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Determinants of Food Prices in Turkiye within the Fourier Area

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ABSTRACT

This study investigates the determinants of food prices in the Turkish economy during the period from January 2006 to January 2025, a time frame marked by the implementation of an explicit inflation targeting strategy. Utilizing Fourier time series methods, the empirical analysis employs key macroeconomic variables including the inflation rate derived from the food and non-alcoholic beverages price index, the industrial production index, the nominal exchange rate of the US dollar, and the global price of Brent crude oil. All variables in the model possess a Fourier unit root at their level values, with a frequency degree of one. The model also reveals the existence of a Fourier cointegration relationship. Accordingly, a 1% increase in industrial production and the nominal exchange rate leads to an average rise in food prices by 0.42% and 0.98%, respectively. The parameter associated with crude oil prices, however, is found to be statistically insignificant. The sine function is statistically significant at the 1% level, suggesting vertical movements in cyclical fluctuations, while the cosine function, though statistically insignificant, indicates no horizontal shift or phase displacement within the business cycle. According to the results of the Fourier causality tests, there exists bidirectional, yet solely linear causality between food prices and industrial production. Moreover, there is strong bidirectional Fourier causality between food prices and the nominal exchange rate. Although a weak causality is observed from food prices to crude oil prices, a strong Fourier-based causality from oil prices to food prices indicates the operative role of cost-push inflation mechanisms.

Türkiye'de Gıda Fiyatlarının Fourier Alanda Belirleyicileri

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ÖZET

Bu çalışmada Türkiye ekonomisinde açık enflasyon hedeflemesi stratejisine geçilen Ocak 2006-Ocak 2025 döneminde gıda fiyatlarının belirleyicileri fourier zaman serisi yöntemleri ile incelenmektedir. Ampirik analizlerde gıda ve alkolsüz içecekler fiyat endeksinden elde edilen enflasyon oranı, sanayi üretim endeksi, Amerikan doları alış kuru, Brent ham petrolün küresel fiyatı değişkenleri kullanılmaktadır. Modelde yer alan değişkenler düzey değerinde fourier birim köke sahiptir. Modelde fourier eşbütünleşme ilişkisi bulunmaktadır. Buna göre sanayi üretim endeksi ve nominal döviz kurundaki %1'lik artış gıda fiyatlarını sırasıyla %0.42 ve %0.98 artırmaktadır. Ham petrol fiyatlarına ait parametre ise istatistiksel olarak anlamsızdır. Sinüs fonksiyonu ise %1 anlam seviyesinde istatistiksel olarak anlamlı ve konjonktürel dalgalanmaların dikey hareket ettiğini, kosinüs fonksiyonu ise istatistiksel olarak anlamsız ve konjonktürel dalgalanmada yatay kayma ve faz kaymasının olmadığını göstermektedir. Fourier nedensellik test sonuçlarına göre gıda fiyatları ile sanayi üretimi arasında çift yönlü ancak yalnızca doğrusal nedensellik bulunmaktadır. Gıda fiyatları ve nominal kur arasında karşılıklı olarak fourier nedensellik bulunmaktadır. Gıda fiyatlarından ham petrol fiyatlarına doğru zayıf bir nedensellik bulunmakla birlikte, ham petrol fiyatlarından gıda fiyatlarına doğru güçlü bir fourier nedensellik bulunmaktadır.

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INTRODUCTION

In recent years, macroeconomic fluctuations at both global and national levels have rendered the attainment of price stability a primary objective of economic policy in developing countries. In Turkiye, in pursuit of this goal, the economy adopted an explicit inflation targeting regime beginning in January 2006, thereby positioning it as the central pillar of monetary policy. One of the core assumptions of this strategy is that monetary policy, insofar as it is effective, should enhance the predictability of the general price level. However, sub-indicators such as food prices (hereafter FD), which are highly sensitive to both external shocks and structural vulnerabilities, can directly influence the success of this targeting strategy. FD represent a significant portion of consumption expenditure for households with low per capita income, making the identification of their determinants crucial—not only for the effectiveness of monetary targeting but also for addressing issues of income distribution and social policy. Hence, instability in FD constitutes a strategic concern for national economies in terms of social welfare. Identifying the determinants of FD thus provides valuable insights for policymakers. The principal aim of this study is to identify the determinants of the food and non-alcoholic beverages price index in Turkiye during the January 2006–January 2025 period. Economic growth affects FD through both demand-side and cost-side mechanisms: increased output can raise FD via higher disposable income, or indirectly by influencing the competitiveness of non-agricultural sectors and complementary activities within the supply chain. In the Turkish economy, fluctuations in the nominal exchange rate clearly affect all economic activities and the forward-looking expectations of economic agents. Similarly, volatility in global oil prices influences the entire food supply chain, thereby affecting FD. In light of these dynamics, examining the impact of output growth as a proxy for domestic economic activity, the nominal exchange rate as a driver of imported agricultural input costs, and oil prices as a determinant of transportation costs on FD may enhance the policy-making process by fostering more informed and predictable decisions.

Although the economics literature includes numerous studies investigating the determinants of FD, the majority of these studies focus predominantly on high-income economies and rely on conventional empirical approaches. In contrast, empirical analyses specific to the Turkish economy often overlook dynamic elements such as structural transformations and frequency distributions. This study addresses that gap by employing Fourier-based tests, which rest on the premise that empirical models may encompass structural breaks, non-linear patterns, and frequency components. Unlike traditional methods, Fourier tests account for cyclical fluctuations and structural shifts that are frequently neglected in standard empirical frameworks. Fourier models enable more robust and comprehensive analyses by incorporating unobserved frequency components that may arise from seasonality or shifts in policy regimes. In the context of FD, which are influenced by supply and demand imbalances, seasonal patterns, production costs, and nominal exchange rate movements, such multifaceted analytical tools prove especially valuable. The integration of these components into empirical analysis enhances explanatory power and policy relevance, offering deeper insight into the complex interplay of macroeconomic variables that shape food price dynamics in middle-income economies such as Turkiye.

The selection of January 2006 as the starting point for the empirical analyses employed in this study has been made strategically, in order to examine both changes in the monetary policy regime and the impacts of internal and external economic shocks. The adoption of an inflation targeting strategy as of January 2006 marks a turning point in the institutionalization of the price stability objective. Since this initial date, several significant events—including the global financial crisis (2008), food crises (2007–2008, 2010–2011), the global pandemic (2020–2022), and irrational monetary policies (post-2018 exchange rate shocks)—have caused fluctuations in FD from both supply and demand perspectives. In the Turkish economy, the high share of food expenditures in the total consumption of low-income households means that food inflation leads to a decline in the real incomes of these

individuals. On the other hand, the high-cost input structure of the agricultural sector, combined with volatility in oil prices and the exchange rate, directly affects the producer price index and results in cost-push inflation. Moreover, changes in output levels trigger both shifts in household income and demand-driven inflationary pressures.

THEORETICAL BACKGROUND AND LITERATURE REVIEW

Over the years, FD in Turkiye have been marked by persistent instability, rendering them a significant issue with implications for social welfare. Continuous and erratic increases in FD have disproportionately impacted low-income individuals while also distorting inflation expectations. Consequently, a substantial body of theoretical and empirical research has emerged to explore the determinants of FD in the Turkish economy. These studies consistently highlight the multidimensional, dynamic, and complex nature of the mechanisms underlying food price formation. The literature further reveals that FD in Turkiye are shaped by both domestic and global macroeconomic variables. In general, the existing research has concentrated on monetary variables, international market conditions, structural challenges in agricultural production, and various socio-economic indicators. Summarizing the literature, five principal categories of determinants can be identified: macroeconomic variables, international factors, agricultural production processes, food security, and food price volatility. Kutlu (2021), in examining the effects of the exchange rate, money supply, and output gap on FD, concludes that currency depreciation increases the cost of imported inputs and thereby exerts upward pressure on FD, while expansion in the money supply contributes to inflationary trends in the general price level. Yıldırım (2021) argues that heightened inflation expectations and exchange rate fluctuations significantly elevate FD. Özçelik and Uslu (2024) contend that high interest rates limit access to credit in the agricultural sector, thus exerting additional pressure on FD. While Oral et al. (2023) reach similar conclusions to Kutlu (2021) regarding exchange rate effects, they diverge from Özçelik and Uslu (2024) by suggesting that the influence of interest rates on FD is more nuanced and indirect. Barbaros et al. (2019) also emphasize the complexity of this relationship. In addition to macroeconomic factors, the literature also considers global influences. Bayramoğlu and Kurt (2015), along with Özçelik (2023), suggest that volatility in global FD adversely affects Turkiye, a country reliant on food imports. According to Özdurak (2021), high volatility in oil and global FD introduces uncertainty for both producers and consumers, complicating decision-making processes.

Güngör and Eren (2022), who examine the non-linear effects of oil prices and exchange rates on FD, argue that large-scale shocks in either variable yield more pronounced and persistent effects. Algan et al. (2021) and Altıntaş (2016) similarly conclude that increases in oil prices exert a stronger influence on FD than decreases, with negative oil price shocks having especially persistent effects. To better clarify the determinants of FD, it is necessary to also consider agricultural production and the producer price index. Bozkurt and Çamoğlu (2023), in their analysis of input costs, exchange rates, and global agricultural prices, identify fertilizer, oil, and feed price volatility as key factors contributing to rising FD. Aytekin and Hatırlı (2021), as well as Tunçsiper and Yamaçlı (2023), focus on unprocessed FD, pointing to high input costs and seasonality in the agricultural sector as determinants of fresh produce prices. They further argue that volatility in the exchange rate negatively affects agricultural sectors reliant on imported inputs. Peker and Gülengül (2023) highlight regional disparities in FD, attributing them to factors such as climate conditions, soil structure, and irrigation systems, which influence the value of crop production. Fluctuations in FD are not merely an economic concern but also a matter of social welfare. Uğur and Özocaklı (2018), in their work on food insecurity, identify income and education levels, unemployment rates, and social assistance as key factors influencing food security. They find that individuals with lower per capita income are more adversely affected by food insecurity, exacerbating income inequality. Erbay and Şentürk (2022) claim that rising FD place psychological

pressure on vulnerable low-income groups, leading to an increase in suicide rates. This literature, which focuses exclusively on the determinants of FD within the Turkish economy, underscores the complexity and multidimensionality of the issue. It also suggests that combating food price inflation in Turkiye requires the adoption of a more holistic policy approach.

EMPIRICAL ANALYSIS

This study analyzes the determinants of FD in the Turkish economy during the period between January 2006 and January 2025, corresponding to the adoption of an explicit inflation targeting regime. The dependent variable is the inflation rate (lnFD), derived from the food and non-alcoholic beverages price index with a 2003 base year. The independent variables include the industrial production index based on 2021 (lnIPI), the nominal exchange rate of the US dollar (lnNEER), and the global price of Brent crude oil per barrel (lnWTI), calculated in nominal US dollars. The Brent oil price data are sourced from the Federal Reserve Bank of St. Louis (FRED), while the remaining variables are retrieved from the Central Bank of the Republic of Turkiye's Electronic Data Delivery System (EVDS). The empirical methodology applies a range of Fourier-based tests to account for potential structural breaks and non-linear dynamics. These include the Fourier KPSS unit root test by Becker et al. (2006), the Fourier Autoregressive Distributed Lag (ARDL) model proposed by Banerjee et al. (2017), the Fourier Standard Granger Causality (GC) test with single frequency by Enders and Jones (2016), and the Fourier Toda-Yamamoto (TY) causality test with single frequency by Nazlıoğlu et al. (2016). Additionally, the analysis incorporates cumulative frequency versions of both the Fourier GC test (Enders & Jones, 2015) and the Fourier TY test (Nazlıoğlu et al., 2016). In the models applied, Y_t denotes the dependent variable, t the trend variable, k the number of frequencies, T the number of observations, and $r_t = r_{t-1} + u_t$ represents the stochastic process under consideration.

$$Y_t = \beta_0 + \beta_1 t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \cos\left(\frac{2\pi kt}{T}\right) + r_t + \varepsilon_t \quad (1)$$

The regression is estimated as specified by Becker et al. (2006). The test statistic is formulated as follows:

$$\tau_\varepsilon(k) = \frac{1}{T^2}\frac{\sum_{t=1}^{T}\widetilde{S}_t(k)^2}{\widetilde{\sigma^2}} \quad (2)$$

where $\widetilde{S}_t(k)^2 = \sum_{J=1}^{t}\widetilde{\varepsilon_j}$denotes the residuals obtained from the corresponding regression. The test is computed by selecting the number of frequencies k that minimizes the RSS, as recommended by Becker et al. (2006).

Table 1

Fourier KPSS Test Results

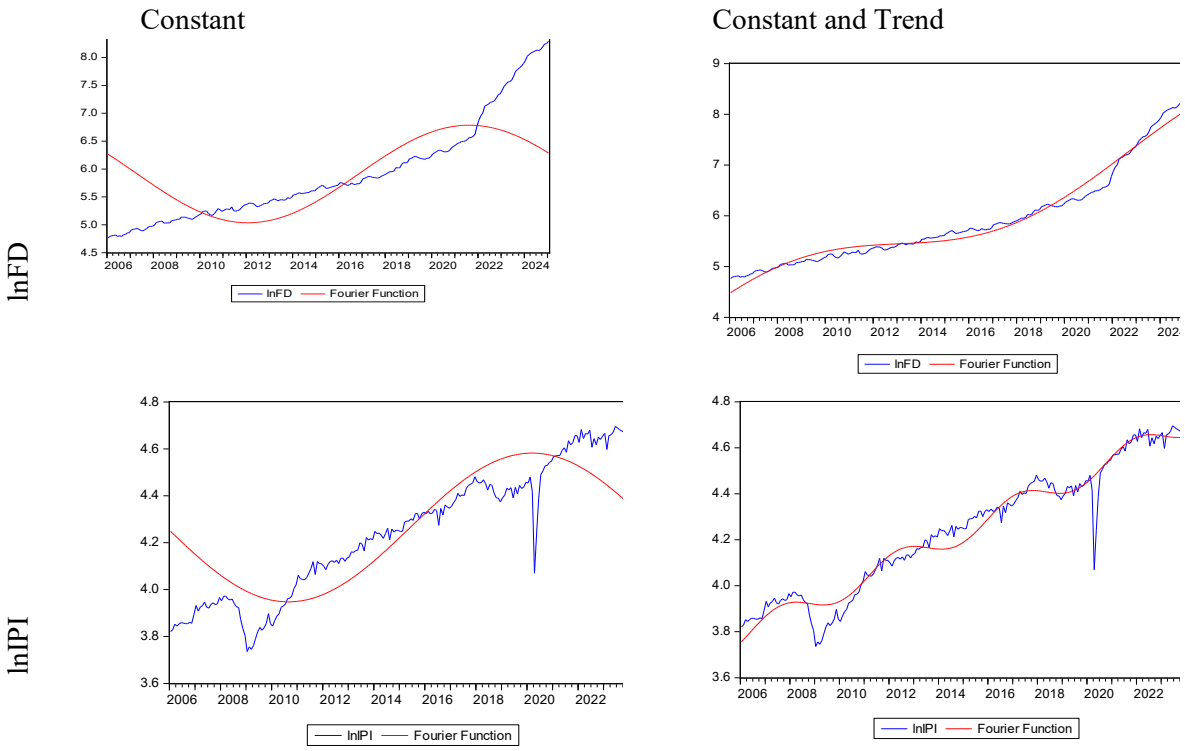
		Frequency (k)	FKPSS $\tau_\varepsilon(k)$
lnFD	Constant	1	0.755[a]
	Constant and Trend	1	0.114[a]
lnIPI	Constant	1	0.717[a]
	Constant and Trend	4	0.098
lnNEER	Constant	1	0.754[a]
	Constant and Trend	1	0.097[a]
lnWTI	Constant	1	0.702[a]
	Constant and Trend	1	0.051[b]

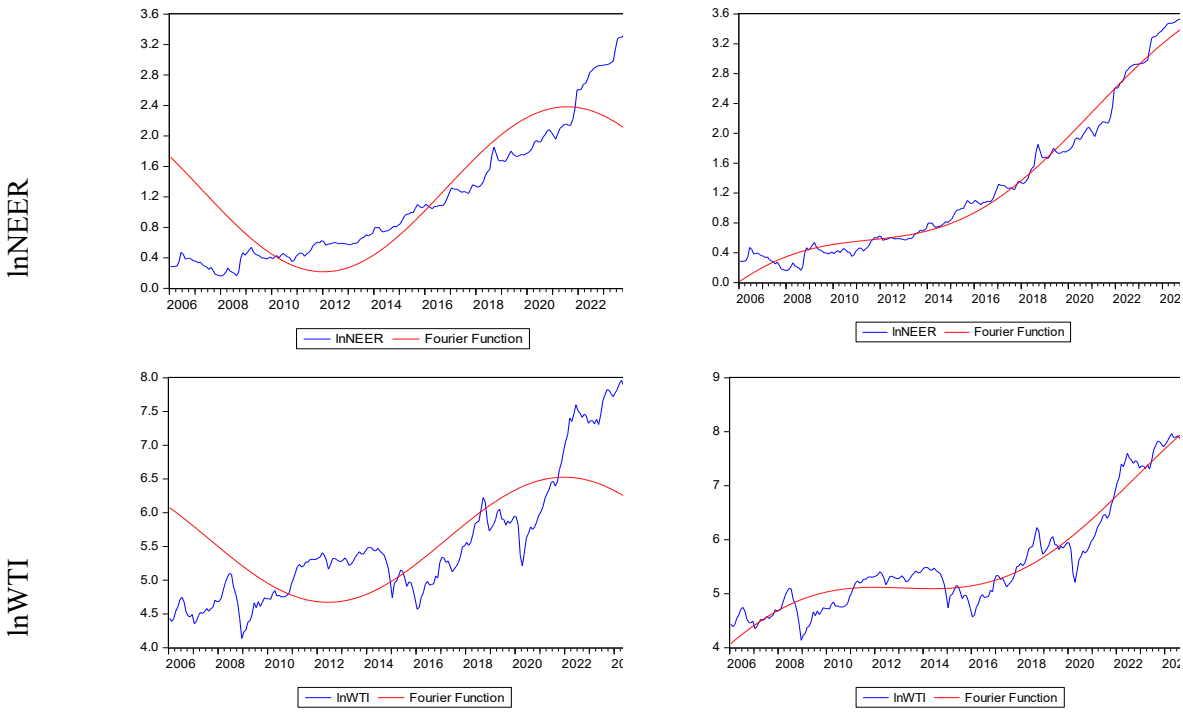
Note.: For k=1, the critical values at the 1%, 5%, and 10% significance levels are 0.131, 0.172, and 0.269, respectively, for the model with intercept only; and 0.047, 0.054, and 0.071, respectively, for the model with both intercept and trend. For k=4, the critical values at the 1%, 5%, and 10% significance levels are 0.118, 0.147, and 0.217, respectively, for the model including both intercept and trend. p<0.01 a, p<0.05 b.

Table 1 presents the results of the FKPSS unit root tests. The variables lnFD and lnNEER exhibit a Fourier unit root at level in both the intercept-only and trend-included models at the 1% significance level. The lnWTI variable carries a Fourier unit root at the 1% level in the intercept-only model and at the 5% level in the trend-included model. The lnIPI variable displays a Fourier unit root at the 1% level in the intercept-only model; however, no unit root is observed in the trend-included model. With respect to frequency components, variables carrying a Fourier unit root exhibit a frequency value of 1. In contrast, lnIPI, which has a frequency of 4, does not exhibit a unit root in the trend-included model. The presence of unit roots in lnFD and lnNEER suggests that internal and external shocks arising in the short term have persistent effects. This finding may be interpreted as evidence of the exchange rate pass-through effect, indicating that currency shocks exert an influence on FD. The lnWTI variable, being susceptible to global eco-political shocks, reveals the permanence of these shocks and the implications of cost-push inflation. The findings concerning lnIPI are more complex: while the presence of a unit root in the intercept-only model suggests the permanence of shocks, its stationarity around a trend in the trend-included model implies a long-run mean-reverting behavior. The fact that lnIPI exhibits a frequency value of 4 in the trend-included model suggests that the Fourier unit root, when present, reflects a cyclical component and that the shocks follow a predictable short-term cyclical pattern. By contrast, the consistent frequency value of 1 in the other variables indicates that the cyclical fluctuations in those series possess a long-term and fundamental structure.

Graphic 1

Raw Data and Fourier Function





Source: Author Own Calculation.

Figure 1 displays the Fourier functions and raw data for the variables included in the model. The Fourier functions assist in interpreting the wave-like structures exhibited by these variables. The pattern observed in lnFD indicates regular and stable cyclical fluctuations over time. This suggests that lnFD is highly sensitive to both internal and external shocks, with such shocks inducing upward or downward movements in the variable—primarily due to the influence of the sine function. The statistical insignificance of the cosine function implies that the timing of the cycles in lnFD is less economically meaningful than the structure of the waves themselves. This, in turn, indicates that the balance between production and consumption in the agricultural sector is strongly shaped by seasonality, and that FD oscillate in accordance with this seasonal pattern. The lnIPI variable demonstrates that the production process exhibits short-term cyclical behavior. This reflects the frequent cycles within production, driven by both domestic demand and fluctuations in input and energy costs, indicating a rapidly adapting production environment. The absence of a Fourier unit root in the trend-included model suggests that Turkiye's production structure fluctuates within long-term structural bounds. The presence of a unit root in lnNEER under both the intercept-only and trend-included models indicates that exchange rate shocks have long-lasting effects. In economies where production is heavily dependent on imports, exchange rate volatility leads to sharp deviations from trend, with speculative movements distorting expectations and directly influencing the general price level. Lastly, the relatively smooth pattern observed in lnWTI highlights the agricultural sector's dependency on energy costs, while also suggesting a comparatively less volatile structure.

$$\Delta lnFD = \beta_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_2 lnFD_{t-1} + \beta_3 lnIPI_{t-1} + \beta_4 lnREER_{t-1} + \beta_5 lnWTI_{t-1} + \sum_{i=1}^{p-1} \grave{\alpha}_i \, \Delta lnFD_{t-i} + \sum_{i=1}^{p-1} \grave{\delta}_i \, \Delta lnIPI_{t-i} + \sum_{i=1}^{p-1} \grave{\theta}_i \, \Delta lnREER_{t-i} + \sum_{i=1}^{p-1} \grave{\varphi}_i \, \Delta lnWTI_{t-i} + \varepsilon_t \quad (3)$$

In the distributed lag model denoted as Equation (3), the frequency parameter k is determined within the interval k=[0.1,…,5] in increments of 0.1. The value of k that minimizes theRSS is selected. An integer value of k indicates the presence of temporary structural breaks, whereas a fractional k signifies permanent structural shifts (Christopoulos & Leon-Ledesma, 2011). Here, β_0 denotes the

intercept term; β_3, β_4 and β_5 represent the effects of lnIPI, lnNEER and lnWTI on lnFD, respectively. The null hypothesis of no fourier cointegration is tested through the following restrictions: for the F_A test, $\beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$; for the t-test, $\beta_2 = 0$; and for the F_B test, $\beta_3 = \beta_4 = \beta_5 = 0$.

Table 2

Cointegration Critical Values Obtained from the FARDL (2,1,0,3) Model

	Test Stat.	%10	%5	%1	k
F_A	11.879[a]	2.690	3.526	4.881	1
t	-5.476[a]	-2.540	-2.993	-3.876	AIC
F_B	13.872[a]	2.958	3.656	6.167	-4.886

Note. p<0.01 a.

According to the results of the fourier cointegration test by Banerjee et al. (2017), as presented in Table 2, there exists a statistically significant Fourier cointegration relationship based on the F_A, *t*, and F_B test statistics at the 1% significance level. The frequency value being equal to 1 indicates the presence of temporary structural breaks in the long-term relationships among the variables.

Table 3

Parameter Estimates with Included Fourier Terms

	FMOLS	DOLS	CCR
Constant	3.063 (0.00[a])	2.966 (0.00)[a]	3.046 (0.00)[a]
β_3 (lnIPI)	0.424 (0.01)[b]	0.443 (0.01)[b]	0.429 (0.01)[b]
β_4 (lnNEER)	0.987 (0.00)[a]	0.976 (0.00)[a]	0.988 (0.00)[a]
β_5 (lnWTI)	-0.043 (0.30)	-0.035 (0.41)	-0.044 (0.29)
γ_1 (Sinus)	0.284 (0.00)[a]	0.275 (0.00)[a]	0.286 (0.00)[a]
γ_1 (Kosinus)	-0.022 (0.35)	-0.034 (0.17)	-0.021 (0.37)

Notes: () probability value, FMOLS fully modified OLS, DOLS dynamic OLS, CCR canonical correlation regression, p<0.01 a, p<0.05 b.

Table 3 presents the coefficient estimates obtained through three different parameter estimation methods. The intercept term is statistically significant at the 1% level across all three models. A 1% increase in lnIPI leads to an average increase of 0.42% in lnFD, indicating the presence of demand-pull inflation from an economic theory perspective. The increase in lnIPI reflects a rise in overall economic activity and aggregate demand (AD). Higher AD, particularly in the context of FD, raises the general price level (Blanchard, 2017) and may also trigger cost-push inflation through input cost increases (Mishkin, 2016). According to Özatay and Sak (2016), in developing economies such as Turkiye, increases in lnIPI are often accompanied by inflationary pressures. When evaluated alongside the Phillips Curve, this suggests that rising production may lead to declining unemployment rates and heightened inflation expectations, thereby fueling inflation. A 1% increase in lnNEER results in an average rise of 0.98% in lnFD. This finding clearly indicates the strength of the exchange rate pass-through effect in the Turkish economy. Fluctuations in the nominal exchange rate increase the costs of both imported food products and agricultural raw materials, which in turn exert upward pressure on the general price level. Furthermore, Turkiye's production structure, which is heavily dependent on imports, exacerbates the sensitivity of FD to exchange rate fluctuations. The lnWTI variable, by contrast, is statistically insignificant, implying that it does not exert a direct effect on lnFD within the scope of this model. Its influence may be indirect, context-specific, or mediated through other variables included in the analysis. Although increases in lnWTI may affect lnFD through input costs, the effect may vary across sectors and product types. According to Mehrara and Oskoui (2007), the relationship between

lnWTI and lnFD evolves over time, undergoing structural breaks and shifts in trend. The sine function is statistically significant at the 1% level, indicating the presence of vertical (i.e., upward and downward) cyclical fluctuations. Conversely, the cosine function is statistically insignificant, suggesting the absence of horizontal shifts or phase deviations in the cycle. Thus, while the sine function captures the presence of economic cycles, the insignificance of the cosine term implies that the timing or starting point of these cycles lacks economic significance. Given the inherently seasonal nature of production and consumption in the food sector, lnFD is prone to cyclical movements (Bellemare et al., 2012). Ultimately, the significance of the sine function, coupled with the insignificance of the cosine term, suggests that cyclical fluctuations are indeed present, but it is the existence of the cycle—rather than its precise onset—that holds analytical value. When evaluated holistically, the FARDL results suggest that lnIPI and lnNEER are the most influential determinants of lnFD in the Turkish economy during the examined period, while lnWTI exhibits only weak influence. Additionally, the presence of cyclical movements in lnFD, as confirmed by the sine function, underscores the necessity of both aggregate demand management and exchange rate control in stabilizing FD in Turkiye.

$$lnFD_t = \beta_0 + \beta_1 \sin\left(\frac{2\pi kt}{T}\right) + \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} \alpha_i lnFD_{t-i} + \sum_{i=1}^{p} \delta_i lnIPI_{t-i} + \varepsilon_t \quad (4)$$

$$lnIPI_t = \beta_0 + \beta_1 \sin\left(\frac{2\pi kt}{T}\right) + \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} \alpha_i lnIPI_{t-i} + \sum_{i=1}^{p} \delta_i lnFD_{t-i} + \varepsilon_t \quad (5)$$

In the unrestricted VAR model with included Fourier terms, denoted as Equation (4), the null hypothesis of no causality from *lnIPI* to *lnFD* is expressed as $\sum_{i=1}^{p} \delta_i lnIPI_{t-i} = 0$ while the alternative hypothesis, indicating the presence of causality from *lnIPI* to *lnFD*, is expressed as $\sum_{i=1}^{p} \delta_i lnIPI_{t-i} \neq 0$. Similarly, in Equation (5), the null hypothesis of no causality from *lnFD* to *lnIPI* is given by $\sum_{i=1}^{p} \delta_i lnFD_{t-i} = 0$ and the alternative hypothesis that *lnFD* causes *lnIPI* is $\sum_{i=1}^{p} \delta_i lnFD_{t-i} \neq 0$.These models form the basis of the Granger Causality (GC) tests. When the maximum order of integration (d_{max}) of the variables is incorporated into these models, they constitute the Toda-Yamamoto (TY) causality tests. There are some differences between single frequency and cumulative frequency approaches. The single frequency method assumes that the structural break occurs at a specific point in time, thus offering limited flexibility. It is typically used when low-level or isolated structural breaks are expected in the variable. In contrast, the cumulative frequency method accounts for the combined effects of multiple frequencies, making it suitable when a variable is subject to multiple, uncertain structural breaks and long-term shifts over time.

Table 4

Fourier Causality Results

	Wald	Asymp. Prob.	Boots. Prob.	k	p	d_{max}
Ho: lnFD ≠>lnIPI						
Fourier Standard GC single Frequency	12.955	0.00[a]	0.00[a]	1	1	-
Fourier TY single frequency	0.248	0.884	0.874	1	2	1
Fourier Standard GC cumulative frequency	13.526	0.00[a]	0.00[a]	3	1	-
Fourier TY cumulative frequency	0.052	0.974	0.966	3	2	1
Ho: lnIPI ≠>lnFD						
Fourier Standard GC single Frequency	14.913	0.00[a]	0.00[a]	1	1	-
Fourier TY single frequency	3.797	0.150	0.144	1	2	1
Fourier Standard GC cumulative frequency	7.986	0.00[a]	0.00[a]	3	1	-
Fourier TY cumulative frequency	2.771	0.250	0.229	3	2	1
Ho: lnFD ≠>lnNEER						
Fourier Standard GC single Frequency	24.749	0.00[a]	0.00[a]	1	2	-

Fourier TY single frequency	7.878	0.049[b]	0.058[c]	1	3	1
Fourier Standard GC cumulative frequency	39.898	0.00[a]	0.00[a]	3	2	-
Fourier TY cumulative frequency	7.230	0.027[b]	0.035[b]	3	2	1
Ho: lnNEER ≠>lnFD						
Fourier Standard GC single Frequency	29.171	0.00[a]	0.00[a]	1	2	-
Fourier TY single frequency	29.327	0.00[a]	0.00[a]	1	3	1
Fourier Standard GC cumulative frequency	23.814	0.00[a]	0.00[a]	3	2	-
Fourier TY cumulative frequency	25.699	0.00[a]	0.00[a]	3	2	1
Ho: lnFD ≠>lnWTI						
Fourier Standard GC single Frequency	2.250	0.134	0.133	1	1	-
Fourier TY single frequency	4.384	0.112	0.104	2	2	1
Fourier Standard GC cumulative frequency	3.303	0.069[c]	0.061[c]	3	1	-
Fourier TY cumulative frequency	3.268	0.195	0.183	3	2	1
Ho: lnWTI ≠> lnFD						
Fourier Standard GC single Frequency	9.456	0.00[a]	0.00[a]	1	1	-
Fourier TY single frequency	8.287	0.016[b]	0.020[b]	2	2	1
Fourier Standard GC cumulative frequency	7.955	0.00[a]	0.00[a]	3	1	-
Fourier TY cumulative frequency	8.154	0.017[b]	0.015[b]	3	2	1

Notes: p<0.01 a, p<0.05 b, p<0.1

According to the Fourier causality test results presented in Table 4, there is bidirectional but solely Granger-type causality between lnFD and lnIPI. This finding suggests that both demand-pull and cost-push inflation mechanisms may be simultaneously at play. Increases in lnFD may reduce households' real disposable personal income, thereby decreasing aggregate demand (AD). This mutual feedback mechanism can evolve into a self-reinforcing process. Between lnFD and lnNEER, Fourier causality is observed in both directions across all alternative test specifications. This result reflects the operation of the exchange rate pass-through effect and the price expectation channel. In economies where production is heavily reliant on imported inputs, the depreciation of the national currency leads to cost-push inflation (Amitrano, 2020). During the feedback process, rising inflation expectations may trigger capital outflows in short-term financial markets, which in turn exerts upward pressure on the exchange rate. Although a weak causal relationship from lnFD to lnWTI is detected, a strong Fourier causality from lnWTI to lnFD is observed. Theoretically, increases in lnFD could elevate demand for agricultural commodities, placing upward pressure on lnWTI; however, given that lnWTI is largely determined within global production chains, such an effect is expected to be minimal. Conversely, the strong causality running from lnWTI to lnFD suggests that the cost-push inflation channel is actively operating.

CONCLUSION

In recent years, structural breaks in the Turkish economy, disruptions in global supply chains, and domestic socio-economic developments have made it increasingly difficult for the Central Bank to achieve price stability. In a country like Turkiye, where the marginal propensity to consume is high, FD—which constitute a substantial share of household consumption—exert a growing influence on overall social welfare through the inflation expectations channel, often pressuring policymakers toward adopting irrational economic policies. For these reasons, both theoretical and empirical investigations into the determinants of FD are of critical importance for scholars and policymakers alike. This study examines the primary macroeconomic components of the food and non-alcoholic beverages price index in Turkiye over the period from January 2006 to January 2025, utilizing Fourier-based methodologies. By moving beyond traditional time series models, this research contributes to the empirical literature by

incorporating Fourier-based cyclical dynamics into the analysis. The study, however, has several limitations. First, the dataset focuses exclusively on the period during which the inflation targeting regime was implemented, excluding earlier phases. Furthermore, agricultural policy, climate change, disruptions in global supply chains, and spatial heterogeneity are not explicitly accounted for. Although Fourier methods capture structural transformations, the inclusion of socio-economic and spatial variables would enhance the reliability of the resulting policy implications. Fourier-based tests indicate that lnIPI and lnNEER are the two most significant determinants of lnFD. This finding suggests that output growth contributes to inflationary pressures by both increasing demand for agricultural products and raising input costs. Hence, the Turkish economy appears to exhibit characteristics of both demand-pull and cost-push inflationary structures. Another critical finding is the nearly one-to-one exchange rate pass-through effect. The import-dependent structure of agricultural production causes fluctuations in the exchange rate to be transmitted directly and rapidly to domestic FD. This leads to increases in both production costs and imported product prices, thereby exerting upward pressure on lnFD. These findings in the Fourier domain confirm that lnNEER generates not only short-term shocks but also long-term structural effects on food inflation. Conversely, the statistically insignificant impact of lnWTI on lnFD suggests that the relationship between the two variables may be indirect and subject to temporal variation. While the literature often posits a direct link via transportation and production costs, this connection does not appear to be stable or significant in the Turkish context. One of the key contributions of the Fourier approach is its ability to incorporate cyclical fluctuations—often overlooked by classical models—into empirical analysis. The inclusion of sine and cosine functions reveals that FD in Turkiye exhibit vertical cyclical movements (i.e., sharp upswings and downswings), without phase shifts. This implies that while seasonality significantly influences the production and consumption cycle, such patterns tend to repeat over time in a consistent phase.

Based on the empirical findings, the most important policy recommendation is that monetary policy instruments alone are insufficient to contain food inflation in Turkiye. Given the strong exchange rate pass-through, fiscal and trade policies must be activated effectively. A structural reorganization of the import-dependent agricultural sector, reduction of production costs, and implementation of effective domestic production subsidies are urgently needed. Considering the significant impact of lnIPI on lnFD, it is necessary to regulate aggregate demand while simultaneously supporting supply through targeted policies. A rational interest rate policy, along with prudent management of international reserves, is crucial to ensuring stability in the nominal exchange rate. Finally, providing favorable financial conditions to support agricultural production would help stabilize lnFD in the long term.

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