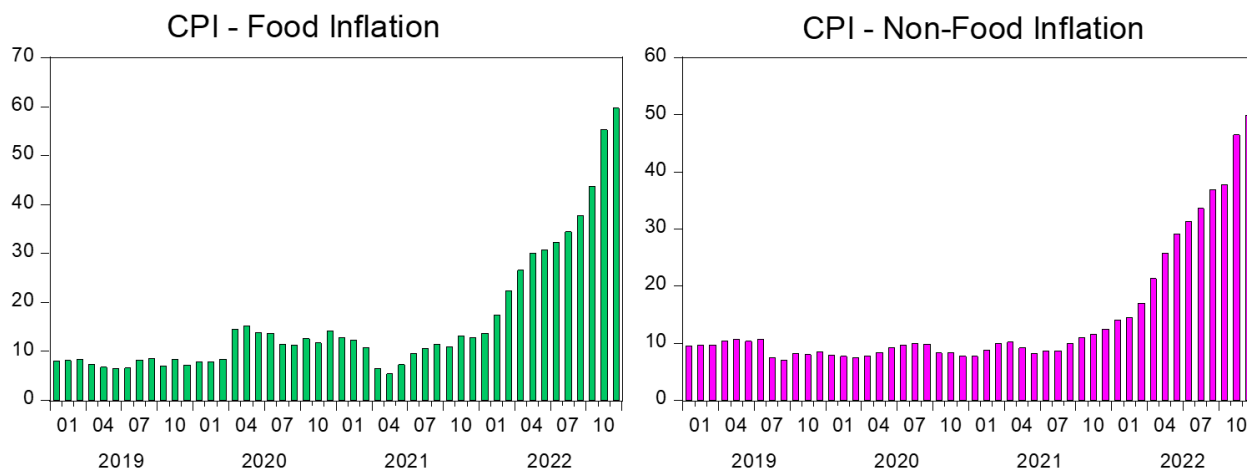


Figure 2. Food and Non-Food Component of CPI Inflation.

3.1. Seasonal swings in CPI and PPI Inflation

We test if the CPI and PPI series contain seasonal elements. We utilise the Seasonal-Trend decomposition using LOESS (STL) technique to identify seasonal and calendar-related movements in the CPI and PPI series. The Seasonal movements in PPI and CPI inflation measures are shown in Figures 3 – 5. Our estimates show that recurring temporal patterns exist in the CPI and PPI data. The CPI exhibits seasonal swings in May and November every year, while the seasonal fluctuations in the PPI heightened in March, July and December. Consumer inflation experience seasonal drops in November (0.74 percentage points) and seasonal jumps in May (1.06 percentage points). Producer inflation experience seasonal decrease in December (3.61 percentage points) and periodic jumps in March (1.64 percentage points) and July (1.33 percentage points). Food inflation experienced seasonal swings in December and May while seasonal shifts in the non-food inflation are observed in July and November. However, seasonal changes have not always been dominant in explaining the inflation transformations.

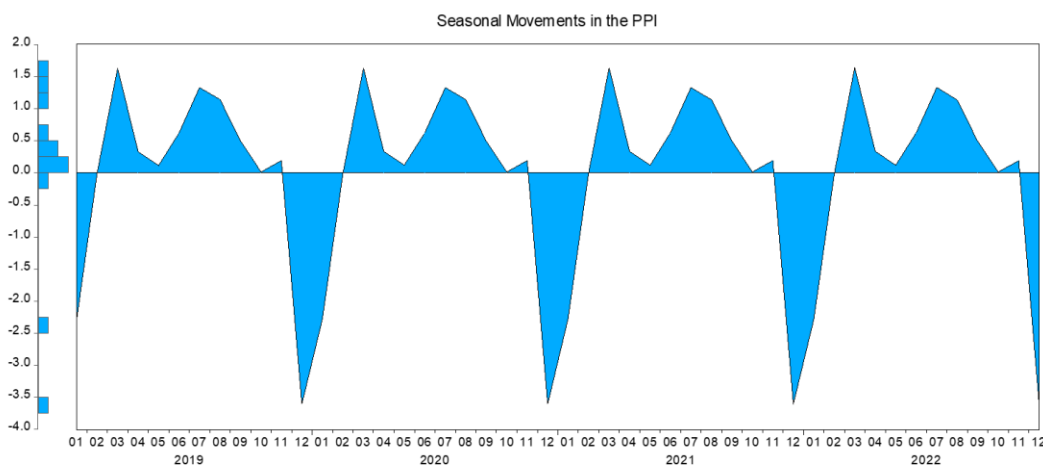


Figure 3. Seasonal Swings in the PPI.

² The FAO's food price index tracks international prices of the most globally traded food commodities.

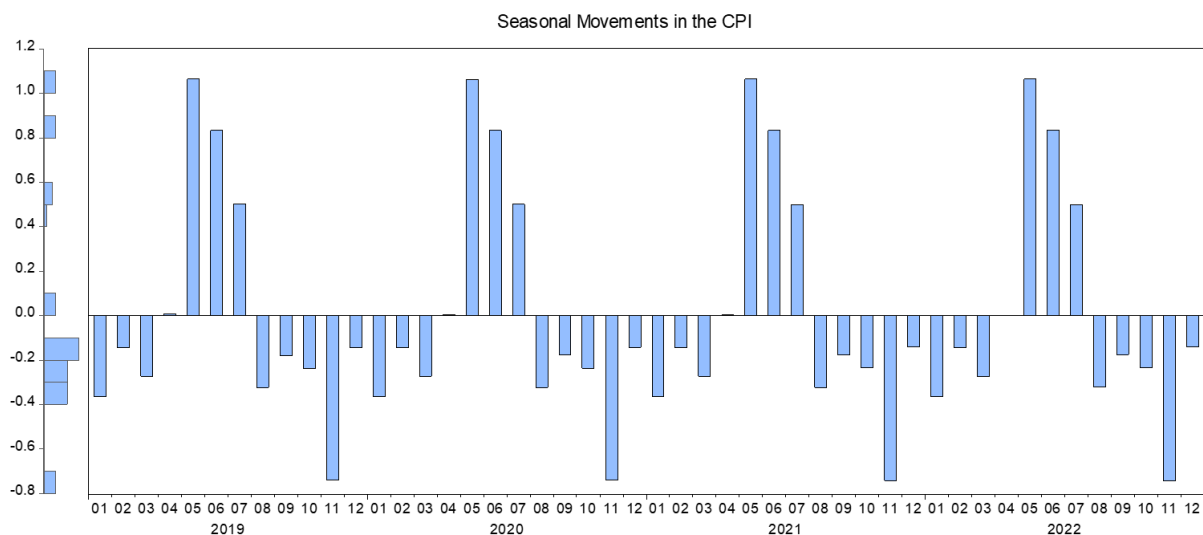


Figure 4. Seasonal Swings in the CPI.

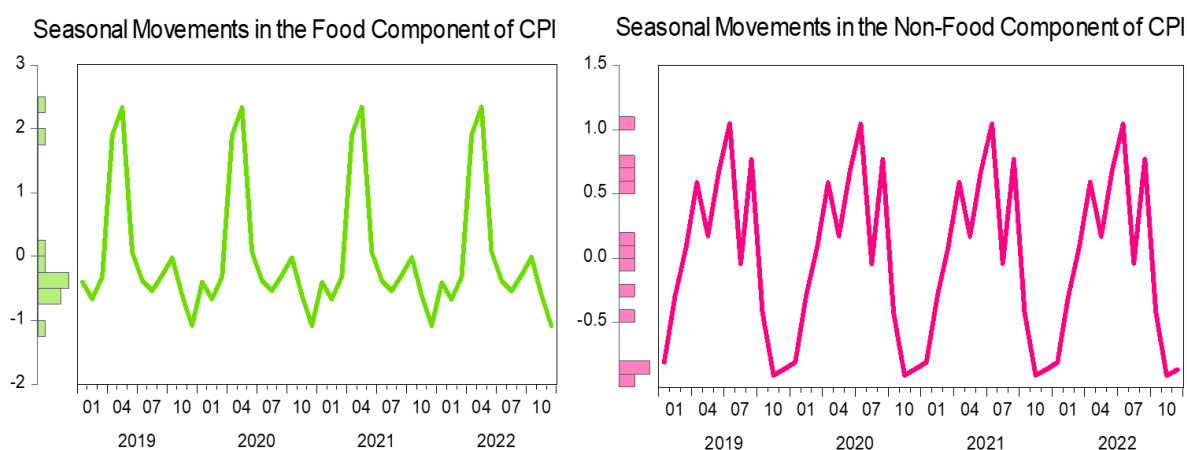


Figure 5. Seasonal Swings in the Food and Non-Food inflation.

4. Do PPI and CPI co-move?

Our foremost concentration is to analyse the correlation between the two inflation indicators. If the CPI and the PPI inflation indicators correlate strongly in the data, then the distinction between the two in theory would be irrelevant in practice. The estimates of the cross correlation between the PPI and CPI are shown in Figures 6 – 8. The evidence from the data shows that the two inflation indicators co-move strongly in the last three years with a correlation above 90%. The peak lead/lag between the PPI and CPI Inflation is at 0. Nonetheless, the PPI leads the CPI more than it lags it. The strongest correlation is between the current month's readings of the PPI and CPI inflation. However, the correlation analysis also shows a considerable correlation between lagged values of PPI inflation and the current month's consumer inflation. Correlation between the current month's consumer inflation and the previous month's producer inflation up to the fourth months are all greater than 50%. The PPI correlates strongly with both food and non-food components of the CPI. Thus, the Bank of Ghana's practice of targeting only the CPI is nearly harmless.

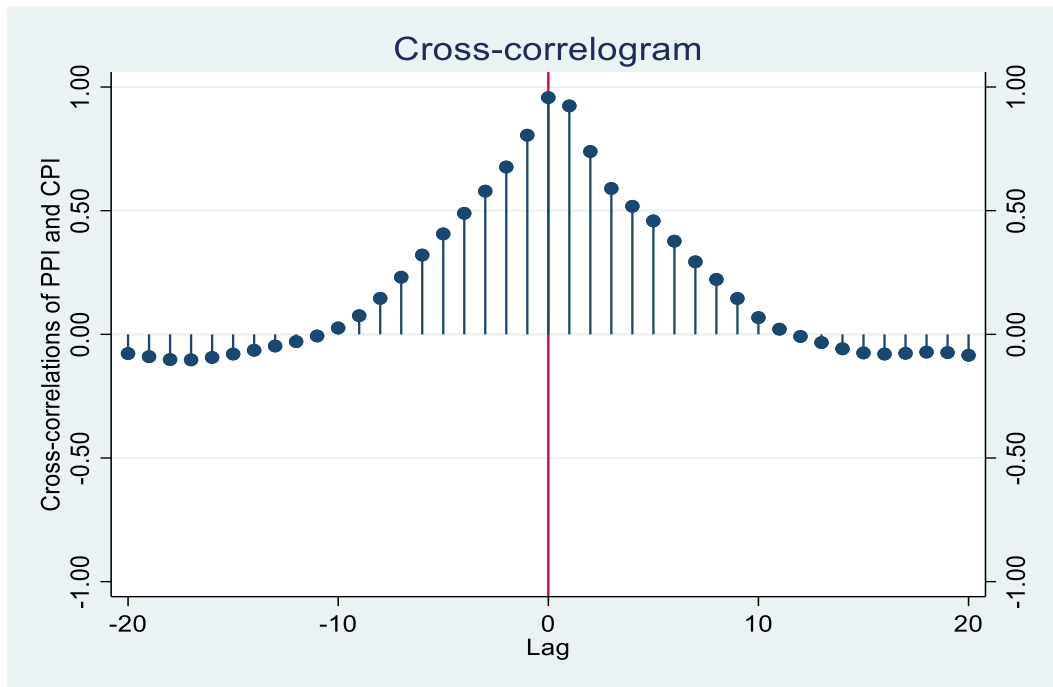


Figure 6. Cross correlation between PPI and CPI Inflation.

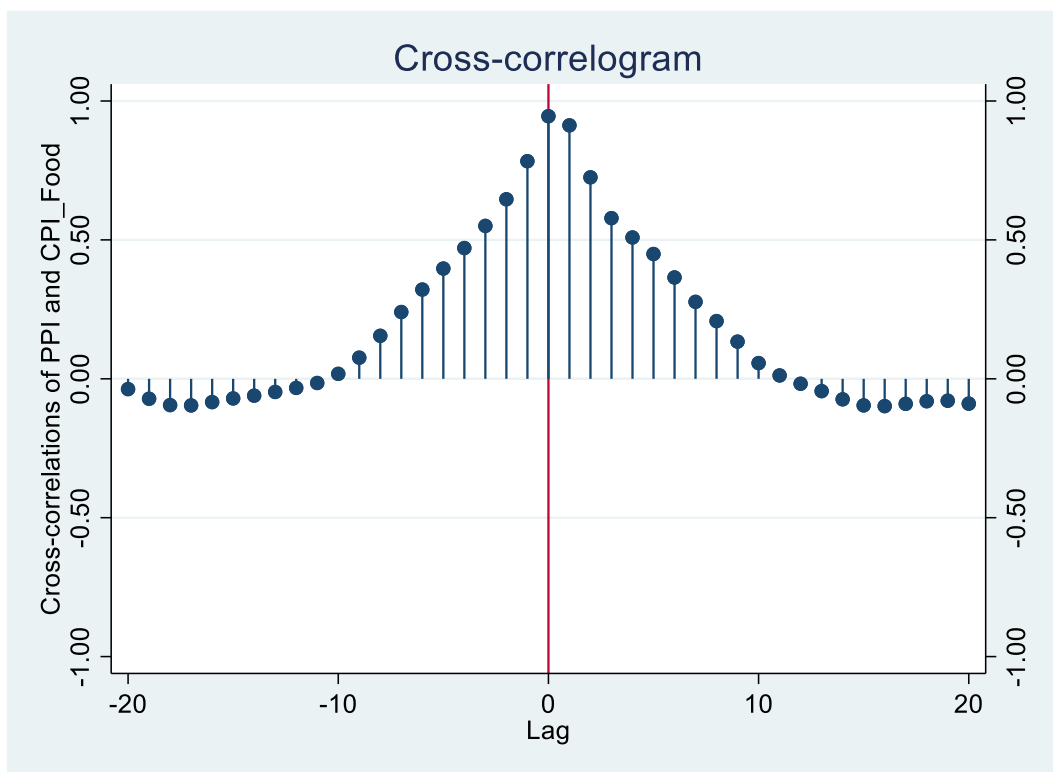


Figure 7: Cross correlation between PPI and CPI (Food) Inflation.

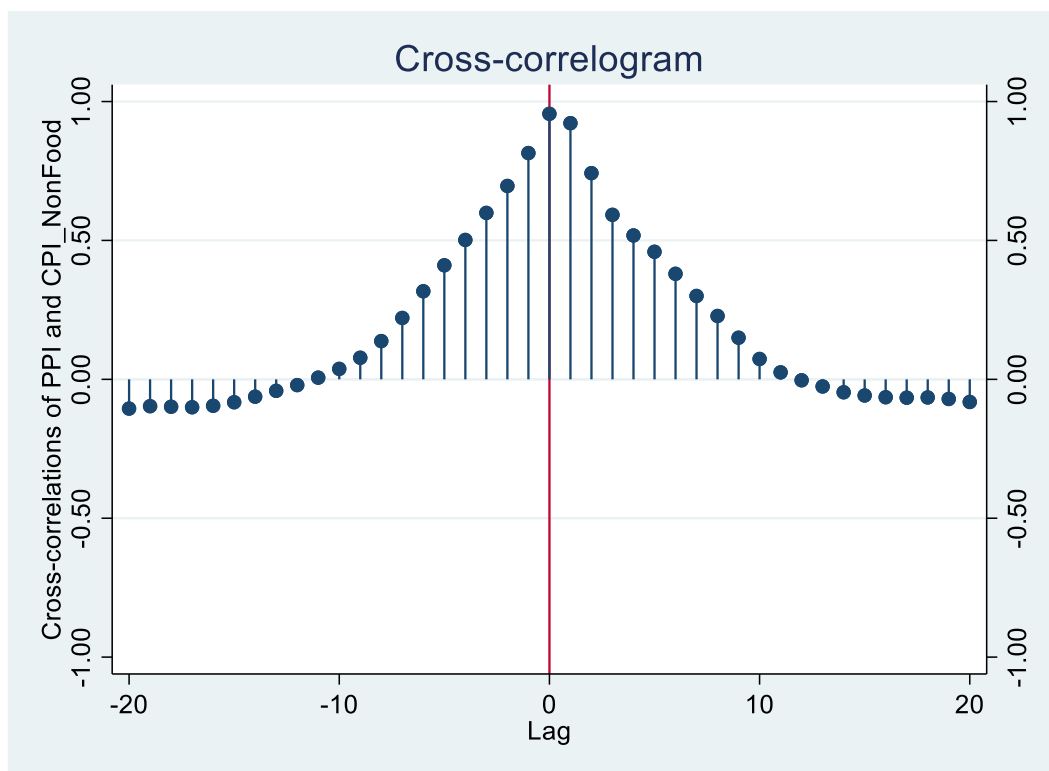


Figure 8. Cross Correlation between PPI and CPI (Non-Food) Inflation.

5. Causality Links Between Producer and Consumer Prices

We start the test of causality by investigating the unit root and univariate time series properties of the CPI and PPI series. The appropriate tests (ADF and PP) show that the series are non-stationary (see Table A1 in the Appendix). Since the statistical properties of the series show the presence of a unit root, we treat the series as $I(1)$ in the analysis.

Given that the variables are consistent with the $I(1)$ hypothesis, we explore whether they are cointegrated. We use Johansen’s trace/max eigenvalue statistics to test for the existence of a long-run relationship. To test for cointegration, we use the VAR (3)³ specifications as follows and include a constant as a deterministic term.

$$Y_t = \sum_{i=1}^3 \beta_i Y_{t-i} + \mu_t \tag{1}$$

where Y_t is a vector of endogenous variables (CPI and PPI), β_i is a coefficient matrix representing the lagged relationship between the endogenous variables and μ_t is a vector of error terms.

Table 1. Test for Cointegration in the PPI and CPI Inflation.

Hypothesized no. of CEs	Test Statistics		p-value	
	Trace	Max-Eigen	Trace	Max-Eigen
r = 0	0.26	0.26	0.02	0.07
r = 1	0.11	0.11	0.02	0.02

³ The lag length of 3 was widely indicated by the information criteria.

The Johansen cointegration test results are presented in Table 1. The test rejects the null hypothesis of no cointegration at the 5% level of significance. Consequently, our estimated cointegration relation indicates the existence of a long-run relationship between consumer inflation and the producer inflation.

On the basis of our cointegration analysis results, we estimate the corresponding Error Correction Model (ECM) model using the vector error correction model (VECM) procedure. The VECM is specified as follows:

$$\Delta CPI_t = \beta_0 + \sum_{i=1}^2 \beta_i \Delta CPI_{t-i} + \sum_{i=1}^2 \gamma_i PPI_{t-i} - \lambda(CPI_{t-1} - \alpha_0 - \alpha_1 PPI_{t-1}) + \mu_t \quad (2)$$

where $(CPI_{t-1} - \alpha_0 - \alpha_1 PPI_{t-1})$ is the error correction term.

We start out from a VECM with cointegrating rank 1 and 2 lagged differences. The results of the estimation (Table 2) suggest that in the long run the PPI has a positive and significant effect on the CPI. Thus, the PPI changes appear to be able to systematically predict movements in the CPI, consistent with the finding of Khan et al (2018) who reported same results for five Central and Eastern European (CEE) countries.

Estimates from the error correction model suggest that the CPI and PPI have a stable long-run relationship where short-run disequilibrium is corrected. The coefficient of the error correction term is negative and significant as expected and indicates a convergence process that ensures that short-term distortions from the long-term trend between PPI and the CPI are corrected.

Table 2. ECM Model Estimation.

Variable	Coefficient	Standard Errors	t-statistics
PPI	0.97	0.11	8.87
EC _{t-1}	-0.24	0.07	-3.59

Notes: The results are for the co-integrating equation depicting long-run equation.

5.1. Test of causality structure between the CPI and PPI

We test for a Granger-causal relation between the CPI and the PPI. Tests for causality based on a VAR(3) model are given in Table 3. The causality tests suggest a strong relation between the variables. All the noncausality null hypotheses can be rejected using a 5% significance level. On the basis of these tests, a strong causal relation between the variables is diagnosed with certainty. The evidence shows a Granger-causal relation from both directions, from PPI to CPI and from CPI to PPI. This is consistent with the findings of Akçay (2011) and Nilcan (2023) who report bidirectional causality between the two price indices. However, the estimates show that the magnitude of the feedback from the PPI to the CPI is greater than from the consumer prices to producer prices. Causality from producer to consumer prices is found in both cases of food and non-food consumer inflation.

Table 3. Test of causality between CPI and PPI.

Causality hypothesis	Test value	p-value
PPI does not Granger Cause CPI	7.75	0.00
CPI does not Granger Cause PPI	3.52	0.02
PPI does not Granger cause CPI - Food	10.95	0.00
PPI does not Granger cause CPI – Non-Food	4.99	0.01

Notes: Sample period: 2019M1 – 2022M12.

6. Conclusion and Policy Recommendations

Recent literature⁴ shows that in an open economy, in which PPI differs from CPI by excluding prices of imported products and including those of domestic products only, central banks should focus on the inflation of domestic products, which PPI inflation captures better. We employed correlation, VECM and Granger causality analyses to assess the correlation and the causality structure between producer and consumer prices and ascertain if the current policy designs that target the CPI inflation alone are problematic.

While it is a certainty that changes in the PPI are passed through to the CPI, we have found that the latter also affects the former. Nonetheless, the feedback from producer to consumer prices dominates. Our econometric and statistical models reveal that producer prices have a positive and non-trivial impact on consumer prices. Thus, the producer price index may be very informative and signal movements in the consumer prices early in the pipeline.

Notwithstanding the wedge between the basket of goods that the two price indices measure⁵, we document a strong co-movement between PPI and CPI inflation indicators. This suggests that the Bank of Ghana's monetary policy rule that does not distinguish between PPI and CPI inflation may be less problematic.

While our analysis ignores causality links with other variables (for simplicity), it is important to note that understanding the causes of the relationship between the PPI and CPI inflation has important implications for the design of monetary policies. Also, a regular examination of the relationship between the CPI and PPI inflation is imperative to identify any structural change. In the event of weakening correlation between the two, the research that advocates putting weights directly on PPI inflation in the monetary policy rule may deserve consideration by the Bank of Ghana.

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

⁴ Galí and Monacelli (2005), De Paoli (2009), and Lombardo and Ravenna (2014)

⁵ 1. The composition of the set of goods and services included in each index is different. The PPI includes the marketed output of domestic producers including the prices of industrial, services and construction products sold to other producers, consumers, government as well as products for exports. The CPI in contrast, measures the price of goods and services (including imported goods which are excluded from the PPI) purchased for consumption by Ghanaian households. 2. Several consumer services included in the CPI are currently not included in the PPI. Education services and insurance and financial services and housing (residential rent) are not currently covered by the PPI. 3. The type of prices collected by each index is different. the PPI measures prices received by the producers and may not reflect VAT. The CPI measures prices expended by consumers and may reflect taxes.

Appendix

A1. Results of ADF and PP tests.

	Level		First Difference	
	ADF	PP	ADF	PP
CPI	4.15	3.88	-4.34***	-4.27***
PPI	1.29	-1.37	-9.11***	-3.48***

Notes: ADF – Augmented Dickey-Fuller. PP - Phillips-Perron. *** indicates significance at 1%.

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