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BUDGET DEFICIT AND INFLATION IN 11 EU COUNTRIES: NEW INSIGHTS FROM PANEL SMOOTH TRANSITION REGRESSION MODELING

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Abstract

The persistent increase in permanent budget deficits and inflation rates observed in developed nations since the 1970s has raised significant global economic concerns. This has prompted both academic and political communities to focus on deficit financing. Previous studies have considered the relationship between budget deficit and inflation to be linear. However, this study posits that the association between the two variables is nonlinear. This study aims to examine the threshold and asymmetric relationship between budget deficit and inflation across different political stability levels in 11 EU countries from 1997 to 2016, using the innovative Panel Smooth Transition Regression Model (PSTR). Empirical results indicate that as the budget deficit increases, the inflation rate rises, especially at a higher political risk index, validating the "Tanzi effect". Conversely, in the low political risk index, as inflation rises, the budget deficit decreases, validating the "Patinkin effect".

Anahtar Kelimeler: Panel Smooth Transition Regression, Budget Deficit, Inflation, Political Risk Index, 11 EU Countries
JEL Sınıflandırması: H62, E31, E6, C24

11 AB ÜLKESİNDE BÜTÇE AÇIĞI VE ENFLASYON: YUMUŞAK GEÇİŞLİ PANEL REGRESYON MODELLEMESİNDEN YENİ BİLGİLER

Öz

1970'lerden bu yana gelişmiş ülkelerde gözlenen kalıcı bütçe açıkları ve enflasyon oranlarındaki sürekli artış, önemli küresel ekonomik endişelere yol açmıştır. Bu durum hem akademik hem de siyasi çevrelerin bütçe açığı finansmanına odaklanmasına neden olmuştur. Önceki çalışmalar bütçe açığı ve enflasyon arasındaki ilişkinin doğrusal olduğunu kabul etmiştir. Ancak bu çalışma, bütçe açığı ve enflasyon arasındaki ilişkinin doğrusal olmadığını öne sürmektedir. Bu çalışmanın amacı, yeni bir teknik olan Panel Düzgün Geçişli Regresyon Modeli (PSTR) kullanarak, 1997-2016 yılları arasında 11 AB ülkesinde farklı siyasi istikrar seviyelerindeki çeşitli rejimlerde bütçe açığı ve enflasyon arasındaki eşik seviyesini ve asimetrik bağlantıyı araştırmaktır. Ampirik sonuçlar, bütçe açığı arttıkça, özellikle politik risk endeksinin daha yüksek seviyelerinde enflasyon oranının da arttığını göstermektedir. Bu durum 'Tanzi etkisinin' geçerliliğini göstermektedir. Aksine, politik risk endeksinin düşük olduğu ülkelerde, enflasyon oranı arttıkça bütçe açığı azalmakta ve bu da 'Patinkin etkisi'nin geçerliliğini göstermektedir.

Keywords: Yumuşak Geçişli Panel Regresyon Modeli, Bütçe Açıkları, Enflasyon, Politik Risk Endeksi, 11 AB Ülkesi
JEL Classification: H62, E31, E6, C24

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1. INTRODUCTION

The increase in permanent budget deficits since the 1970s in developed countries has caused significant global economic issues, attracting academic and political attention to financing deficits. Budget deficits are now major concerns for both developed and developing economies, leading to economic instability and crises in recent years. To ensure fiscal discipline in the face of increasing budget deficits, the European Union (EU) has introduced economic regulations under the Maastricht Agreement. These regulations, known as the Maastricht criteria, aim to limit the budget deficit to no more than 3% of GDP. These measures aim to ensure fiscal discipline. These criteria, which are important in terms of ensuring fiscal discipline, have brought about new fiscal policy measures as well as changing the economic and political framework. Within the framework of these new measures, countries have attempted to reduce budget deficits by increasing public revenues and/or reducing public expenditures. However, in many countries where public debt exceeds GDP, such as Greece, Italy, or Portugal, high levels of budget deficits are not considered conducive to economic growth. Nevertheless, given the necessity of structural budget deficits, reducing uncertainty in budget deficits and inflation rates, or at least achieving long-term stability, is considered a solution. On the other hand, some countries aim to maintain a budget surplus to ensure stability in public finances. However, this can be challenging to sustain over time due to the high uncertainty in the budget balance, which can lead to instability in public revenues and/or expenditures with unpredictable sources of financing. Reducing high uncertainty in the budget balance may be necessary to ensure long-term public financial stability. This is because such uncertainty can lead to instability in public revenues and/or expenditures, with unpredictable. In addition to this, these deficits, along with related uncertainties, harm countries in various ways, such as inefficient resource distribution, jeopardizing financial sustainability for future generations, and triggering inflation by threatening central bank independence. Therefore, addressing the concept of budget deficits is crucial to tackling these issues head-on.

Therefore, our study aims to explore how budget deficit, inflation rate, and political stability are interconnected in a nonlinear way. Unlike previous research that relies on linear models or adds quadratic terms, we take a different approach. By analyzing yearly data from 1997 to 2016 across 11 EU countries, we use a nonlinear model called Panel Smooth Transition Regression (PSTR), developed by González et al. (2005). This method helps us identify specific points where inflation might positively and negatively impact budget deficit in these countries. The empirical findings seek to address the following inquiries: (i) Does inflation have a nonlinear effect on the budget deficit concerning political stability? (ii) If it does, what are the extent and specific features of this nonlinear effect across varying levels of political stability?

Previous research has extensively explored the linear connections between budget deficit, inflation, and political stability globally. However, there is a notable absence of studies examining this relationship through nonlinear models. This study aims to fill this gap by introducing three novel aspects or motivations. To handle issues related to heterogeneous panel models and changing parameters over time, this study uses the PSTR model by González et al. (2005). The main argument for this approach is that the PSTR model permits different impacts of explanatory variables on the focused variables across various cross-sections and time periods. Furthermore, it facilitates a smooth transition of the threshold variable coefficient between different regimes based on the threshold level and slope parameter outcomes. As far as we know, no prior research has employed the PSTR approach in the subject area of this study. Secondly, it is the first study to examine the relationship between budget deficit and inflation using political stability as a threshold value. Thirdly, 11 EU countries were selected in the study.

The paper is structured into several sections. Sections 2 and 3 provide a comprehensive review of the theoretical and empirical literature. Section 4 outlines the methods and data used in our analysis. In Section 5, we present the findings of our empirical analysis. Finally, we summarize the study's policies, recommendations, and limitations, and suggest potential areas for future research.

2. THEORETICAL LITERATURE FRAMEWORK

Economic conditions after the Second World War led to permanent budget deficits in many developed and developing countries. However, deteriorations occurred in the internal balances of the countries and the public borrowing requirement increased along with the budget deficits. According to economists, high and fluctuating budget deficits can negatively affect the welfare of countries in many ways. For example, it can create an exclusion effect by causing inefficient resource distribution; By increasing the debt/GDP ratio, it can negatively affect the country's financial sustainability and the living standards of future generations. In addition, it can increase the uncertainty and level of inflation, especially when the central bank is not independent. Therefore, increasing budget deficits are a major macroeconomic issue in many countries.

In the years after World War II, economists primarily viewed the relationship between budget deficits and inflation through two perspectives: the Keynesian perspective and the quantity theory approach. The conventional understanding of how fiscal deficits impact inflation originates from post-World War II Keynesian models. These models propose that any increase in overall demand, such as consumer spending, investments, government spending minus taxes, and net exports, tends to raise nominal income. Whether the increase in demand leads to higher prices depends on the shape of the aggregate supply curve. Early Keynesians believed that traditional monetary policies would be ineffective because the economy was in a liquidity trap, making fiscal policy the primary tool for influencing economic activity. The authors propose a supply curve that takes the shape of a reverse L, where increased demand boosts real activity until full employment is reached. Further demand expansion beyond this point leads to price level increases. In contrast to the earlier Phillips curve framework, the supply curve is positively sloped, meaning that expansionary demand not only raises prices but also increases output (Lipsey, 1960). Therefore, fiscal policy can contribute to inflation in Keynesian models.

Changes in the nominal income in an economy are primarily driven by alterations in the amount of money available, assuming that the demand for money remains stable, and determining how quickly money circulates in the economy. Sustained increases in the price level, known as inflation, are typically a result of continuous growth in the money supply, as suggested by Friedman (1956). When inflation becomes expected, higher nominal interest rates decrease the demand for money, causing money to change hands faster and thereby intensifying the impact of the money supply on prices. Early monetarists also argued that fiscal policy, unless it involved financing through the creation of money (as in wartime when central banks were under government control), would not significantly affect the nominal income or price levels (Anderson and Jordan, 1968). Milton Friedman, the founder of monetarism, offers a similar explanation based on the contemporary version of the quantity theory. He asserts that "Inflation is always and everywhere a monetary phenomenon" (Friedman, 1970:24). Therefore, from the monetarist perspective, budget deficits contribute to inflation only if they are financed by creating new money (Erkam and Çetinkaya, 2014).

Mainstream theoretical studies have highlighted the influence of fiscal factors, particularly budget deficits, on determining the price level (Erkam and Çetinkaya, 2014). It is argued that fiscal dominance, persistent deficits, and growing debt can push central banks to adopt inflationary monetary policies, as outlined by Sargent and Wallace (1981) in their work, 'Some Unpleasant Monetarist

Arithmetic.' The monetarist perspective has been expanded within a dynamic framework that features rational expectations and perfect foresight. According to this scenario, fiscal deficits, even when funded by government bonds, ultimately lead to inflationary increases in high-powered money to align with the government's long-term financial position.

Recent studies by Sims (2011), Leeper (1991), and Cochrane (2018) suggest that persistent fiscal deficits, without corresponding future tax increases or expenditure cuts to control national debt growth, can result in a phenomenon known as fiscal dominance. In this state, individuals perceive the rise in nominal government debt as an increase in real wealth, prompting higher consumption expenditure. This increased spending leads to rising prices, which in turn diminish the real value of the national debt, ultimately restoring fiscal balance.

On the other hand, issues related to budget deficits and inflation are also related to political economy. That is, political stability can also affect budget deficits and inflation. Budget discipline is affected by many factors such as government structure (number of parties and ideological differences of parties), types of government, and opportunistic and partisan cyclical policies. There is a strong relationship between government structure and budget composition.

In this context, it is stated that short-lived and multi-party coalitions increase budget deficits (Roubini and Sachs, 1989). This is because, with negative economic shocks, it is difficult for coalition governments to agree around a budget proposal. At the same time, budget discipline is affected by many factors such as government structure (number of parties and ideological differences of parties), types of government, and opportunistic and partisan cyclical policies. There is a strong relationship between government structure and budget composition. In this context, it is stated that short-lived and multi-party coalitions increase budget deficits (Roubini and Sachs, 1989). This is because, with negative economic shocks, it is difficult for coalition governments to agree around a budget proposal. Because, according to game theory, cooperation becomes impossible if the number of players in the system is high and the time horizon of the players is short. In addition, some economists emphasize that taking public sector financial decisions within decentralized structures will negatively affect the public income-expenditure balance. For example, it is predicted that public expenditures will tend to increase upwards and budget targets will subsequently deviate as decisions regarding public expenditures and revenues are taken during an incompatible structure (by central, regional and local units) (Akçoroğlu and Yurdakul, 2004). As a result of this situation, the budget deficit is expected to be negatively affected.

Four streams of literature have arisen in support of the political budget cycle theory. The first group of early authors, according to the opportunistic cyclical fluctuations' theory put forward by Nordhaus (1975), the ruling party increases its chances of being re-elected by easily manipulating the voters in every election, as voters are naive, quickly forget the past, and make systematic expectation errors (Telatar, 2004). In other words, narrow-minded or short-term myopic voters reward the ruling party that exhibits opportunistic behavior, without taking into account the fact that the need to reduce inflation created by the policies followed before the election will create the cost of recession. Because the timing of expansionary macroeconomic policies is artificially determined by the timing of elections, the electoral cycle creates suboptimal economic fluctuations. In other words, the model states that the parties in power artificially expanded the economy before the election and had to create a recession to eliminate the inflation created by this policy after the election (Telatar, 2004). Therefore, politicians, taking advantage of the myopia of voters, increase public expenditures while cutting taxes in the pre-election period. So, according to this theory, the budget deficit tends to increase during election times (Imbeau and Chenard, 2002). As a result, this situation disrupts the effectiveness of the political process and negatively affects the budget deficit by creating deviations in public expenditures and revenues.

The second perspective, supported by scholars such as Alesina and Tabellini (1995), and Alt and Lassen (2006), suggests that politicians might intentionally create deficits for partisan reasons. According to this perspective, politicians have different preferences regarding how public money should be spent. If an incumbent politician is worried about not getting re-elected, they might choose to spend more money than the government earns, leading to a deficit. On the other hand, a politician who doesn't plan to stay in office might prefer to reduce taxes by running deficits, as explained by Persson and Svensson (1989).

The third perspective focuses on deficits that stem from conflicts over public resources. Budget deficits can arise from disagreements over how resources are distributed, known as distributional conflicts. Early research by Weingast et al. (1981) and Baron and Ferejohn (1989) highlighted this issue. The process of bargaining over budget resources often becomes fragmented because different self-interested groups are involved. Recent studies by scholars such as Velasco (2000), Von Hagen and Harden (1995), and Krogstrup and Wyplosz (2010) have further explored these dynamics.

The final perspective concerns budget institutions' quality. Alesina et al. (1999) define budget institutions as rules, procedures, and practices that influence the budget process by controlling deficits and setting voting rules. In this context, laws and regulations (legal system) are considered as a good criterion in determining institutional quality. Because the legal system is corruption control, the impartiality and power of the judicial system, the justice system, the protection of property rights, the judicial system. It covers many components such as its effect on in countries with strong institutions, the legal infrastructure provides guarantees for the protection of property rights and the security and enforcement of contracts. However, situations where the legal system is not strong and property rights are not well-defined cause additional costs and create uncertainty in the economy. This uncertainty increases transaction costs and reduces enthusiasm for investments with an exclusionary effect. In summary, an ineffective legal system slows down economic growth by negatively affecting capital accumulation and productivity. When economic growth slows down, tax revenues decrease, leading to budget deficits as the government falls short of its targets.

3. EMPIRICAL LITERATURE FRAMEWORK

The connection between inflation and budget deficits is a commonly debated topic in economic literature. Many economists have explored this relationship across different countries, time periods, econometric methods, and variables, offering various insights into the direction of this relationship. Studies testing this relationship are reviewed below. The studies examining this association are reviewed below.

Tanzi (1978)'s empirical study first pioneered this field. In his study on the Argentinian economy, Tanzi stated that the increase in inflation reduces the real value of tax revenues, which in turn increases the budget deficit. Increasing inflation diminishes the actual worth of tax revenues for various reasons, including delays in tax collection and the of flexibility the tax system. Tax collection delays refer to the time between the event generating the tax and its payment, while tax system flexibility reflects how tax revenues react to changes in national income. Tanzi (1978) argues that if tax collection delays are short and the tax system is highly responsive to price changes (elasticity greater than 1), inflation won't erode the real value of tax revenues. Conversely, if delays are long and elasticity equals or is less than 1, inflation will reduce tax revenues' real value. In developed nations, tax collection periods are short and tax systems are highly elastic. In contrast, developing countries face longer tax collection periods and less elastic tax systems (Tanzi, 1978:424). Consequently, inflation leads to increased real tax revenues in developing countries. However, the diminished value of these revenues

contributes to a larger budget deficit, which represents the disparity between public revenues and expenditures. This positive relationship between inflation and budget deficits is referred to as the "*Tanzi effect"* in literature.

Alternatively, inflation not only reduces the actual value of tax revenues but also affects real spending. The inverse relationship between high inflation rates and real expenditures is known as the "*Patinkin effect"*, proposed by Cardoso (1998) based on Patinkin's (1993) analysis of Israel's stabilization program of 1985.

Patinkin observed that prior to 1985, Israel's budget policy was influenced by political coalitions, resulting in ministries lacking the authority to reduce their budget demands. With government planned expenditures surpassing expected income levels, deficits emerged, leading the government to finance these deficits by printing money, thus increasing inflation. However, it was found that escalating inflation led to a decrease in real public expenditures. Similarly, Seghezza (2022) finds that the Patinkin effect was valid during hyperinflation in Germany, reducing the real value of the government deficit.

Fischer and Easterly (1990) found that the relationship between inflation and budget deficits is weak during periods of low inflation but becomes significant during hyperinflation periods. They suggested that deficits funded by money creation lead to inflation, reducing real tax revenues and increasing the budget deficit. They advocated for a moderate budget policy to promote sustainable growth and stability. Boariu and Bilan (2007) discovered that financing the budget deficit through debt leads to inflation. Their findings indicated that, typically, developing economies with high budget deficits experience elevated inflation, whereas developed countries exhibit minimal evidence of a link between budget deficits and inflation. Likewise, Catao and Terrones (2003), in their study covering 107 countries covering the years 1960-2001, observed a strong positive correlation between inflation and budget deficits in developing countries, while finding that this relationship was less evident in developed countries.

Makochekanwa (2008) studied the connection between deficits and inflation in the Zimbabwean economy. From 1980 to 2005, the study used Johansen's cointegration technique and discovered a direct connection between Zimbabwe's budget deficit and inflation. It concluded that the fiscal deficit led to price level increases, particularly noting the significant inflationary impact of extensive monetization of the deficit. Similarly, Ssebulime and Edward (2019) showed a positive relationship between the two variables, suggesting that budget deficits drive inflation in Uganda. Similar results are also obtained by Eita et al. (2021) for Nambia and Erkam and Çetinkaya (2014) for Türkiye. The study by Eita et al. (2021) confirms that a negative fiscal balance affects inflation in both the short and long term. This means that large government budget deficits could make it difficult for monetary policy to achieve price stability. Additionally, Erkam and Çetinkaya found a significant positive relationship between budget deficits and inflation rates during the high inflation period from 1987 to 2003.

In examining how political stability influences budget deficits and inflation, Agnello and Sousa (2009) analyze the uncertainty surrounding budget deficits by considering economic, institutional, and political variables. In the study, a GMM analysis of 125 countries is performed using annual data covering the period 1980-2006. Based on the findings, it's revealed that there's a positive connection between political instability and the uncertainty of budget deficits. This means that as political instability rises, so does the uncertainty surround budget deficits. Similar results are also obtained by Javid et al. (2011) for ASEAN countries and Arif and Hussain (2018) for South Asia and ASEAN countries. Javid et al. (2011) have found that a high inflation rate increases budget deficit uncertainty. Arif and Hussain (2018) show that with a high level of political stability, the budget is more stable, and in the presence of

a high level of corruption, the budget deficit is uncertain. Likewise, De Haan et al. (2013) used panel-fixed effects models to explore how political and size fragmentation affect the connection between budgetary institutions and budget deficits. Analyzing data from European Union countries between 1984 and 2003, they found that robust budgetary institutions significantly decrease fiscal deficits, with this effect unaffected by size fragmentation, such as the number of parties in government or spending ministers.

4. METHODOLOGY AND DATA

4.1. Data And Variables

The study analyzed data from 1997 to 2016 for 11 EU countries (see Table1). The data cover the following variables (i) budget deficit (BD), representing the government's financial balance between income and spending, sourced from OECD; and (ii) inflation rate (INF), calculated using the consumer price index. This rate signifies the yearly percentage change in the cost of a standard set of goods and services purchased by the average consumer, also sourced from OECD.; and (iii) political risk index, which allows political stability to be assessed on a comparable basis, provided by The International Country Risk Guide (ICRG).

Table 1. List Of Countries İn The Study (Alphabetical Order)

S. no	Name	S. no	Name
1	Austria	7	Greece
2	Belgium	8	Italy
3	Denmark	9	Netherlands
4	Finland	10	Portugal
5	France	11	Spain
6	Germany		

Table 2. Dataset Source And Variable Description

Variables	*Description*	*Units*	*Source*
Budget Deficit (BD)	The general government deficit is the difference between what the government earns and spends, including both regular income and expenses related to investments. It's usually shown as a percentage of the country's overall economic output (GDP).	% of GDP	OECD
Inflation rate (INF)	Inflation, as measured by the Consumer Price Index (CPI), shows how prices for a set of goods and services commonly bought by different households change over time. Inflation is typically reported as the yearly rate of increase and is shown on an index scale based on 2015 prices. This helps track how the cost-of-living changes over time.	Annual growth rate %	OECD
Political Risk Index (POL)	The political risk index attempts to provide a comparable method for analyzing the political stability of ICRG-covered nations. This is accomplished by giving risk points to a variety of political risk components and subcomponents, for a maximum total of 100 points. The risk is higher when the risk point total is low, and lower when the risk point total is higher.	Index (1-100 scores)	ICRG

4.2. The Model: Panel Smooth Transıtıon Regressıon (PSTR)

The PSTR method introduced by González et al. (2005) was used in this study. This method can be viewed as either a linear heterogeneous panel model or a nonlinear homogeneous panel model. It extends Hansen's (2000) panel threshold regression (PTR) model and addresses the heterogeneity problem in the nonlinear model. The PSTR method is a fixed effects model with exogenous regressors. This is a panel model that allows for heterogeneity in the regression coefficients, which vary over time and across nations. The coefficients of an observable variable are assumed to be continuous and to vary between extreme values via a limited function known as the variable's transition function (Raza et al., 2020). According to González et al. (2005), a basic PSTR model can be described as having a single transition function and two extreme regimes:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} \mathrm{g}(q_{it}; \gamma, c) + \varepsilon_{it} \quad (1)$$

where *i =1,…,N, t =1,…,T; N* denotes the number of cross-sections and *T* denotes the time dimensions, y_{it} denotes the independent variable, μ_i represents the fixed individual effect, x_{it} is the vector of explanatory and control variables, and $\mathrm{g}(q_{it}; \gamma, c)$ is the transition function and depends on q_{it} (the threshold variable), c (threshold parameter), γ (parameter which determines the slope of the transition function), and ε_{it} is the error term. The assumption is that asymmetry characterizes the nonlinear relationship between inflation and budget deficit. Hence, a nonlinear model is employed to confirm this relationship. The PSTR function is stated as:

$$BD_{it} = \mu_i + INF_0' x_{it} + INF_1' x_{it} \mathrm{g}(q_{it}; \gamma, c) + \varepsilon_{it} \quad (2)$$

where the cross-section is exhibited by *i* ("11 EU countries"), *T* is for time-frequency (1997-2016). BD means budget deficit balance as an endogenous variable; INF explains the inflation rate. "$\mathrm{g}(q_{it}; \gamma, c)$" is the transition function and in which "q_{it}" represents the threshold variable which is the political risk index. In the provided function, g represents the slope parameter, which determines how smoothly the transition occurs between regimes, and the threshold variable is denoted as "q_{it}". Following research conducted by González et al. (2005) and Fouquau et al. (2008), a logistic function is defined below;

$$\mathrm{g}(q_{it}; \gamma, c) = \frac{1}{1 + \exp[-\gamma(q_{it} - c)]} \quad (3)$$

The threshold parameter is denoted by *c* in the equation above, while the slope of the transition function is represented by $\gamma > 0$. Further, note that as $\gamma \to \infty$, the transition function approaches the indicator function $I(q_{it} > c)$ that takes the value of 1 if $q_{it} > c$, respectively. Therefore, the range of the transition function is standardized to be constrained between 0 and 1. As the threshold variable increases, the BD and INF coefficients efficiently and gradually change from the first to the second regime, that is, from the low regime (β_0) to the higher regime $(\beta_0 + \beta_1)$. The threshold parameter of the PSTR model changes across cross-section and time. The equation below illustrates how cross-section *i* and time *t* respond to the relationship between BD and INF:

$$\varepsilon_{it} = \beta_0 + \beta_1 x \mathrm{g}(q_{it}; \gamma, c) \quad (4)$$

Analyzing the PSTR model involves three steps. In the first step, we evaluate the model's linearity assumption and determine if the connection between BD and INF is linear (basic panel model)

or nonlinear (PSTR model). We examine whether a linear model holds compared to a nonlinear PSTR model by testing the null assumption, $H_0: r = 0$ againts $H_1: r = 0$. If the linearity is rejected, we calculate the optimal number of transition functions, gi, and the suitable order of m by testing for no remaining nonlinearity. However, to address the issue of unidentified nuisance factors in the model, a regression equation is generated in which the transition function "$(q_{it}; \gamma, c)$" in equation (1) is altered by the first-order Taylor expansion around $\gamma = 0$, and the resulting regression is described below:

$$y_{it} = \mu_i + \beta'^{*}_{0} x_{it} + \beta'^{*}_{1} x_{it} q_{it} + \cdots + \beta'^{*}_{m} x_{it} q_{it}^{m} + \varepsilon_{it}^{*} \tag{5}$$

where the parameters $\beta'^{*}_{0}, \ldots, \beta'^{*}_{m}$ are multiples of γ and $\varepsilon_{it}^{*} = \varepsilon_{it} + R_m \beta'^{*}_{1} x_{it}$, with R_m is the remainder of the Taylor expansion. Furthermore, following Colletaz and Hurlin (2006), testing $H_0: \gamma = 0$ in Eq. (1) is similar to testing $H_0^{*}: \beta'^{*}_{1} = 0$ in Eq. (5). The Wald LM, Fischer LM, and Likelihood Ratio tests may be described as follows:

$$Wald\ LM\ test = LM_w = \frac{NT(SSR_0 - SSR_1)}{SSR_0} \tag{6}$$

$$Fischer\ LM\ test = LM_f = \frac{\frac{NT(SSR_0 - SSR_1)}{mk}}{SSR_0(TN - N - mk)} \tag{7}$$

$$Likehood\ Ratio\ test = LR = -2[\log(SSR_1) - \log(SSR_0)] \tag{8}$$

SSR_0 and SSR_1 represent the panel model's squared residuals under the null hypothesis (fixed effect in linear panel model) and the alternative hypothesis (*m* regime PSTR model), respectively. Under the null hypothesis, the LM_w and LR statistics are distributed as $\chi^2(k)$ and the LM_f statistic has an approximate $F\ (mk, TN - N - mk)$ distribution, where k, m, N, and T represent the number of independent variables, maximum thresholds, countries, and periods under consideration, respectively. If the null hypothesis is not rejected, it implies that the model is linear. Conversely, if the null hypothesis of the linearity test is rejected, suggesting a nonlinear relationship between variables, it favors employing the PSTR model with a minimum of two regimes. Subsequently, we investigate if any nonlinearity persists to ascertain whether the relationship between variables fits the PSTR model with two extreme regimes or alternative hypotheses. Once the regimes are determined, we use the PSTR model to estimate the relationship between budget deficit and inflation.

5. EMPIRICAL RESULTS

In panel data analysis, it's important to conduct tests for cross-sectional dependence and homogeneity of variables to assess their stationary level. Initially, we check if the variables are homogeneous using the Hsiao test. The results from Table 3 indicate that rejecting the homogeneity criterion, which implies accepting heterogeneity, is possible for all three hypotheses at a significance level of 5%.

Table 3. Specification Tests Of Hsiao (1986)

Hypotheses	*F-Stat*	*P-values*
H1	5.575032	4.85E-14
H2	3.244640	1.30E-05
H3	8.411570	1.90E-11

Notes:*H1 = Null Hypothesis: The panel is homogeneous versus the Alternative Hypothesis: H2.*
H2 = Null Hypothesis: H3 versus Alternative Hypothesis: the panel is heterogeneous
H3 = Null Hypothesis: The panel is homogeneous. Alternative Hypothesis: The panel is partially homogeneous

The following step is to evaluate whether there is cross-correlation among panel sections. Depending on the presence of cross-sectional dependence, we choose between using first- and second-generation unit root tests. If there is no cross-sectional dependence, we use the first-generation unit root test. However, if there is cross-sectional dependence, we apply the second-generation unit root test. Deviant and inconsistent results may be obtained in analyses where these tests are not performed (Turgut and Uçan, 2019: 8–9).

Table 4. Cross-Sectional Dependence Test Results

Variables	*Breusch-Pagan LM (P-values)*	*Pesaran scaled LM (P-values)*	*Pesaran CD (P-values)*
BD	391.8669***	32.11900***	17.72040***
	(0.000)	(0.000)	(0.000)
INF	528.8643***	45.18119***	22.51582***
	(0.000)	(0.000)	(0.000)
POL	455.2644***	38.16371***	19.89450***
	(0.000)	(0.000)	(0.000)

Notes: *** indicate 1% levels of significance. Figures in parentheses show probability values.
H0: There is no cross-sectional dependency.
H1: There is cross-sectional dependency.

After examining the results of cross-sectional dependency in Table 4, we reject the null hypothesis for all three tests. This indicates that the study variables exhibit cross-sectional dependence, revealing that shocks in one country affect others as well. The third step verifies the stationarity of the data series. The stationarity of the series is investigated using second-generation unit root tests, namely Moon and Perron (2004) and Pesaran (2007) CIPS, due to concerns about cross-section dependence among the variables. Table 5 displays the results of the Moon and Perron (2004) and Pesaran (2007) unit root test CIPS applied in the panel. The results strongly reject the null hypothesis of non-stationarity at the conventional significance level, indicating that the variables in the PSTR model are stationary at the level.

Table 5. Moon And Perron (2004) and Pesaran (2007) Unit Root Test Results

Moon and Perron (2004)	$\hat{\gamma}$	t_a^*		t_b^*	$\hat{\rho}pool$		
BD	1	-27.628 (0.000)		-8.721 (0.000)	0.812		
INF	1	-81.888 (0.000)		-13.660 (0.000)	0.469		
POL	1	-21.150 (0.000)		-4.189 (0.000)	0.911		
Pesaran (2007)	Panel CIPS (C)	Critical Values			Panel CIPS (C and T)	Critical Values		
		0.01	**0.05**	**0.10**		**0.01**	**0.05**	**0.10**
BD	-2.211*	-2,59	-2,33	-2,20	-2.824*	-2,59	-2,33	-2,20
INF	-2.295*	-2,59	-2,33	-2,20	-2.275*	-2,59	-2,33	-2,20
POL	-2.595***	-2,59	-2,33	-2,20	-3.450***	-2,59	-2,33	-2,20

Notes: $\hat{\gamma}$ is the estimated number of common factors. t_a^* and t_b^* are the unit root test statistics based on de-factored panel data. Corresponding p-values are in parentheses. $\hat{\rho}pool$ is the corrected pooled estimates of the autoregressive parameter. Respectively. ***, **, * indicate respectively the significance levels at 1%, 5%, and 10%.

In the first step of PSTR, the linear test is conducted. Table 6 presents the results of the linearity tests, which aimed to determine whether a linear panel model or a PSTR model (nonlinear panel model) could capture the link between the budget deficit and inflation in 11 EU countries. Table 6 shows that

the null hypothesis is rejected, and the alternative hypothesis is accepted. The PSTR model can assess the non-linear relationship between budget deficit and inflation, validating our intuition to investigate the model with at least two regimes.

Table 6. Linearity Tests Results

Threshold variable Politic Risk Index	***Statistic***	***P-values***
H0: Linear Model H1: PSTR model with at least one Threshold Variable (r=1)		
Wald Tests (LM)	31.339	0.000
Fisher Tests (LMF)	34.551	0.000
LRT Tests (LRT)	33.809	0.000

Note: LM and LR denote Lagrange multiplier and likelihood ratio tests for linearity.

Next, we conduct the no remaining nonlinearity test to confirm the correct number of thresholds. Following the approach of González et al. (2017), this test examines whether a PSTR (panel smooth transition regression) model with one threshold or two regimes is suitable. The null hypothesis (H0) proposes that a PSTR model with one threshold is adequate, while the alternative hypothesis (H1) suggests that a PSTR model with at least two thresholds is necessary to analyze asymmetry or nonlinearity.

Table 7. Remaining non-linearity result

Threshold variable Politic Risk Index	***Statistic***	***P-values***
H0: PSTR with r = 1 against H1: PSTR with at least r = 2		
Wald Tests (LM)	1.941	0.164
Fisher Tests (LMF)	1.834	0.177
LRT Tests (LRT)	1.950	0.163

Note: LM and LR denote Lagrange multiplier and likelihood ratio tests for linearity.

Table 7 shows that the null hypothesis was accepted whereas the alternative hypothesis was rejected. To put it simply, the PSTR technique with one transition or two regimes is sufficient to explore the non-linear relationship between the budget deficit and inflation.

Table 8. Results Of Panel Smooth Transition Regression Model Regression

Variable	β_0	*t-stats*	β_1	*t-stats*
INF	-1.364***	-3.805	2.088***	6.371
	(0.358)		(0.328)	
Threshold (c)	73.751			
Slope parameter (γ)	0.504			
AIC	1.609			
BIC	1.671			
RSS	1036.065			

Note: β_0 and $\beta_1$stand for regime-1 and regime-2, respectively. ***, **, * indicate respectively the significance levels at 1%, 5%, and 10%. Numbers in parentheses are standard errors of estimated slope parameters corrected for heteroskedasticity.

Table 8 presents the results of estimating the PSTR model with one threshold or two regimes using the political risk index as a threshold variable. The slope parameter (γ), which can take values ranging from zero to plus infinity, was calculated as = 0.543. Because the value in question is modest (near zero), the shift between regimes in the relationship between regime 1 and regime 2 is not sudden and sharp that is, it is smooth. As a result, the utilization of the Panel Smooth Transition Regression Model, which entails a gradual transition between regimes as opposed to the abrupt changes in parameters characteristic of the Threshold Panel Regression Model, is advocated based on our findings. The identified threshold level, denoted by c = 73.751, delineates the point at which the regime transitions occur. Specifically, regime 1 corresponds to instances of a low political risk index (below c), whereas regime 2 signifies scenarios characterized by a high political risk index (exceeding c). Table 8 illustrates a statistically significant negative correlation between budget deficit and inflation under low political

risk index conditions. Conversely, as countries transition to regimes with higher political risk index, the correlation between budget deficit and inflation becomes positive and statistically significant. Notably, an increase in the political risk index is indicative of decreased political risk within the country. In instances where the threshold value is surpassed (i.e., surpassing c), a positive relationship emerges between budget deficit and inflation, thereby validating the presence of the 'Tanzi effect'. Conversely, in countries characterized by low political risk index, a negative association is observed between budget deficit and inflation, thereby validating the 'Patinkin effect' in politically unstable contexts.

6. CONCLUSION

The prevalence of budget deficits and high inflation rates constitutes foundational challenges within the economic landscapes of all nations, irrespective of their developmental stages. Consequently, the inquiry into the existence and directionality of the interdependence between budgetary deficits and inflation has engendered substantial scholarly discourse. In light of this context, the current investigation is positioned as an endeavor to meticulously examine the nuanced role of the relationship between these two variables. We examined the relationship between budget deficits and inflation across 11 European Union (EU) member states spanning the period from 1997 to 2016. Instead of using simple linear models, we explored more complex patterns because the usual methods had some flaws like differences between countries and how they influence each other. Specifically, we employed the panel smooth transition regression (PSTR) model to elucidate the dynamics between budget deficits and inflation. Our analysis began by testing for cross-sectional independence using the CD tests, revealing significant deviations from the assumption of independence and necessitating the application of asymptotic theory for nonlinear models. Subsequently, employing the panel unit root test recommended by Moon and Perron (2004) and Pesaran (2007), we confirmed the stationarity of our variables. To validate the suitability of a nonlinear model, we conducted a linearity test, which supported our decision to adopt a nonlinear panel model. Ultimately, our investigation culminated in the implementation of a Panel Smooth Transition Regression model with two regimes, allowing us to delve into the nonlinear relationship between budget deficits and inflation. The findings of this study provide substantial evidence that in the case of higher regimes (political risk is low), the link between budget deficit and inflation is positive in 11 EU countries. This finding reveals that the “Tanzi effect” is valid. However, the results become negative and significant in the lower regimes. That is, It has been determined that the Patinkin effect is valid in countries where political risk increases.

These results have important policy implications. The results of the study have determined that political stability, which affects both variables in the budget deficit and inflation relationship for 11 EU countries, affects the direction of the relationship and has made a positive contribution to which policymakers should implement. In the country group considered, it has been revealed that in countries with high political stability, the relationship between the decrease in public expenditures and inflation and budget deficit is negative, that is, the Patinkin effect is valid and measures should be taken accordingly. On the other hand, in countries with low political stability, it has been shown that the relationship between the decrease in budget revenues and inflation and budget deficit is positive, that is, the Tanzi effect is valid and measures should be taken accordingly.

The limits of this study stem from the complexities of the relationship between the budget deficit and inflation. First, other macroeconomic factors that were not examined in this study may have an impact on the budget deficit as well. Examples include trade openness and debt stock. In the future, additional useful elements could be added to the control variable pool to produce more robust and interesting results. Second, future studies can further explore using data from developing countries other than European Union member countries and can provide more meaningful results.

Ethical Statement

The rules of research and publication ethics were followed during the writing and publication of the study, and the data collected were not manipulated. The study does not require ethics committee approval.

Contribution Rate Declaration

The study was conducted with a single author. The author is responsible for the drafting and writing of the study. He contributed to all the processes until the final version was read and approved.

Conflict Statement

This study did not lead to any individual or institutional/organizational conflict of interest.

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Extended Abstract

Budget Deficit and Inflation in 11 EU Countries: New Insights from Panel Smooth Transition Regression Modeling

The persistent increase in permanent budget deficits and inflation rates observed in developed nations since the 1970s has raised significant global economic concerns. This has prompted both academic and political communities to focus on deficit financing. Previous research has extensively explored the linear connections between budget deficit, inflation, and political stability globally. However, there is a notable absence of studies examining this relationship through nonlinear models. This study aims to fill this gap by introducing three novel aspects or motivations. To handle issues related to heterogeneous panel models and changing parameters over time, this study uses the PSTR model by González et al. (2005). The main argument for this approach is that the PSTR model permits different impacts of explanatory variables on the focused variables across various cross-sections and time periods. Furthermore, it facilitates a smooth transition of the threshold variable coefficient between different regimes based on the threshold level and slope parameter outcomes. As far as we know, no prior research has employed the PSTR approach in the subject area of this study. Secondly, it is the first study to examine the relationship between budget deficit and inflation using political stability as a threshold value. Thirdly, 11 EU countries were selected in the study.

The study analyzed data from 1997 to 2016 for 11 EU countries. The data cover the following variables (i) budget deficit (BD), representing the government's financial balance between income and spending, sourced from OECD; and (ii) inflation rate (INF), calculated using the consumer price index. This rate signifies the yearly percentage change in the cost of a standard set of goods and services purchased by the average consumer, also sourced from OECD; and (iii) political risk index, which allows political stability to be assessed on a comparable basis, provided by The International Country Risk Guide (ICRG).

In panel data analysis, it's important to conduct tests for cross-sectional dependence and homogeneity of variables to assess their stationary level. Initially, we check if the variables are homogeneous using the Hsiao test. The results otherindicate that rejecting the homogeneity criterion, which implies accepting heterogeneity, is possible for all three hypotheses at a significance level of 5%. The following step is to evaluate whether there is cross-correlation among panel sections. After examining the results of cross-sectional dependency, we reject the null hypothesis for all three tests. This indicates that the study variables exhibit cross-sectional dependence, revealing that shocks in one country affect others as wellThe other step verifies the stationarity of the data series. The results of the Moon and Perron (2004) and Pesaran (2007) unit root test CIPS applied in the panel strongly reject the null hypothesis of non-stationarity at the conventional significance level, indicating that the variables in the PSTR model are stationary at the level.

The PSTR model can assess the non-linear relationship between budget deficit and inflation, validating our intuition to investigate the model with at least two regimes. We conduct the no remaining nonlinearity test to confirm the correct number of thresholds. Null hypothesis was accepted whereas the alternative hypothesis was rejected. To put it simply, the PSTR technique with one transition or two regimes is sufficient to explore the non-linear relationship between the budget deficit and inflation.

The results of estimating the PSTR model with one threshold or two regimes using the political risk index as a threshold variable. The slope parameter (γ), which can take values ranging from zero to plus infinity, was calculated as = 0.543. Because the value in question is modest (near zero), the shift between regimes in the relationship between regime 1 and regime 2 is not sudden and sharp that is, it is smooth. As a result, the utilization of the Panel Smooth Transition Regression Model, which entails a gradual transition between regimes as opposed to the abrupt changes in parameters characteristic of the Threshold Panel Regression Model, is advocated based on our findings. The identified threshold level, denoted by c = 73.751, delineates the point at which the regime transitions occur. Specifically, regime 1 corresponds to instances of a low political risk index (below c), whereas regime 2 signifies scenarios characterized by a high political risk index (exceeding c). In instances where the threshold value is surpassed (i.e., surpassing c), a positive relationship emerges between budget deficit and inflation, thereby validating the presence of the 'Tanzi effect'. Conversely, in countries characterized by low political risk index, a negative association is observed between budget deficit and inflation, thereby validating the 'Patinkin effect' in politically unstable contexts.