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Research Article

The Functional Composition of Public Expenditure and Inflation Dynamics in Türkiye: A Fourier Toda–Yamamoto Causality Analysis under Structural Breaks

Lütfü Sizer [a]

Abstract

Introduction: This study examines the relationship between inflation and the functional composition of public expenditures in Türkiye, emphasizing that fiscal policy affects price dynamics not only through its size but also through its allocation across expenditure categories. Given Türkiye's experience with persistent inflation and policy regime shifts, understanding how different public spending components interact with inflation is of particular importance.

Method: The analysis employs quarterly data covering the period 2006Q1–2025Q2 and includes the shares of general public services, economic affairs, health, education, and social protection expenditures in GDP. To account for mixed integration orders and smooth structural changes without prior knowledge of break dates, the study applies the Fourier-augmented Toda–Yamamoto causality approach.

Results or Findings: The results reveal that the inflationary effects of public expenditures differ across functional categories. Unidirectional causality is identified from General Public Services and Health expenditures to inflation. In contrast, bidirectional causal relationships are detected between inflation and Economic Affairs, Education, and Social Protection expenditures, indicating the presence of feedback mechanisms.

Discussion or Conclusion: The findings suggest that inflation dynamics in Türkiye depend critically on the functional composition of public spending rather than aggregate expenditure alone. From a policy perspective, expenditure reallocation strategies that consider category-specific inflationary effects may enhance the effectiveness of fiscal policy in supporting price stability and macroeconomic sustainability.

Keywords: public expenditures, inflation dynamics, fourier toda–yamamoto

JEL Codes: B22, C01, C22

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Araştırma Makalesi

Türkiye'de Kamu Harcamalarının Fonksiyonel Bileşimi ve Enflasyon Dinamikleri: Yapısal Kırılmalar Altında Fourier Toda–Yamamoto Nedensellik Analizi

Lütfü Sizer[a]

Öz

Giriş: Bu çalışma, Türkiye'de enflasyon ile kamu harcamalarının fonksiyonel bileşimi arasındaki ilişkiyi incelemekte ve maliye politikasının fiyat dinamiklerini yalnızca harcama büyüklüğü üzerinden değil, aynı zamanda harcamaların fonksiyonel dağılımı yoluyla da etkilediğini vurgulamaktadır. Türkiye'nin kalıcı enflasyon sorunları ve politika rejimi değişimleri dikkate alındığında, farklı kamu harcama kalemlerinin enflasyonla nasıl etkileşime girdiğinin anlaşılması büyük önem taşımaktadır.

Yöntem: Analizde, 2006Q1–2025Q2 dönemini kapsayan üç aylık veriler kullanılmış ve Genel Kamu Hizmetleri, Ekonomik İşler, Sağlık, Eğitim ve Sosyal Koruma harcamalarının GSYİH içindeki payları dikkate alınmıştır. Değişkenlerin farklı bütünleşme derecelerine sahip olması ve önceden belirlenemeyen yumuşak yapısal kırılmaların varlığı nedeniyle Fourier genişletilmiş Toda–Yamamoto nedensellik yaklaşımı uygulanmıştır.

Sonuçlar ya da Bulgular: Elde edilen bulgular, kamu harcamalarının enflasyon üzerindeki etkilerinin harcama kalemlerine göre farklılaştığını göstermektedir. Genel Kamu Hizmetleri ve Sağlık harcamalarından enflasyona doğru tek yönlü nedensellik ilişkisi tespit edilirken; Ekonomik İşler, Eğitim ve Sosyal Koruma harcamaları ile enflasyon arasında çift yönlü nedensellik ilişkileri belirlenmiştir. Bu durum, bazı harcama kalemlerinde geri besleme mekanizmalarının varlığına işaret etmektedir.

Tartışma ya da Yapılan Çıkarımlar: Sonuçlar, Türkiye'de enflasyon dinamiklerinin yalnızca toplam kamu harcaması düzeyine değil, harcamaların fonksiyonel bileşimine de güçlü biçimde bağlı olduğunu ortaya koymaktadır. Politika açısından, harcama kalemlerine özgü enflasyonist etkileri dikkate alan bir kamu harcaması bileşimi, fiyat istikrarını desteklemede maliye politikasının etkinliğini artırabilir.

Anahtar Kelimeler: kamu harcamaları, enflasyon dinamikleri, fourier toda–yamamoto

JEL Kodlar: B22, C01, C22

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Introduction

Inflation remains one of the most persistent challenges to macroeconomic stability and sustainable growth. Particularly in developing economies, inflation dynamics cannot be explained solely by monetary factors such as money supply growth or exchange rate pass-through. Instead, fiscal policy—and more specifically the structure and composition of public expenditures—plays a crucial role in shaping price dynamics. This perspective aligns with theoretical frameworks that emphasize the interaction between fiscal policy regimes and price level determination, commonly referred to as the Fiscal Theory of the Price Level (FTPL) (Leeper, 1991; Sims, 2013; Woodford, 1995). In countries such as Türkiye, which has experienced recurrent episodes of high and volatile inflation, the coherence between fiscal policy and price stability has long been a central issue of economic analysis (Anand & van Wijnbergen, 1989). Recent empirical research focusing on Türkiye also highlights the importance of fiscal policy dynamics in shaping inflation outcomes. For instance, Ekincı, Saygılı, and Yılmaz (2025) find that specific fiscal instruments, particularly indirect taxes and operational government expenditures, are significantly associated with long-run inflation dynamics in Türkiye.

While the relationship between public expenditures and inflation has been widely examined in the literature, much of the empirical evidence relies on aggregate measures of government spending or fiscal deficits. Such an approach implicitly assumes that different categories of public expenditures exert homogeneous effects on inflation, thereby overlooking the fact that government spending influences the economy through multiple and heterogeneous channels. In contrast, the public finance literature has long emphasized the importance of functional classifications of government expenditures. Therefore, analyzing the inflationary effects of public spending solely through aggregate expenditure measures may be misleading. A focus on the functional composition of public expenditures provides a more informative framework for understanding the underlying fiscal–inflation nexus. Building on Musgrave's (1959) functional approach to public finance, the Classification of the Functions of Government (COFOG) provides a standardized framework that distinguishes government spending according to its primary objectives, including general public services, economic affairs, health, education, and social protection (Eurostat, 2019; United Nations Statistics Division [UNSD], n.d.).

The main research questions addressed in this study are as follows:

1. How does the functional composition of public expenditures affect inflation dynamics in Türkiye?
2. Which categories of public expenditures exhibit unidirectional or bidirectional causality with inflation?
3. How do structural shifts in fiscal policy regimes influence the relationship between public expenditures and inflation?

The functional composition of public expenditures is theoretically relevant for inflation dynamics because each spending category operates through distinct demand- and supply-side mechanisms. General Public Services expenditures mainly encompass administrative services, public governance, and debt-related items. These expenditures are typically associated with short-run demand pressures and fiscal sustainability concerns, which may influence inflation expectations and price formation processes. In the Fiscal Theory of the Price Level (FTPL)

framework, fiscal imbalances and the financing of government obligations can directly affect the price level, even in the absence of monetary accommodation (Leeper, 1991; Sims, 2013; Woodford, 1995). Empirical evidence for Türkiye also suggests that the interaction between government spending, fiscal financing, and inflation has been a persistent feature of macroeconomic outcomes (Anand & van Wijnbergen, 1989).

By contrast, economic affairs expenditures include public investments and interventions aimed at supporting productive sectors such as transportation, energy, agriculture, and industry. These expenditures are not limited to stimulating aggregate demand; they also enhance productive capacity and infrastructure, thereby influencing inflation through supply-side channels. Endogenous growth models highlight that productive public spending can raise private sector productivity and long-term output, potentially mitigating inflationary pressures over time (Barro, 1990). Recent empirical studies further show that the inflationary impact of fiscal expansions critically depends on the composition of public spending, with investment-oriented expenditures exerting weaker—or even disinflationary—effects compared to consumption-oriented spending (Klein & Linnemann, 2023). Evidence from developing economies also indicates that inflation outcomes under different fiscal regimes are closely linked to the allocation of public expenditures across functional categories (Apeti et al., 2023).

Health services and education services expenditures occupy a distinct position within the functional classification of government spending, as they are directly related to human capital formation. From a theoretical perspective, health is considered a form of human capital that enhances labor productivity and effective labor supply, thereby expanding an economy's productive capacity (Grossman, 1972). Similarly, education expenditures improve workforce skills and technological adaptability, reinforcing long-term growth and supply-side resilience (Barro, 1990; Aghion & Howitt, 1998). Consequently, expenditures on health and education services may exert a dual effect on inflation: while they may generate short-run demand pressures, their long-run impact may be disinflationary through productivity and capacity-enhancing channels. This perspective suggests that analyzing health and education spending solely as expenditure aggregates may obscure their broader macroeconomic role.

Social protection expenditures, including social transfers, pensions, unemployment benefits, and income support programs, primarily function as automatic stabilizers. By smoothing household income and consumption over the business cycle, social protection mechanisms can mitigate output volatility and economic downturns. However, during periods of high inflation, expansionary social transfers may amplify demand-side pressures and contribute to price increases, particularly when not accompanied by corresponding productivity gains (Dolls et al., 2009). As a result, the relationship between social protection expenditures and inflation is inherently context-dependent and may involve feedback effects between prices, fiscal policy, and household income dynamics.

Despite the growing recognition of composition effects in fiscal policy, the existing literature remains relatively limited in its application of a comprehensive functional classification framework that simultaneously examines general public services, economic affairs, health services, education services, and social protection in relation to inflation. Most empirical studies focus on either aggregate public spending or isolated expenditure categories, thereby failing to capture the broader interaction between expenditure composition and inflation dynamics (Eurostat, 2019; UNSD, n.d.). Yet recent evidence underscores that fiscal shocks can have markedly different inflationary consequences depending on how public resources are allocated across functions (Klein & Linnemann, 2023; Apeti et al., 2023).

Against this backdrop, the present study investigates the causal relationships between inflation and the functional components of public expenditures—general public services, economic affairs, health services, education services, and social protection—in Türkiye. Given the country's experience with structural transformations, policy regime shifts, and persistent inflationary pressures, these relationships are likely to be nonlinear and subject to gradual structural changes over time. To address these features, the study employs the Fourier Toda–Yamamoto causality approach, which allows for smooth structural shifts without requiring prior knowledge of their timing or form. By combining a functional expenditure perspective with an advanced causality framework, this study aims to contribute to the literature by providing a more nuanced understanding of how the composition of public spending shapes inflation dynamics in Türkiye. In this respect, the study contributes to the literature in two main ways. First, it provides a comprehensive analysis of the functional composition of public expenditures based on the COFOG framework within a unified empirical setting. Second, by incorporating smooth structural shifts through the Fourier Toda–Yamamoto approach, the study offers a more flexible framework for examining fiscal–inflation dynamics in an economy characterized by recurring inflationary regimes such as Türkiye.

Literature Review

The empirical literature examining the relationship between public expenditures and inflation is diverse in terms of country coverage, methodological approaches, and the classification of government spending. While a substantial body of research focuses on aggregate public expenditure or specific spending categories, fewer studies employ a functional classification framework that enables a systematic comparison across different public expenditure components. To provide a structured overview of the existing evidence, Table 1 summarizes the key studies that investigate the links between public spending, its composition, and inflation dynamics.

Table 1

Summary of the Literature on Public Expenditure Components and Inflation

Authors (Year)	Country	Expenditure Component(s)	Methodology	Main Findings
Anand & van Wijnbergen (1989)	Türkiye	Aggregate public expenditure	Analytical & empirical	Fiscal financing of public spending plays a significant role in inflation dynamics.
De Haan & Zelhorst (1990)	Developing countries	Government expenditure	Cross-country regression	Expansionary fiscal policy contributes to inflation persistence.
Barro (1990)	Cross-country	Productive public spending	Endogenous growth model	Productive spending enhances supply capacity and may reduce inflationary pressures.
Bleaney (1996)	Developing countries	Government consumption	Panel analysis	Government consumption growth is positively related to inflation.
Ruge-Murcia (1999)	Brazil	Government expenditure (including interest payments), budget deficit, seigniorage-financed spending	Markov-switching regime model	Government expenditure is the main driver of high inflation; shifts to high-spending regimes significantly increase inflation and money growth, while stabilization programs without fiscal reform fail to curb inflation.
Alavirad & Athawale (2005)	Iran	Government expenditure	Time series analysis	Long-run relationship exists between government spending and inflation.

Catão & Terrones (2005)	Cross-country	Fiscal deficits & public spending	Panel econometrics	Fiscal imbalances are a key determinant of inflation in developing countries.
Olubusoye & Oyaromade (2008)	Nigeria	Government expenditure	VAR & Granger causality	Government expenditure Granger-causes inflation in the long run.
Afonso & Jalles (2012)	OECD & EU countries	Government spending	Panel regressions	Public spending may generate inflationary pressures depending on regime.
Tiwari, A.K., Tiwari, A.P., & Pandey (2012)	India	Total government expenditure, fiscal deficit, money supply (M3)	Dolado–Lütkepohl (1996) augmented VAR Granger causality test; standard Granger causality analysis	Findings vary by method; government expenditure (and partly money supply) drives fiscal deficit, while inflation shows no causal role in India.
Lin & Chu (2013)	91 countries	Public debt & expenditure	Panel threshold model	Inflationary effects of fiscal policy depend on spending and debt levels.
Nguyen (2015)	Asian economies	Fiscal deficit, government expenditure, money supply (M2)	Panel GMM	Fiscal deficit, government expenditure, and interest rates are robust determinants of inflation, while the impact of money M2 is significant only under PMG estimation.
Akobi, Umeora & Atueyi (2021)	Nigeria	Agriculture, education, health, and telecommunications expenditures	Johansen cointegration and ECM	Health and telecommunications expenditures have significant positive effects on inflation, while education and agriculture expenditures show positive but insignificant effects, indicating heterogeneous inflationary impacts of public expenditure components.
Sequeira (2021)	Cross-country	Education expenditure	Panel econometrics	Education spending influences macroeconomic performance, including inflation indirectly.
Barro & Bianchi (2023)	OECD countries	Fiscal expenditure composition	Panel macroeconomic analysis	Fiscal policy and expenditure composition play a significant role in post-pandemic inflation dynamics across OECD countries.
Klein & Linnemann (2023)	OECD countries	Spending composition	VAR analysis	Inflationary effects of fiscal policy depend on expenditure composition.
Apeti et al. (2023)	Developing countries	Public spending composition	Panel regressions	Composition of public expenditure matters for inflation targeting performance.

Raza, Laurentjoye, Byrialsen & Valdecantos (2023)	Denmark	Fiscal and macroeconomic policy channels (aggregate public spending)	Stock-flow consistent macroeconomic model	Coordinated fiscal and monetary policies play a crucial role in mitigating inflationary pressures, indicating that fiscal policy contributes to inflation dynamics through aggregate demand and income channels.
Serin & Demir (2024)	Türkiye	Fiscal policy & inflation	Fourier-ADL & Fourier TY	Fiscal regime changes affect inflation dynamics.
Tuncer (2024)	Türkiye	Total public expenditure	ARDL & TY causality	Evidence of causality between public spending and inflation.
Diğer & Uyar (2025)	Türkiye	Health expenditures (COFOG – Health)	Wavelet coherence analysis	The relationship between health expenditures and inflation exhibits heterogeneous interdependence across provinces and time horizons, indicating that sector-specific public expenditures generate differentiated inflationary effects.
Özmen Bol & Cantürk (2025)	Türkiye	Health expenditure	Descriptive & policy analysis	High inflation erodes real value of health spending.
Cevik & Miryugin (2024)	140 countries (panel)	Fiscal policy shocks	Panel econometric analysis	Expansionary fiscal policy shocks generate inflationary pressures in the short and medium term, particularly in developing economies.

Note. Created by the author.

The studies summarized in Table 1 highlight that the relationship between fiscal policy and inflation is far from uniform. Existing research suggests that the inflationary consequences of government spending depend not only on the magnitude of public expenditures but also on their functional composition. Some categories of spending may generate short-run demand pressures, while others may contribute to productive capacity and long-run macroeconomic stability. These findings indicate that different components of public expenditures may exhibit heterogeneous interactions with inflation dynamics.

Building on these theoretical insights and empirical findings, the present study formulates the following hypotheses regarding the relationship between inflation and the functional composition of public expenditures:

H1: The functional composition of public expenditures has a significant relationship with inflation dynamics.

H2: Different categories of public expenditures exhibit heterogeneous causal relationships with inflation.

H3: Structural shifts in fiscal policy regimes influence the causal interaction between public expenditures and inflation.

Econometric Methodology

This section outlines the econometric procedures employed to investigate the dynamic relationships between public expenditure components and inflation in Türkiye. The analysis proceeds in two stages. First, the integration properties of the variables are examined using both

conventional and Fourier-based unit root tests. Second, the direction of causality among the variables is analyzed using the Fourier Toda–Yamamoto causality framework, which accounts for potential structural changes in the data-generating process.

Unit Root Tests: ADF and Fourier ADF

Standard unit root tests such as the Augmented Dickey–Fuller (1979) (ADF) and Phillips–Perron (1988) (PP) tests are widely used to assess the stochastic properties of macroeconomic time series. However, these conventional tests do not explicitly consider structural changes in the deterministic components of the series. When such changes are present, the power of traditional unit root tests may be substantially reduced, leading to biased inferences regarding stationarity. Perron (1989) highlighted that ignoring structural breaks—particularly in the intercept or trend—can distort unit root test outcomes.

Subsequent studies developed unit root testing procedures that allow structural breaks to be determined endogenously. Prominent examples include Zivot and Andrews (1992), Perron (1994), Lumsdaine and Papell (1997), and Lee and Strazicich (2003, 2013), which permit one or multiple sharp breaks in the deterministic structure of the series. While these approaches represent important methodological advances, they require assumptions regarding the number, timing, or form of structural breaks, which may limit their applicability in practice.

To address this limitation, Becker, Enders, and Lee (2004, 2006) proposed a flexible framework based on Fourier approximations that captures structural changes without requiring prior knowledge of their number or timing. Building on this approach, Enders and Lee (2012) extended the conventional ADF test by incorporating low-frequency sine and cosine terms into the deterministic component, resulting in the Fourier Augmented Dickey–Fuller (FADF) unit root test. This method is particularly well-suited for modeling smooth and gradual structural changes commonly observed in macroeconomic series.

In the Fourier ADF framework, the deterministic component is specified as a time-varying function:

$$\alpha(t) = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right), \tag{1}$$

where k denotes the Fourier frequency, t is the time index, and T represents the sample size. The sine and cosine terms flexibly approximate unknown structural changes in the intercept and trend of the series.

By incorporating this deterministic structure into the ADF regression, the Fourier ADF test equation can be written as (Enders & Lee, 2012):

$$\Delta y_t = \alpha_1 + \delta t + \beta y_{t-1} + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} \phi_i \, \Delta y_{t-i} + u_t. \tag{2}$$

In practice, the Fourier ADF model is estimated over a range of frequencies, typically $1 \leq k \leq 5$, and the optimal frequency is selected based on the minimum residual sum of squares. If the Fourier terms are jointly significant, unit root inference relies on the FADF test statistics. Otherwise, the conventional ADF results are considered more appropriate. In this study, both ADF and FADF tests are employed to ensure robust identification of the integration properties of the variables by accounting for linear dynamics as well as potential smooth structural changes.

Causality Analysis: Fourier Toda–Yamamoto Approach

After establishing the integration properties of the variables, the causal relationships among public expenditure components and inflation are examined using the Fourier Toda–Yamamoto (TY) causality test. Conventional Granger causality tests may produce unreliable results when variables are non-stationary or integrated of different orders, as the associated Wald statistics may not follow their standard asymptotic distributions. These issues are further exacerbated in the presence of structural changes. To overcome such limitations, this study adopts the causality testing framework proposed by Toda and Yamamoto (1995).

The TY approach conducts causality testing within a vector autoregressive (VAR) model estimated in levels, regardless of whether the variables are stationary or cointegrated. The method involves estimating an augmented VAR model of order $p + d_{\max}$, where p denotes the optimal lag length selected by information criteria and $d_{\max}$ represents the maximum integration order among the variables. By augmenting the VAR system with additional lags equal to $d_{\max}$, the TY procedure ensures the validity of Wald test statistics used for causal inference.

Despite its advantages, the standard TY test does not explicitly account for structural changes in the deterministic components of the model. To address this shortcoming, Nazlıoğlu et al. (2016) proposed a Fourier version of the TY causality test, which incorporates smooth structural shifts using low-frequency trigonometric terms. In this context, the use of the Fourier approximation provides a flexible way of capturing smooth structural changes without requiring prior identification of break dates. This feature is particularly useful for economies such as Türkiye where macroeconomic policies and inflation regimes have experienced gradual shifts over time. The deterministic component of the model is specified as:

$$Z_t = \alpha_0 + \alpha_1 t + \alpha_2 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_3 \cos\left(\frac{2\pi kt}{T}\right), \tag{3}$$

where k denotes the Fourier frequency and T is the sample size. These terms allow the model to approximate unknown forms of gradual structural change without requiring explicit identification of break dates.

Incorporating the Fourier terms, the resulting Fourier VAR model of order $p + d_{\max}$ is given by:

$$y_t = \alpha_0 + \alpha_1 t + \alpha_2 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_3 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p+d_{\max}} J_i \, y_{t-i} + \varepsilon_t, \tag{4}$$

where y_t denotes the vector of endogenous variables, J_i represents coefficient matrices, and ε_t is a vector of independently and identically distributed error terms.

A key step in implementing the Fourier TY causality test is the joint selection of the optimal lag length p and Fourier frequency k. Following Nazlıoğlu et al. (2016), this study employs the Schwarz Information Criterion (SIC) to determine the parameter combination that minimizes information loss while maintaining model parsimony.

The dataset consists of quarterly observations covering the period 2006Q1–2025Q2, yielding 78 observations. Although this sample size is sufficient for VAR-based inference, the Turkish economy experienced multiple policy shifts and inflation regimes during the sample period. In this context, the Fourier TY approach is particularly suitable, as it combines robustness to mixed integration orders with the ability to capture smooth, time-varying structural changes. Accordingly, this framework provides a reliable empirical strategy for

analyzing the directional predictability between the functional composition of public expenditures and inflation dynamics in Türkiye.

Data Set and Descriptive Statistics

This study employs quarterly data covering the period 2006Q1–2025Q2 to examine the relationship between the functional composition of public expenditures and inflation dynamics in Türkiye. The sample period is determined by data availability and ensures consistency across all variables included in the analysis. All variables are obtained from official public institutions, ensuring data reliability and transparency.

Inflation is derived from the Consumer Price Index (CPI) obtained from the Electronic Data Delivery System (EVDS) of the Central Bank of the Republic of Türkiye. Although the CPI is available at a monthly frequency, inflation is computed as the year-on-year logarithmic change in the CPI and subsequently converted to quarterly frequency by selecting end-of-quarter observations. Public expenditure variables are obtained from the Ministry of Treasury and Finance of the Republic of Türkiye, published by the General Directorate of Public Accounts, and are expressed as ratios to Gross Domestic Product (GDP).

To ensure clarity and consistency throughout the empirical analysis, all variables are denoted using abbreviated notation. Variable definitions, transformations, and data sources are summarized in Table 2.

Table 2

Variable Definitions, Notation, and Data Sources

Notation	Variable	Definition / Measurement	Source
INF	Inflation	Year-on-year CPI inflation (quarterly)	Electronic Data Delivery System (EVDS)
GEN	General Public Services	General public services expenditures / GDP	Ministry of Treasury and Finance
ECO	Economic Affairs	Economic affairs and services expenditures / GDP	Ministry of Treasury and Finance
HEA	Health Services	Health expenditures / GDP	Ministry of Treasury and Finance
EDU	Education Services	Education expenditures / GDP	Ministry of Treasury and Finance
SOC	Social Protection	Social security and social assistance expenditures / GDP	Ministry of Treasury and Finance

Note. Created by the author.

All public expenditure variables are included in the analysis in level form, as they represent proportional fiscal measures. Inflation (INF) is modeled in growth-rate form. This specification is consistent with the econometric framework adopted in the study and preserves the economic interpretation of each variable.

The relationship between inflation and the functional composition of public expenditures is summarized by the following general functional form:

$$INF_t = f(GEN_t, ECO_t, HEA_t, EDU_t, SOC_t)$$

Based on this functional relationship, the corresponding econometric model can be expressed as:

$$INF_t = \alpha_0 + \alpha_1 GEN_t + \alpha_2 ECO_t + \alpha_3 HEA_t + \alpha_4 EDU_t + \alpha_5 SOC_t + \varepsilon_t$$

where, α_0 is the constant term, α_1–α_5 represent the coefficients associated with each expenditure category, and ε_t denotes the error term.

Descriptive Statistics

This subsection presents a brief overview of the statistical properties of the variables used in the analysis. Table 3 summarizes the descriptive statistics for inflation and functional public expenditure components (ECO, EDU, GEN, HEA, and SOC) over the period 2006Q1–2025Q2, based on 78 quarterly observations. The statistics indicate substantial volatility in inflation relative to public expenditure variables, reflecting Türkiye's pronounced inflationary dynamics during the sample period. While expenditure shares generally exhibit smoother behavior, noticeable heterogeneity is observed across functional categories, with social protection and general public services displaying comparatively higher variability. The distributional characteristics further suggest deviations from normality in all variables except the education variable, underscoring the relevance of econometric methods capable of accommodating non-linear dynamics and potential structural changes in the subsequent analysis.

Table 3

Descriptive Statistics

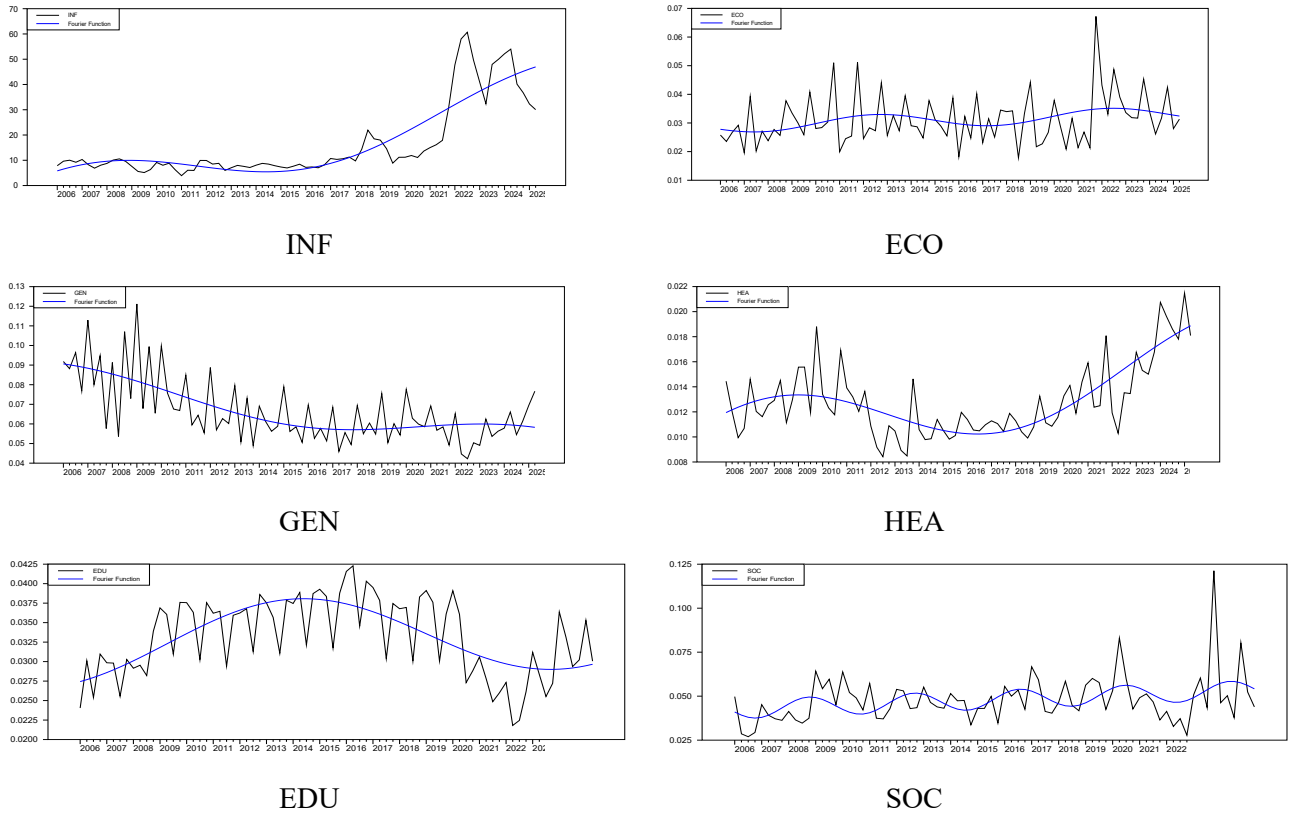
Statistic	INF	ECO	EDU	GEN	HEA	SOC
Mean	16.261	0.031	0.033	0.067	0.013	0.048
Maximum	60.679	0.067	0.042	0.121	0.021	0.121
Minimum	3.909	0.018	0.022	0.042	0.008	0.027
Std. Dev.	14.736	0.0087	0.0050	0.0165	0.0029	0.0135
Skewness	1.716	1.317	−0.269	1.212	1.012	2.336
Kurtosis	4.599	5.712	2.013	4.127	3.494	12.980
Jarque–Bera	46.607	46.454	4.109	23.231	14.097	394.612
Probability	0.000	0.000	0.128	0.000	0.001	0.000

INF denotes quarterly year-on-year CPI inflation. ECO, EDU, GEN, HEA, and SOC represent functional public expenditure components expressed as ratios to GDP.

Note. Created by the author using Eviews 12 econometric software.

Figure 1

Time path graph of the Variables



INF ECO

GEN HEA

EDU SOC

Note. Created by the author in WinRATS; Arial font customization is not supported.

Unit Root Test Results

The stationarity properties of the variables included in the analysis, namely inflation and the functional components of public expenditures (GEN, ECO, HEA, EDU, and SOC), are examined using two complementary unit root testing procedures. First, the conventional Augmented Dickey–Fuller (1979) (ADF) test is employed to assess stationarity under standard deterministic specifications. Second, the Fourier Augmented Dickey–Fuller (FADF) unit root test, proposed by Enders and Lee (2012), is applied to account for potential smooth structural changes in the data-generating process. The results obtained from the ADF and FADF tests are reported in Table 4 and Table 5, respectively.

Table 4

ADF Unit Root Test Results

	Constant		Constant and Trend	
Variables	**Test Statistic**	**5% Critical Value**	**Test Statistic**	**5% Critical Value**
INF	-1.055 (5)	-2.902	-2.128 (5)	-3.473
GEN	-1.909 (3)	-2.901	-1.305 (3)	-3.471
ECO	-2.864 (3)	-2.901	-3.093 (3)	-3.471

HEA	0.201 (3)	-2.901	-0.314 (3)	-3.471
EDU	-1.943 (4)	-2.901	-2.140 (4)	-3.472
SOC	-7.525 (0)	-2.899	-8.112** (0)	-3.469
ΔINF	-3.612** (1)	-2.902	-3.583** (4)	-3.471
ΔGEN	-10.866**(2)	-2.901	-11.029**(2)	-3.471
ΔECO	-13.213**(2)	-2.901	-13.125**(2)	-3.471
ΔHEA	-10.488**(2)	-2.901	-10.674**(2)	-3.471
ΔEDU	-3.301**(3)	-2.901	-3.321**(3)	-3.471
ΔSOC	-10.127** (2)	-2.901	-10.075**(2)	-3.471

** indicates significance at 5% significance level. Values in parentheses indicate the appropriate lag length determined according to Schwarz information criteria.

Note. Created by the author using Eviews 12 econometric software.

Table 5

Fourier ADF Unit Root Test Results

Models	**Constant**			**Constant and Trend**		
Variables	**k**	**FADF stat.**	**F (Fourier)**	**k**	**FADF stat.**	**F (Fourier)**
INF	1	-3.016	3.031	4	-3.152	1.643
GEN	1	-3.559*	2.971	1	-4.421**	4.859
ECO	2	-10.227***	3.349	2	-10.373***	2.041
HEA	2	-5.452***	6.576*	1	-7.709***	16.176***
EDU	1	-5.542***	9.060**	1	-5.564***	8.707**
SOC	5	-8.136***	3.607	5	-8.666***	3.376

Note. Created by the author using WinRATS econometric software.

FADF denotes the Fourier Dickey–Fuller test statistic. k represents the selected Fourier frequency that minimizes the residual sum of squares. The F (Fourier) statistic tests the joint significance of the sine and cosine terms. Critical values for the FADF test statistics are obtained from Enders and Lee (2012) and depend on the deterministic specification (constant or constant and trend) and the chosen Fourier frequency. For models with a constant, critical values are taken from Table 1b in Enders and Lee (2012), while for models with a constant and trend, critical values are taken from Table 1a. Values in parentheses indicate the optimal lag length selected according to the (SIC). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4 and Table 5 report the results of the conventional Augmented Dickey–Fuller (1979) (ADF) and the Fourier Augmented Dickey–Fuller (FADF) unit root tests, respectively. According to the ADF test results, the inflation variable (INF) and most public expenditure components (GEN, ECO, HEA, and EDU) fail to reject the null hypothesis of a unit root at levels under both constant and constant-with-trend specifications, whereas social protection expenditures (SOC) appear to be stationary when a deterministic trend is included. However, all variables become stationary after first differencing, indicating that they are predominantly integrated of order one, I(1).

The FADF test results largely corroborate the findings of the conventional ADF test while additionally accounting for smooth structural changes in the data-generating process. The joint significance of the Fourier sine and cosine terms is confirmed for several variables, particularly ECO, HEA, EDU, and SOC, implying the presence of smooth structural shifts. Based on the FADF test statistics and the corresponding critical values reported by Enders and Lee (2012), GEN, ECO, HEA, EDU, and SOC are found to be stationary at levels under at least one deterministic specification, while INF remains non-stationary in level form. Overall, the combined evidence from the ADF and FADF tests suggests a mixed integration structure, with variables being either I(0) or I(1), thereby justifying the use of the Fourier Toda–Yamamoto causality framework in the subsequent analysis.

The unit root test results indicate that the variables are integrated of different orders, with most series being I(1) while some exhibit stationarity at levels when structural changes are taken into account. This mixed integration structure renders conventional cointegration-based causality tests inappropriate. However, the Toda–Yamamoto causality framework and its Fourier-augmented extension allow for valid inference regardless of the integration properties of the variables. Accordingly, the causal relationships between inflation and the functional components of public expenditures are examined using the Fourier Toda–Yamamoto causality test.

Fourier Toda–Yamamoto Causality Results

As discussed in the previous subsection, the divergence between the conventional ADF and Fourier ADF unit root test results stems from their distinct methodological foundations. While the standard ADF test assumes a stable deterministic structure over time, the Fourier ADF framework explicitly allows for smooth and gradual structural changes through low-frequency trigonometric terms. This feature is particularly important in the context of the Turkish economy, where policy regimes and inflation dynamics have undergone notable transformations over the sample period.

To avoid potential pre-testing bias and ensure valid inference in the presence of variables with mixed integration orders, the maximum order of integration among the variables is set to $d_{max} = 1$. Given that the Fourier terms are found to be statistically significant for several series, indicating the presence of smooth structural shifts, the (Fourier TY) causality approach is adopted in the subsequent analysis.

Prior to implementing the Fourier TY causality test, the optimal lag length of the underlying VAR model is determined using standard information criteria. Following the principle of parsimony and placing particular emphasis on the Schwarz Information Criterion—commonly preferred in relatively moderate sample sizes—the optimal lag length is selected as $p = 2$. Accordingly, an augmented VAR($p + d_{max}$) = VAR(3) model is estimated in levels. This specification ensures that the Wald-type test statistics used for causality inference retain their standard asymptotic properties, regardless of the integration or cointegration characteristics of the variables.

Within this framework, the Fourier TY causality test is conducted by incorporating sine and cosine terms into the deterministic component of the VAR model to capture smooth structural changes without requiring prior knowledge of their timing, number, or functional form. By combining the robustness of the Toda–Yamamoto procedure with the flexibility of the Fourier approximation, this approach provides a reliable empirical strategy for examining the directional relationships between inflation and the functional components of public expenditures in Türkiye.

Table 6

Toda–Yamamoto and Fourier Toda–Yamamoto Causality Test Results

	TY		Fourier TY		
Variables	**Wald Stat.**	**prob.**	**k**	**Wald Stat.**	**prob.**
ECO → INF	7.834387	0.021	1	9.039234	0.002
INF → ECO	4.316515	0.116	1	7.32622	0.006
GEN → INF	25.13544	0.000	1	4.037685	0.044
INF → GEN	2.043379	0.365	1	1.114889	0.291
HEA → INF	9.254539	0.009	1	5.704799	0.016
INF → HEA	32.11856	0.000	1	0.985036	0.321
EDU → INF	22.09303	0.000	1	5.839843	0.016
INF → EDU	5.770043	0.056	1	4.099142	0.043
SOC → INF	19.87962	0.000	1	7.446898	0.006
INF → SOC	12.98707	0.001	1	6.486484	0.011

Note. Created by the author using Eviews 12 econometric software.

Table 6 reports the causality results obtained from both the standard Toda–Yamamoto (TY) and the Fourier Toda–Yamamoto (Fourier TY) approaches. The comparison of the two methodologies reveals that accounting for smooth structural changes substantially enriches the causal structure between inflation and the functional components of public expenditures in Türkiye. These results indicate that the effects of public spending on inflation differ across expenditure categories and that, for certain components, the inflation–expenditure relationship involves feedback mechanisms. These findings highlight that the inflation–expenditure relationship is heterogeneous across expenditure categories, with some components exhibiting feedback mechanisms while others reflect a more direct fiscal influence on inflation dynamics.

The conventional TY results indicate unidirectional causality running from economic affairs, general public services, health, education, and social protection expenditures to inflation, while reverse causality from inflation is detected only for selected spending categories. However, once smooth structural shifts are incorporated through the Fourier TY framework, the causal relationships become more pronounced and, in several cases, bidirectional.

In particular, the Fourier TY results reveal bidirectional causality between inflation and economic affairs, education, and social protection expenditures, suggesting the presence of feedback mechanisms in which inflation both influences and is influenced by these spending components. By contrast, causality from general public services and health expenditures to inflation remains predominantly unidirectional, implying that these categories exert inflationary effects mainly through structural and demand-driven channels rather than short-run feedback adjustments.

Overall, the findings demonstrate that ignoring structural changes may conceal important causal linkages in fiscal–inflation dynamics. The Fourier TY approach uncovers more robust causal relationships compared to the standard TY test, highlighting the critical role of public expenditure composition in shaping inflation dynamics in Türkiye. It should be noted that the Toda–Yamamoto framework identifies directional predictability rather than the magnitude or persistence of effects. Therefore, the results should be interpreted as evidence of causal linkages rather than precise quantitative estimates of fiscal impacts on inflation.

Conclusion

This study examined the causal links between inflation and the functional composition of public expenditures in Türkiye over the period 2006Q1–2025Q2 by using COFOG-based expenditure shares in GDP. Motivated by the Fiscal Theory of the Price Level perspective and the possibility that Türkiye's inflation process is shaped not only by monetary factors but also by fiscal regimes and expenditure allocation, the analysis employed a two-stage econometric strategy. First, the integration properties of the series were assessed through conventional ADF and Fourier ADF unit root tests. Second, to obtain valid causal inference under mixed integration orders and potential smooth structural shifts, the study implemented the Fourier-augmented Toda–Yamamoto causality framework.

The unit root evidence confirmed that the variables exhibit a mixed integration structure. While the conventional ADF results suggested that most variables are I(1), the Fourier ADF test indicated that several expenditure components display stationarity in levels once smooth structural changes are accounted for, whereas inflation remains non-stationary at levels. This divergence is consistent with the methodological insight that ignoring structural change may distort stationarity inference in macroeconomic time series. Given this mixed integration environment and the presence of regime changes in Türkiye's macroeconomic history, the Fourier Toda–Yamamoto approach provided an appropriate and robust setting for causality analysis.

The causality findings underscore that the inflation–fiscal nexus in Türkiye is not homogeneous across expenditure functions and becomes clearer once smooth structural shifts are incorporated. The Fourier TY results indicate that inflation is significantly affected by economic affairs, general public services, health, education, and social protection expenditures. Importantly, the causal structure differs across categories. For general public services and health, causality runs predominantly from expenditures to inflation, implying that these items shape inflation dynamics mainly through expenditure-side or structural channels rather than short-run feedback adjustments. In contrast, economic affairs, education, and social protection display bidirectional causality with inflation, suggesting feedback mechanisms whereby these spending components both influence inflation and adjust endogenously to inflationary conditions.

These results contribute to the broader literature in several ways. First, the finding that multiple public spending components Granger-cause inflation aligns with the long-standing view that fiscal policy is a key driver of inflation in developing and high-inflation settings (e.g., the fiscal-financing emphasis in Türkiye in Anand & van Wijnbergen, 1989; and the broader evidence on fiscal imbalances and inflation in Catão & Terrones, 2005). Second, the bidirectional relationships uncovered for social protection and education are consistent with the idea that certain expenditure categories operate as both policy instruments and automatic or quasi-automatic responses to macroeconomic stress—particularly in economies where inflation redistributes income and triggers compensatory fiscal measures. This feedback structure complements the panel evidence that inflationary consequences depend on fiscal composition and regime features (Afonso & Jalles, 2012; Lin & Chu, 2013) and is in line with more recent arguments that the inflationary impact of fiscal policy depends critically on how spending is allocated across functions (Klein & Linnemann, 2023; Apeti et al., 2023). Third, the stronger causal patterns obtained under Fourier TY relative to the standard TY test reinforce the methodological point that structural changes can conceal key fiscal–inflation linkages—an issue that is particularly relevant for Türkiye given multiple policy shifts and inflation regimes within the sample period. In this sense, the evidence also resonates with recent Türkiye-focused

studies emphasizing the importance of fiscal regime changes and nonlinear dynamics (Serin & Demir, 2024; Tuncer, 2024).

From a policy perspective, the results imply that the effectiveness of fiscal policy in supporting price stability depends not only on the size of public spending but also on its functional composition. The unidirectional effects from general public services to inflation suggest that expenditure items closely related to administration and debt-related services may exert inflationary pressure through demand and fiscal-sustainability channels, highlighting the importance of expenditure discipline and credibility. At the same time, the bidirectional relationships for economic affairs, education, and social protection point to a more complex interaction: inflation can trigger fiscal adjustments in these categories, while changes in these expenditures can feed back into inflation dynamics. Accordingly, expenditure reallocation strategies aimed at strengthening productive capacity and limiting inflationary pressures should take into account this feedback nature and the timing of fiscal responses under high inflation.

Beyond its empirical findings, the study contributes to policy discussions by emphasizing that inflation control strategies cannot be designed solely around aggregate fiscal contraction. Instead, policymakers should consider the functional allocation of public expenditures and their heterogeneous transmission mechanisms. In this respect, effective inflation management in Türkiye requires coordinated fiscal–monetary frameworks in which expenditure composition is aligned with price stability objectives.

Finally, the study has limitations that open avenues for further research. While the Fourier TY framework provides robust evidence on directional predictability under smooth structural shifts, causality tests do not quantify the magnitude of effects or distinguish short- and long-run transmission channels. Future work may complement these results with structural VAR/FAVAR approaches, local projections, or regime-dependent models that explicitly identify fiscal shocks and quantify dynamic impulse responses by expenditure function. Extending the analysis to alternative inflation measures and incorporating financing-side variables (e.g., debt dynamics, tax revenues, or monetary accommodation) may further refine the interpretation within the FTPL context.

Overall, the evidence presented here supports the view that in Türkiye inflation dynamics are closely linked to the functional composition of public expenditures and that accounting for structural change is essential to uncover the underlying causal structure. The findings highlight that compositional fiscal policy—rather than aggregate spending alone—should be treated as a core element of policy design in pursuing durable price stability. The conclusion now includes more detailed policy recommendations, focusing on the importance of fiscal–monetary coordination and differentiating between efficient and inefficient public expenditures for effective inflation control.

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