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The Triangle of Public Expenditures, Public Sector Deficits, and the Informal Economy: The Case of Türkiye

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Kamu Harcamaları, Kamu Kesimi Açıkları ve Kayıt Dışı Ekonomi Üçgeni: Türkiye Örneği

Abstract

The informal economy poses a significant challenge to the effectiveness of public finance policies worldwide. Reducing tax revenues raises public sector deficits and complicates the financing of public services, while increasing public expenditures and expanding public sector deficits are also encouraged. This study employs Wavelet Coherence Analysis to examine the relationships among public spending, public sector deficits, and the informal economy in Türkiye from 1990 to 2020. The results reveal that public expenditures and public sector deficits, both individually and collectively, influence the informal economy, while the growth of the informal economy lessens the impact of both.

Keywords : Public Expenditures, Public Sector Deficits, Informal Economy, Wavelet Coherence Analysis.

JEL Classification Codes : H50, H62, E26, C32.

Öz

Kayıt dışı ekonomi, kamu maliyesi politikalarının etkinliği açısından küresel ölçekte önemli bir sorundur. Vergi gelirlerini azaltarak kamu kesimi açıklarını artıran ve kamu hizmetlerinin finansmanını zorlaştıran kayıt dışı ekonomi, aynı zamanda artan kamu harcamaları ve kamu açıkları tarafından da teşvik edilebilmektedir. Bu çalışma, 1990-2020 döneminde Türkiye ekonomisi özelinde kamu harcamaları ve kamu kesimi açıklarının kayıt dışı ekonomiyle ilişkisini Wavelet Uyum Analizi ile incelemektedir. Çalışmanın bulguları, kamu harcamaları ve kamu kesimi açıklarının kayıt dışı ekonomiyi ayrı ayrı ve bütünleşik olarak etkilediğini ve kayıt dışı ekonomideki genişlemenin kamu harcamalarını ve kamu kesimi açıklarını azaltıcı etkisi olduğunu ortaya koymaktadır.

Anahtar Sözcükler : Kamu Harcamaları, Kamu Kesimi Açıkları, Kayıt Dışı Ekonomi, Wavelet Uyum Analizi.

1. Introduction

Public expenditures and public sector deficits are two vital aspects of fiscal policy aimed at achieving macroeconomic stability and promoting sustainable economic growth. The influence of these elements on economic activities can differ across countries, depending on their levels of development, institutional frameworks, and policy choices. However, the size and scope of the informal economy directly impact the efficiency of public finance, making it challenging for public policies to meet their goals. In particular, in developing economies, the informal sector's size can diminish government tax revenues, worsen public-sector deficits, and complicate the financing of public expenditures. Indeed, rising tax rates may tempt individuals to evade taxes, thereby enlarging the informal economy through increased currency demand and indirectly causing losses in public revenues (Tanzi, 1984: 290). This situation can present serious issues for both economic growth and social welfare.

Generally, the informal economy includes economic activities that are not recorded in official accounts or that evade government regulation. Key components of this sector include tax evasion, unregistered employment, and violations of regulatory obligations. An increase in public expenditures and continuously rising budget deficits can lead to the growth of such activities. Furthermore, the expansion of the informal economy diminishes the tax base, reduces tax revenues, and consequently accelerates the growth of public deficits. High tax rates and complex regulations often encourage informality, which in turn weakens public finances, creating a cycle that reinforces itself (Schneider & Enste, 2000: 98). This reciprocal relationship may intensify economic instability and issues related to fiscal sustainability.

The prevalence of the informal sector reduces the financial resources available for public service funding and limits the state's capacity for economic intervention. The efficiency of public service provision and the level of public trust directly influence tax morale and individuals' propensity to engage in informal economic activities (Alm & Gomez, 2008: 86). The expansion of the informal economy may result in inefficient resource allocation, distort economic incentives, and disrupt the savings-investment balance, ultimately exerting a negative impact on economic growth and development. Furthermore, excessive regulatory burdens, high transaction costs, and complex bureaucratic procedures may also drive individuals or firms toward informal activities. Consequently, the informal economy can reduce state revenues and constrain public expenditure. On the other hand, redirecting public spending toward infrastructure and productive sectors may mitigate informality (Gupta & Barman, 2015: 82).

On the other hand, there is an interaction between public expenditures and the public sector's fiscal balance. While increasing public spending may lead to higher public deficits, reducing expenditures can help alleviate them. Therefore, it is possible to posit a relationship between the interaction of public spending and fiscal balance and the informal economy. Since the effectiveness of public expenditures also depends on the level of the public sector deficit, the interaction between public spending and the informal sector may vary

accordingly. In fact, public sector deficits may exert either a positive or a negative influence on the relationship between public expenditures and the informal economy. This suggests the need to analyse the impact of public spending on informality and public deficits. It also highlights the need to account for the indirect effects of informality, such as the informal sector's dampening of the government spending multiplier (Kamara, 2024: 140).

Therefore, governments aiming to combat or minimise informal economic activities tend to design reforms targeting informality alongside efforts to improve macroeconomic indicators. Limiting the informal economy in a given country would generate significant economic, political, and institutional benefits. In this context, effective public budget management is pivotal in fostering economic growth and containing the informal economy's size and scope (Devine, 2021: 227). Thus, policies to tackle informality should not be seen merely as political showcases but as essential components of enhancing the effectiveness and sustainability of public financial resources. Accordingly, this study aims to analyse the effects of public expenditures and public sector deficits on the informal economy in the Turkish context, both individually and collectively. For this purpose, the Wavelet Coherence Analysis method is employed, as it prevents loss of observations and allows for the simulation and exponential generation of new data. This study contributes to the existing literature in several respects: (i) it examines the separate and combined impacts of public expenditures and deficits on the informal economy in Türkiye; (ii) it utilizes the Wavelet Coherence Analysis to reveal dynamic interactions among variables; (iii) it is methodologically innovative and policy-relevant; and (iv) to the best of our knowledge, it represents the first empirical investigation into the triadic relationship between public spending, public sector deficits, and the informal economy in the Turkish context.

2. Theoretical Framework

Managing public budgets is seen as a vital tool for achieving economic stability, growth goals, and reducing the extent of informal economic activities (Devine, 2021: 227). The literature has explored the causes behind the large and persistent size of the informal economy in many developing countries, but no agreement has been reached on its determinants. Economic approaches provide various viewpoints on how public spending and fiscal deficits influence the informal economy.

According to the Classical Economic Approach, increases in public expenditures generally require higher taxation, which raises costs for businesses and individuals, making the informal economy more attractive. Similarly, public sector deficits force governments to borrow or implement additional taxes to keep fiscal balance. These policies increase the financial pressure on the formal sector while encouraging a shift towards the informal economy. The Classical Economic perspective highlights rational behaviour by economic agents and downplays the role of government intervention in promoting economic efficiency. As a result, public sector deficits are viewed unfavourably within this framework. Gibson and Kelley (1994) laid out a theoretical basis for this relationship by showing how high public spending and fiscal deficits encourage the informal economy through taxation

and regulation. They argued that inefficient public expenditure and rising deficits weaken the state's regulatory and supervisory capacities, making it easier for the informal sector to operate. Therefore, classical economists contend that government intervention can reduce the size of the formal economy and expand the informal sector, instead of improving overall economic efficiency.

The Keynesian view, however, argues that public spending and fiscal deficits can impact the informal economy by boosting aggregate demand, especially during economic cycles (Granados, 2003: 24). Increased government expenditure can strengthen aggregate demand, lower unemployment caused by lack of demand in the labour market, and stimulate economic activity (Arestis et al., 2018: 3-4). Nonetheless, the informal economy complicates this process, as the informal sector decreases tax revenues based on total income, restricting the government's fiscal flexibility. According to this view, public investments are vital for reducing unemployment and preventing the shift to the informal sector (Arestis et al., 2018: 3-4). Furthermore, guiding public expenditure towards productive sectors can reduce the scope of the informal economy. For example, investments in infrastructure, roads, energy, and transport can enhance business efficiency and encourage the transition to the formal economy (Gupta & Barman, 2015: 81). The size of the informal economy also limits the effectiveness of Keynesian policies in the labour market. Workers in the informal sector contribute very little to aggregate demand because they cannot access social security or pension schemes. Additionally, low wages and insecure working conditions in the informal sector decrease consumption, which hampers economic growth (Schneider & Enste, 2000: 83).

Social transfer expenditures aimed at increasing the income of individuals near the poverty line may also unintentionally encourage informal activities. Some individuals may direct their labour toward informal economic activities to meet the conditions of social assistance programmes or choose to work informally while receiving such aid (May, 2004: 7-8; Shaikh & Tonak, 1994: 164-165). In many developing countries, the informal economy emerges as part of the structural transformation process (Portes & Haller, 2005: 420). Insufficient infrastructure, low levels of education, and limited access to finance hinder businesses from joining the formal economy (Loayza, 1996: 149). In this context, allocating public expenditures to education and infrastructure can potentially reduce the informal economy in the long term (Schneider & Enste, 2000: 77).

The Neoliberal approach considers the informal economy a natural result of market forces. Supporters contend that limiting government intervention, simplifying regulations, and encouraging entrepreneurship can reduce the size of the informal economy (De Soto, 1989: 210). According to this view, lowering fiscal deficits and diminishing the government's role in the economy can help manage the informal sector. It holds that individuals and firms make economic choices based on the incentives created by tax levels and regulations. Therefore, high taxes and complicated rules are thought to increase the likelihood of engaging in the informal economy (Schneider & Enste, 2000: 81). Particular emphasis is placed on high indirect taxes and social security premiums as driving forces

behind informal employment. Furthermore, the shift to the informal economy caused by high tax rates further diminishes public revenues and hampers the effectiveness of fiscal policies. This dynamic, especially in developing countries, results in fiscal policies diverging from their original objectives (Loayza, 1996: 130). It is also argued that a lack of fiscal discipline may promote informality by driving up public expenditures (Barro, 1990: 105).

The Institutional Approach connects the informal economy to the government's limited regulatory capacity and weak legal infrastructure. According to this view, strong institutions prevent informality by making sure that economic activities take place within the formal economy (North, 1990: 58). Weak regulations and poor enforcement mechanisms cause individuals and firms to participate in informal activities. Fiscal deficits combined with institutional weaknesses can worsen the growth of the informal economy. For example, poorly managed budgets may reduce trust in the formal sector, encouraging people to work informally. Factors such as institutional efficiency, the rule of law, corruption levels, and bureaucratic barriers greatly affect the likelihood of economic actors shifting to informality (Centeno & Portes, 2006: 29). High corruption and weak legal protections are especially linked to the expansion of the informal economy (Nwabuzor, 2005: 122).

The Marxist perspective views the informal economy as a consequence of the capitalist system of production. This approach contends that the informal economy functions as a means of exploiting the working class under flexible, insecure conditions, stemming from tendencies in capital accumulation (Szeman & Kaposy, 2010: 323). The capacity of public spending to diminish the informal economy relies on the process of capital accumulation. For instance, investments in social welfare and workers' rights may effectively decrease informality. Allocating fiscal deficits to social expenditures can help prevent workers from shifting to the informal economy.

The Structuralist Approach views the informal sector as complementary to the formal economy. According to this perspective, the informal economy fulfils the need for low-cost labour in the formal sectors, and the two sectors exist in a mutually dependent relationship (Tokman, 1979: 1068). Rather than seeing the informal economy as a problem, this approach considers it an essential part of the economic system. For example, regional development policies may help reduce informality. Instead of concentrating on reducing fiscal deficits, the structuralist approach supports increasing expenditures to address social inequalities, thereby encouraging informal workers to transition into the formal sector.

The informal economy presents a serious obstacle to economic sustainability and public sector finances. By shrinking the tax base, it diminishes the government's revenue capacity and worsens fiscal deficits, disrupting public-sector fiscal balances (Benjamin et al., 2014: 26). The resulting decrease in tax revenues hampers the government's ability to implement flexible fiscal policies and countercyclical measures to respond to economic shocks. Moreover, higher tax rates may encourage informality, leading to further reductions in tax income and a contraction of the formal economy (Damiani, 2024: 11). Behavioural public finance literature examines individuals' tax compliance decisions alongside

psychological and social influences (Frey & Torgler, 2007: 137). It highlights that tax morale and trust between the state and its citizens strongly influence tax evasion tendencies. Therefore, policies that boost citizens' confidence in the state, coupled with financial incentives, can effectively reduce the size of the informal economy.

The revenue losses linked to the informal economy also negatively impact the sustainability of public spending and the manageability of public debt (Andrews et al., 2011: 7-8). This requires the development of innovative approaches in policy creation. The effectiveness of expansionary fiscal policies may be limited if expected revenues cannot be realised due to the informal economy, making it harder to achieve macroeconomic stability. While Keynesian policies aim to boost demand through increased public expenditure, they can sometimes unintentionally support informality. For example, weaknesses in the tax system can worsen informality (Orsi et al., 2014: 418). Funding public sector deficits via indirect taxes can raise business costs, encouraging informality. Large infrastructure projects with weak oversight may employ informal workers, illustrating how Keynesian policies can contribute to informality. In developing economies, poor oversight and high tax burdens can amplify informal economic activity under Keynesian policies. Thus, the success of Keynesian policies depends on the country's implementation conditions and structural factors. On the other hand, supply-side economic policies tend to be more effective in reducing informality. Actions like lowering tax rates and simplifying legal regulations can motivate businesses to formalise, thereby increasing tax revenues and strengthening public finances (Levy, 2008: 287). While supply-side policies offer notable opportunities to stimulate growth and cut informality, they need to be carefully designed and executed to prevent issues such as income inequality, fiscal fragility, and inadequate social protection. A thorough analysis and balanced measures are vital for managing these risks.

3. Literature Review

The effects of public expenditures and public sector deficits on the informal economy have been examined only to a limited extent in fiscal and economic literature at the empirical level. The structure of public expenditures and the size of public sector deficits are key factors that can influence the extent of informality. However, the determinants of the informal economy, as a complex phenomenon, are highly diverse. Since theories about the informal economy mainly focus on fiscal and institutional factors, the impacts of public expenditures and fiscal deficits are often viewed as secondary topics within the literature and are not sufficiently explored. In this context, the informal economy is often linked to tax policies (Tanzi, 1982; Martinez-Vazquez, 2007), corruption (Esaku, 2021; Baklouti & Boujelbene, 2020), and institutional quality (Elgin & Oztunali, 2014; Wang, 2022). The disciplinary separation, with the informal economy primarily studied in economics and sociology, and public expenditures examined within fiscal studies, has resulted in limited research at the intersection of these fields. Nevertheless, the interaction among public spending, public sector deficits, and the informal economy could encourage policymakers to develop more effective public expenditure strategies.

The size and dynamics of the informal economy are closely connected to the effectiveness of public policies. The impact of public spending on the informal economy often depends on the type, efficiency, and fiscal discipline of these expenditures. Studies exploring the effects of public spending on reducing informality highlight factors such as human capital, institutional quality, and social welfare. For example, Berrittella (2015) analysed data from 70 countries with different income levels from 1999 to 2007, discovering that public education expenditures significantly lowered informality. This was achieved through developing human capital and improving institutional quality. Similarly, Van Nguyen et al. (2022), who examined 32 Asian countries from 2000 to 2017, found that social welfare and infrastructure spending negatively affected the informal economy, with the effectiveness and transparency of these expenditures strengthening this relationship. Tran et al. (2024) offered a more detailed analysis of Asian countries over the period 2000-2017, emphasising that effective public spending helped reduce informality, though large fiscal deficits could limit this positive effect. Sawhney (2023) highlighted the beneficial role of education and healthcare spending in reducing informality across 154 countries with varying income levels and levels of economic development from 1950 to 2017. Kamara (2024) investigated how the informal sector influences the multiplier effect of government expenditure, finding that informality reduces the capacity of public spending to boost economic output. This finding is especially relevant for economies with significant informal sectors, providing valuable insights for the design and implementation of fiscal policies.

Regarding the effects of budget deficits on the informal economy, Vo et al. (2023) analysed data from 32 Asian countries for the period 2000-2017. They found that budget deficits amplified the impact of public expenditures on informality, emphasising the importance of managing budget deficits to address the informal economy. Wijaya & Dewi (2024), in their study of 14 G20 member countries for the period 2010-2018, examined how the informal economy and budget deficits influence tax revenues. Their findings revealed that growth in the informal economy reduced VAT revenues, while good governance helped to reduce informality and budget deficits. Çiçek and Elgin (2011), studying 78 countries from 1960 to 2007, analysed the relationship between fiscal policies, economic cycles, and the informal economy. Their findings indicated that fiscal policies in countries with larger informal economies were more pro-cyclical, with public expenditures increasing during economic expansion and decreasing during contractions. This highlights how a lack of fiscal discipline and economic uncertainty can worsen informal activities. Bello & Sanusi (2024) examined the effects of expansionary fiscal policies during economic downturns under different levels of informality in Nigeria from 2010 to 2020. Their findings revealed that, although expansionary fiscal policies helped stabilise aggregate demand in the short term, tax revenue losses from the informal sector created fiscal imbalances, threatening economic stability.

Focusing on Brazil from 2004 to 2018, Junior, Garcia-Cintado, and Usabiaga (2021) examined the relationships among public expenditures, budget deficits, and the informal economy. Their study found that the informal economy indirectly diminishes public revenues, thereby contributing to the growth of budget deficits. While reductions in public

expenditure had contractionary effects on the formal sector in the short term, they increased the likelihood of engaging in informality in the long term.

4. Data and Methodology

4.1. Data

This study empirically investigates the relationships between public expenditures, public sector deficits, and the informal economy in Türkiye. To achieve this aim, the Wavelet Coherence Analysis method is used. The econometric analysis is based on data from 1990 to 2020. The start and end points of the period were chosen according to the availability of data on the informal economy, which is the study's main variable. Annual data for the variables were utilised in the analysis.

To assess the public sector's borrowing needs, the study employs the Public Sector Borrowing Requirement (PSBR) indicator. The PSBR measures the difference between the public sector's total cash expenditures and total cash revenues. When this difference shows that expenditures surpass revenues, fiscal deficits occur. This concept captures the overall financial stance of all public sector units. An increase in the PSBR suggests that the public sector's total revenues are inadequate to cover its total expenditures, signalling a financing need (Şen et al., 2007). Accordingly, to evaluate Türkiye's fiscal position from a broader perspective, the study includes the public sector borrowing requirement as a key variable. Data on the informal economy were obtained from the World Bank (WB), total public expenditures from the Ministry of Treasury and Finance, and the public sector borrowing requirement from the Presidency of Strategy and Budget database. Table 1 provides detailed information on the variables used in the study.

Table: 1
Variable Set and Sources Employed in the Wavelet Coherence Analysis (1990-2020)

Data	Abbreviation	Source
Informal Economy	Ie	World Bank
Total Public Expenditures	Pe	Ministry of Treasury and Finance
Public Sector Borrowing Requirement	Psbr	Presidency of Strategy and Budget

Note: The logarithms of the variables, total public expenditures and public sector borrowing requirement, have been taken.

4.2. Research Methodology

Wavelet Coherence Analysis is a modern analytical method that transforms time series data or observations into wavelets, based on Fourier cycles and wavelets. It involves converting a wavelet representation of a variable into a wave function to form a primary wave, then restricting the resulting wavelets to a specific frequency and time scale. Fourier cycles translate changes, values, or observable measurements into frequencies within a designated time frame. The ability of Fourier cycles to extract frequencies forms the foundation of Wavelet Coherence Analysis (Grinsted et al., 2004: 562-564).

The Wavelet Approach, developed by Morlet, Grossman, and Meyer, enables the transformation of any variable or value into wavelet values in the time domain. Unlike

Fourier cycles, the Wavelet Approach converts wavelet values in the direction of the variable's or value's movement. During this transformation, a scale is used to constrain the cycle by setting lower and upper bounds for the frequency band. This process results in a continuous oscillation within the bandwidth, effectively producing wavelets. Consequently, continuous oscillations in time-series data can be observed alongside scale and time arguments, revealing the inherent characteristics of the variable (Combes & Grossman, 1987: 126-132). Meyer's contributions allowed this transformation to be performed for a single variable. Furthermore, to conduct simultaneous analyses of multiple variables, each variable undergoes a transformation process followed by cross-transformation. Methods such as Wavelet Coherence or Cross-Wavelet Spectrum are employed for these analyses (Rathinasamy et al., 2017: 6-10). This study used the Morlet Wave Function for the Wavelet Coherence method and transformation.

The Wavelet method offers several advantages. This approach facilitates the extraction of findings for each time segment within a cross-section, allowing the analysis of non-stationary time series without applying transformations or experiencing data loss (Uyar, 2019: 141). Additionally, it enables the examination of time series in the time and frequency domains, providing insights into previously unobservable behaviours by decomposing time series into different frequencies for scale-level analysis (Crowley, 2007: 256). This approach also allows for the consideration of non-linear relationships between variables without causing data loss. Moreover, since the approach incorporates simulations, it can generate exponential values for variables, thereby expanding the dataset and significantly improving the construction of prediction models. In this study, time series data comprising 31 observations related to the informal economy, public expenditures, and public sector borrowing requirements were simulated to a dimension of 31^{10000}, and the analysis was conducted using this dataset. By simulating variables and generating new data exponentially, the dataset achieves high dimensionality, thereby enhancing the accuracy and validity of the analysis results. Furthermore, Wavelet Coherence Analysis enables the simultaneous examination of causality, correlation, and interaction between variables.

Wavelet Coherence Analysis helps convert data into wavelet form and adds a time element to the wavelets. These applications involve several stages, outlined below:

Stage I: It involves creating the wave function. The function is given in Equation (1) (Vacha & Barunik, 2012: 242-243). In this function, m represents the scale dimension and ı denotes the time dimension.

$$\psi_{ı,m} = \frac{1}{\sqrt{m}}\psi\left(\frac{(t-1)}{m}\right), ı, m \in R, m \neq 0 \quad (1)$$

Stage II: The wave function is the primary wave function derived from the above equation. The mother wave function is transformed into Morlet wavelets. The function is shown in equations (2), (3), and (4) (Menon et al., 2013: 105).

$$WIe(ı,m)= \int_{-\infty}^{\infty} Ie_t \ \frac{1}{\sqrt{m}} \ \psi \ (\frac{(t-1)}{m})d_t \quad (2)$$

$$WPe(ı,m)= \int_{-\infty}^{\infty} Pe_t \ \frac{1}{\sqrt{m}} \ \psi \ (\frac{(t-1)}{m})d_t \quad (3)$$

$$WPsbrg(ı,m)= \int_{-\infty}^{\infty} Psbr_t \ \frac{1}{\sqrt{m}} \ \psi \ (\frac{(t-1)}{m})d_t \quad (4)$$

Stage III: In Equations 2, 3, and 4, the wavelets obtained separately for the variables are applied to the diagonal transform, and the results for the variables are then derived. The corresponding functions are shown in Equations (5) and (6).

$W_{(Ie,Pe)} = W_{Ie}(ı,m)W_{Pe}(ı,m)$ ~ for the informal economy and public expenditures

$$R^2(ı,m)= \frac{IS(m^{-1}\, W_{IePe}\,(ı,m))I^2}{S(m^{-1}IW_{Ie}\,(ı,m)I^2)S(m^{-1}IW_{Pe}\,(ı,m)I^2\,)} \sim \text{for each } R^2(ı,m) \text{ için } 0 \leq R^2(ı,m) \leq 1 \quad (5)$$

$W_{(Ie,Psbr)} = W_{Ie}(ı,m)W_{Psbr}(ı,m)$ ~ for the informal economy and public sector borrowing requirement.

$$R^2(ı,m)= \frac{IS(m^{-1}\, W_{IePsbr}\,(ı,m))I^2}{S(m^{-1}IW_{Ie}\,(ı,m)I^2)S(m^{-1}IW_{Psbr}\,(ı,m)I^2\,)} \sim \text{for each } R^2(ı,m) \text{ için } 0 \leq R^2(ı,m) \leq 1 \quad (6)$$

In Equation (5) and Equation (6), S is the wave smoothing coefficient, R^2 (ı,m) value approaching 1 indicates the dependence of the variables, and approaching 0 indicates that there is no relationship between the variables.

Stage IV: The above equations are based on square values. At this stage, negative phase values are also considered. The corresponding functions are presented in Equations (7) and (8).

$$\varphi_{IePe}\,(ı, m) = \tan^{-1}(\frac{\aleph\{S(m^{-1}W_{IePe}(ı,m))\}}{\rho\{S(m^{-1}W_{IePe}(ı,m))\}} \sim \text{for the informal economy and public expenditures} \quad (7)$$

$$\varphi_{IePsbr}\,(ı, m) = \tan^{-1}(\frac{\aleph\{S(m^{-1}W_{IePsbr}(ı,m))\}}{\rho\{S(m^{-1}W_{IePsbr}(ı,m))\}} \sim \text{for the informal economy and public sector borrowing requirement} \quad (8)$$

In Equations (7) and (8), ℵ represents visualisation, while ρ denotes the operation operator.

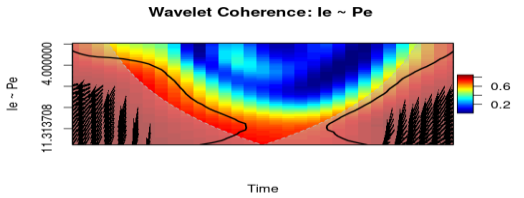
5. Findings

When the visualisation ℵ and operation operator ρ defined in the functions of the Wavelet Coherence Analysis method are executed, an image is generated. This resulting image simultaneously reveals the variables' correlation, causality, and interaction. The colour gradients in the generated image represent the interaction or relationship between the variables. In wavelet coherence graphs, a predominance of blue indicates a decrease in interaction between the two variables, while a shift towards red signifies increased interaction. The arrows in the wavelet coherence graph convey information about the

correlation and causality between the two variables. If the arrows point directly to the right at 180^0 (Π level), this indicates a perfect positive correlation between the two variables. Conversely, if the arrows point directly to the left at (Π level), this indicates a perfect negative correlation. If the arrows are directed upward at 90^0 (Π/2 level), it suggests a causal relationship from the second variable to the first. If the arrows are directed downward at 90^0 (Π/2 level), it indicates a causal relationship from the first variable to the second.

Figures 1, 2, and 3 present the results obtained from the functions described in the four stages above using the R Studio program.

Figure: 1
The Relationship Between the Informal Economy and Public Expenditure

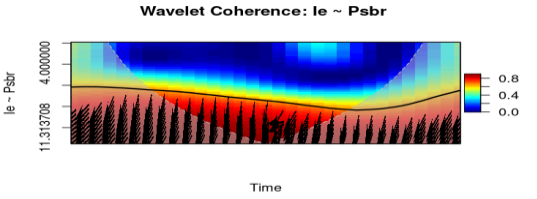


When Figure 1 is examined, it is observed that the interaction between the informal economy and public expenditures is high throughout the entire period (1990-2020). Additionally, there is an approximately -0.6 level negative correlation between the variables, and a causal relationship is identified from the informal economy to public expenditures. However, it is notable that this relationship was significantly strong between 1990 and 1996 and after 2014. Conversely, between 1996 and 2014, it was challenging to assert a causal relationship between the variables. Furthermore, during the 2000-2010 period, the interaction between the variables appears to be low. Based on the obtained data, it is determined that the increase in the informal economy in Türkiye during the 1990-1996 period and after 2014 led to a decrease in public expenditures. The blue areas in the figure indicate reduced interaction, which is primarily observed between 2000 and 2015. On the other hand, although the interaction between the variables decreased significantly in 2008, the overall interaction remained above 50%. The causality and correlation findings also support this observation.

The overall negative correlation between the informal economy and public expenditure suggests that the expansion of the informal economy reduces public spending. This finding aligns with the theoretical framework proposed by Vito Tanzi (1980, 1983), which asserts that the informal economy decreases tax revenue, leading to a reduction in public resources. A drop in tax revenue can cause difficulties in funding public services, ultimately decreasing public expenditure. The observed causal relationship between the informal economy and public spending indicates that informal economic activities directly impact public finances.

During the 1990-1996 period, there was a strong relationship: an increase in the informal economy was associated with a decrease in public expenditures. This finding aligns with the economic and political crises Türkiye experienced in the 1990s. For instance, the 1994 economic crisis significantly expanded the informal economy and exerted considerable pressure on public finances. The strong negative correlation highlights a direct relationship between public expenditures and the growth of the informal economy, clearly demonstrating the pressure on fiscal discipline caused by a shrinking tax base. The lack of a meaningful causal relationship between the variables during the 1996-2014 period suggests that the dynamics between public expenditures and the informal economy became more complex. Economic reforms and fiscal discipline efforts undertaken by Türkiye in the 2000s may have alleviated the direct impacts of the informal economy. Post-2001, IMF-supported economic programmes and tax system reforms might have limited the influence of the informal economy and contributed to greater predictability in public expenditures. Additionally, the effects of the 2008 global financial crisis could partially explain the lower interactions during this period. The resurgence of the informal economy's influence on public expenditures after 2014 is noteworthy. Increasing economic vulnerabilities in Türkiye during this period, such as exchange rate fluctuations and high inflation, may have driven an increase in informal economic activities. Consequently, this likely led to a decline in public revenues, resulting in constrained public expenditures.

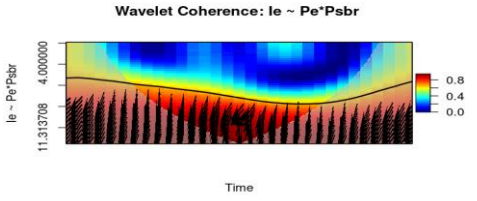
Figure: 2
The Relationship Between the Informal Economy and Public Sector Deficits



Examining Figure 2 reveals that the relationship between the informal economy and public sector deficits remains strong throughout the entire period (1990-2020). There is a negative correlation of approximately -0.45 between the variables, with causality running from the informal economy to public sector deficits. Notably, causality takes precedence over correlation, and causal links are consistent over time. When considered as a whole, the data shows that about 50% of the interaction involves a one-way causal flow from the informal economy to public sector deficits. The blue areas in the figure persist throughout the period but stay around 50%. Conversely, the red areas indicating interaction intensity confirm that causality remains continuous. Based on the data, a high level of interaction between the informal economy and public sector deficits is observed in Türkiye, with an increase in the informal economy associated with a reduction in public sector deficits. This suggests that a larger informal economy helps to constrain public sector deficits.

Reducing public sector deficits as the informal economy expands reveals a paradoxical relationship. Theoretically, the informal economy is expected to weaken public finances by shrinking the tax base. However, findings indicate that, in Türkiye, the growth of the informal economy actually decreases public sector deficits. Income generated informally may contribute to the budget indirectly through indirect taxes, producing an unexpected effect on public sector deficits, especially in developing economies. While this dynamic might stabilise public finances in the short term, it could lead to structural issues in vital areas such as income equality, social security funding, and the sustainability of public services. Therefore, this discovery highlights the importance of implementing reforms aimed at reducing the informal economy, lowering budget deficits, and balancing economic and social systems. In Türkiye's case, this relationship can be largely explained by the role of informal activities in supporting domestic demand and increasing indirect tax revenues. This situation suggests that the informal economy may have indirectly helped to balance public finances.

Figure: 3
The Relationship Between Informal Economy and Public Expenditures - Public Sector Deficits



Examining Figure 3 reveals that the relationship between the informal economy, public expenditures, and public sector deficits remains strong throughout the entire period (1990-2020). There is a negative correlation among the variables, with a causal link from the informal economy to both public expenditures and public sector deficits. The findings suggest that a rise in the informal economy leads to decreased public spending and deficits. This observation underscores the paradoxical stabilising effect of the informal economy on public finances.

From 1990 to 1996, the informal economy significantly affected public expenditure and public sector deficits. Economic crises during this time led to the growth of the informal economy, exerting considerable pressure on public finance indicators. In Türkiye, the public sector might have tried to compensate for tax revenue losses from the informal economy by borrowing during these years. However, the informal economy also appears to have indirectly stabilised public finances by allowing households and small businesses to continue their economic activities. Between 2000 and 2010, the connection between the informal economy, public expenditure, and public sector deficits weakened somewhat. Reforms after the 2001 economic crisis probably enforced fiscal discipline and partly reduced the impact

of the informal economy on public finance. Nonetheless, the informal economy still indirectly influenced public revenues during this period, leading to a decreasing trend in public sector deficits. The strengthening of the relationship between the informal economy, public expenditure, and public sector deficits after 2014 is particularly notable. This period was characterised by rising economic vulnerabilities and falling macroeconomic stability. The growth of the informal economy may have limited public revenues but also indirectly supported public finance by stimulating broader economic activity. However, this dynamic is not a sustainable long-term solution.

6. Conclusion

This study empirically explored the interactions among public expenditures, public sector deficits, and the informal economy in the Turkish economy from 1990 to 2020 using the Wavelet Coherence Analysis method. The findings revealed a negative causal relationship between the informal economy, public expenditures, and public sector deficits.

The first finding shows that the growth of the informal economy in Türkiye indirectly reduces public revenues, putting downward pressure on public spending. Structural issues, such as informal-sector workers' lack of access to social security services and their exclusion from social insurance coverage, are among the main causes of this situation. Additionally, while indirect taxes collected from the consumption of goods and services temporarily transfer income from the informal economy into public finance, this system narrows the tax base in the long run, resulting in revenue losses and vulnerabilities in the social security system. This process deprives individuals of social protection and weakens public finance over time. Similar challenges have been observed in other developing countries, where the persistence of the informal economy contributes to these issues (Sawhney, 2023; Tran et al., 2024).

The second finding is that the informal economy reduces public sector deficits. While, in theory, the informal economy is expected to decrease public revenues and increase deficits, the relationship in Türkiye has developed in the opposite direction. During the 1990s, although the informal economy caused tax losses, it served as an alternative economic activity area for households and small businesses, indirectly balancing the public sector's borrowing needs. Similarly, during economic crises, the informal economy acted as a "buffer mechanism" for impoverished individuals and small businesses, allowing them to meet their basic needs, as cited in the literature (Bello & Sanusi, 2024). However, this dynamic can potentially increase economic vulnerabilities in the long term.

The third finding shows that an increase in the informal economy decreases public spending and public sector deficits. While the informal economy is usually linked to negative effects on fiscal balance, this result suggests it might counteract these effects by lowering deficits. This indicates that, beyond its adverse impacts, the informal economy could have an indirect stabilising effect on public finances. Therefore, policies aimed at

reducing the informal economy should be approached comprehensively, taking into account their effects on public expenditure and deficit management.

In the Turkish economy, where a significant portion of public revenues derives from indirect taxes, income generated in the informal economy is reflected in these taxes through consumption, alleviating short-term pressures on public finances. However, reducing resources allocated to public services can adversely affect economic growth and social welfare. This finding aligns with the literature, as emphasised by Kamara (2024), that the informal economy may limit the effectiveness of the public expenditure multiplier.

Based on the evaluation of the findings, the following recommendations can be presented:

- Implement comprehensive structural reforms to decrease the informal economy. Policies that boost tax compliance should be introduced to motivate individuals and firms operating informally to join the formal economy.
- Redirecting public spending towards education and infrastructure could help lower the informal economy in the long run.
- Tackle corruption and reinforce the legal framework, as these are vital in reducing the informal economy.
- Reduce tax rates and streamline the tax system to motivate individuals and businesses to participate in the formal economy.
- Promote the rule of law and strengthen institutional efficiency to reduce informal activities.

Since the informal economy acts as a buffer supporting the formal economy during crises, it is crucial to develop a more resilient and sustainable public finance structure. Policy designs should focus on long-term solutions that diminish the informal economy while improving the efficiency of public finance.

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