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Dynamic Interactions Between Regional Unregistered Employment and Macroeconomic Variables in Türkiye: A Panel VAR Analysis

Türkiye'de Bölgesel Kayıt Dışı İstihdam ve Makroekonomik Değişkenler Arasındaki Karşılıklı Dinamik İlişkiler: Bir Panel VAR Analizi

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ABSTRACT

The presence of the informal economy and unregistered employment engenders adverse working conditions and job insecurity and diminishes tax revenues. Post-2000, Türkiye has placed considerable emphasis on fighting the informal economy and unregistered employment. Nevertheless, current data from the Social Security Institution reveals a 29% unregistered employment rate. Numerous factors affect the informal economy, with their impact contingent on the developmental status of economies. In Türkiye, characterized by substantial regional disparities, policymakers must account for regional heterogeneities. Within this context, an examination of the dynamic relationship between unregistered employment and key economic indicators such as growth, unemployment, and inflation in the Turkish economy is conducted using a homogeneous panel VAR model. Moreover, the study delves into gender-specific distinctions in unemployment rates and their relationship with unregistered employment. Utilizing annual data spanning 2009 to 2021 from NUTS 2 of TURKSTAT, the findings underscore the necessity for unregistered employment policies to address regional variations. Significantly, the interdependence between registered and unregistered economies underscores the guiding role of the unregistered sector within the registered economy. Hence, it is suggested that fighting unregistered employment may require a fundamental redesign of the current economic production structure to mitigate its prevalence.

Keywords: Unregistered employment, regional dynamic analysis, panel VAR

ÖZ

Kayıt dışı ekonomi ve kayıt dışı istihdam vergi gelirlerinde yarattığı azalmanın yanında çalışanlar için kötü çalışma koşulları ve güvencesiz işler sunması nedeniyle arzu edilen bir durum değildir. Türkiye'de 2000 sonrası dönemde kayıt dışı ekonomi ve kayıt dışı istihdam ile mücadeleye önem verildiği görülmektedir. Sosyal Güvenlik Kurumunun verilerine göre mevcut kayıt dışı istihdam oranı %29'dur. Kayıt dışı ekonomiyi meydana getiren pek çok faktör bulunmaktadır. Bu faktörlerinde ekonomilerin gelişmişlik durumlarına göre etkileri farklılıklar göstermektedir. Ayrıca, Türkiye gibi bölgesel farklılıkların büyük ve anlamlı olduğu ekonomilerde bölgesel heterojenliklerin dikkate alınması politika yapıcılar açısından önemlidir. Bu bağlamda bu çalışmada Türkiye ekonomisinde kayıt dışı istihdam ile ekonomik büyüme, işsizlik ve enflasyon arasındaki karşılıklı dinamik ilişkiler homojen bir panel VAR modeli ile incelenmektedir. Kadın ve erkek işsiz oranı ayrımında kayıt dışı istihdam ile olan ilişkisi de ele alınmaktadır. Çalışmada TÜİK İBBS 2 düzeyinde 2009-2021 dönemi yıllık verileri kullanılmaktadır. Elde edilen bulgular kayıt dışı istihdam politikalarının bölgesel heterojenlikler dikkate alınmasını işaret etmektedir. En önemli nokta ise kayıtlı ve kayıt dışı ekonomi arasındaki ilişkide kayıt dışı ekonominin kayıtlı ekonominin yönlendirici bir parçası haline geldiğini işaret etmesidir. Sonuç olarak, kayıt dışı istihdam ile mücadelede mevcut ekonomik üretim yapısının kayıt dışı istihdama engel olacak şekilde yeniden dizayn edilmesi gerektiği düşünülmektedir.

Anahtar Sözcükler: Kayıt dışı istihdam, bölgesel dinamik analiz, panel VAR

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INTRODUCTION

Unregistered employment, which may be observed in all economies, is a type of employment that is characterized by not being reported to or being underreported to official authorities and in which employees in this category frequently lack social security or full access to social security benefits. Moreover, it is more common in economies where control and oversight are inadequate. Unregistered employment not only adversely affects the well-being of the employees but also leads to reduced government revenue in the form of taxes and contributions, thereby potentially diminishing the quantity and quality of public services. On the contrary, it is argued that unregistered employment serves as a source of labor market absorption for unskilled workers, functioning as a buffer during periods of economic crisis. Nevertheless, it is widely accepted that the long-term socio-economic consequences of unregistered employment tend to be negative.

Employees engage in unregistered employment for a variety of reasons, which may broadly be categorized into four main factors: economic, tax system and structure, judicial, and social factors. In developed countries, it is commonly acknowledged that judicial factors play a pivotal role in driving unregistered employment. Conversely, in developing countries, economic factors are often seen as the primary driver, taking precedence over other considerations. It is important to note that unregistered employment is a dynamic variable that exerts influence on fundamental macroeconomic indicators such as unemployment rates, economic growth, and inflation.

According to Önder (2012), the proliferation of unregistered employment in the Turkish economy gained momentum after the year 1980. He contends that the prevailing political and economic conditions prior to the 2001 crisis were not conducive to effectively fighting against unregistered employment and were largely limited to mere political rhetoric. Furthermore, Önder (2012) asserts that substantial efforts were undertaken to curtail the informal economy after the year 2001. In this context, the project of the Fight Against Unregistered Employment[1] in 2006 and the Turkish Social Insurances and Universal Health Insurance Law No. 5510 in 2008 are regarded as pivotal milestones (Önder, 2012: 64-65). The rate of unregistered employment, which stood at 55.6% in 1990, averaged 50.5% during the period of 1990-2000. According to data from the Social Security Institution (SSI), it had declined to approximately 50% by 2005. By 2021, it had further decreased to 29%. While substantial progress has been made in reducing unregistered employment, it remains insufficient, as evidenced by the aforementioned trends.

Numerous variables contribute to unregistered employment and among them some of the empirical research have suggested that the development levels of countries have an impact on the structure of the unregistered economy (see Schneider, 2005; Dreher and Schneider, 2010). Moreover, the structural process of unregistered employment may vary in an economy with disparities in regional growth and development. In light of the obvious geographical disparities in Türkiye, it would be appropriate to consider regional heterogeneities in unregistered employment research.

When all of this aforementioned knowledge is considered it has been realized that there is a notable gap in the empirical literature pertaining to Türkiye, where the dynamic interplay between unregistered employment and key economic indicators such as economic growth, unemployment, and inflation, taking regional heterogeneities into account, has not been thoroughly explored. As a response to this gap, with this study, it is employed a panel Vector Autoregressive (VAR) model to investigate the mutual dynamic relationships between unregistered employment and economic

[1] It is aimed to identify and eliminate the causes of unregistered employment and foreign illegal worker employment in Türkiye and to increase registered employment through KADİM project (KADİM, 2006).

growth, unemployment, and inflation within the Turkish economy. In addition, the relationship between unregistered employment and unemployment in gender is also considered. Annual data from 2009 to 2021, obtained at the Nomenclature of Territorial Units for Statistics (NUTS) level 2 from the Turkish Statistical Institute (TURKSTAT), is used for the empirical study.

When we look at the frame of this study, in the beginning the relationship between unregistered employment and economic growth, unemployment, and inflation is discussed. After that, the empirical literature is reviewed in light of the research hypothesis, and the econometric model and variables are included in the third section, which follows. Then, econometric analysis results are reported and as finally, it has been served discussing the findings.

I- THE RELATIONSHIP BETWEEN UNREGISTERED EMPLOYMENT AND MACROECONOMIC VARIABLES

Based on the main motivation of this study, the mutually dynamic relationships between unregistered employment and main macroeconomic variables such as economic growth, unemployment, and inflation are examined in here. For this purpose, there is a wide literature investigating the relationship between economic growth, unemployment, and inflation and it is seen that the relationship between these variables is generally considered binary, such as economic growth with unemployment and unemployment with inflation. The consistent equilibrium among economic growth, unemployment, and inflation plays a pivotal role in shaping the overall trajectory of an economy. Therefore, an examination of the simultaneous interactions between economic growth, unemployment, and inflation has the potential to yield more knowledge about the overarching dynamics of an economy.

While an unregistered economy and consequently unregistered employment have existed across all economies, variations in their scale may vary from economies. Furthermore, a structural relationship arises between the registered economy, characterized by registered economic activities, and the unregistered economy. The dynamics of the formal economy are essentially influenced by the interplay between economic growth, unemployment rates, and inflation levels. The unregistered economy also maintains a relationship with economic growth, unemployment, and inflation through direct and indirect channels. Therefore, the effectiveness of policy initiatives formulated considering the registered economy is contingent upon the magnitude of the unregistered economy and the strength of this inherent linkage. Thus, the exploration of the relationship between unregistered employment, which serves as a manifestation of the informal economy, and key economic factors such as economic growth, unemployment, and inflation is important for the improvement of appropriate policies.

According to the definition of the Turkish Statistical Institute (TURKSTAT), unregistered employment refers to individuals who work without being formally registered with any social security institution.[2] The unregistered economy encompasses economic activities that either essentially go unreported or are inadequately reported to official authorities. In addition, there exists a situation of informality that is acknowledged by official authorities in the agricultural sector and small businesses, where registering household production can be challenging. Consequently, the expansion of the unregistered economy tends to lead to an uptick in unregistered employment. However, the decrease in tax and premium revenues resulting from the growth of the unregistered economy is anticipated to have a detrimental impact on economic growth due to a reduction in public expenditures (see Loayza, 1996; Cooray, Dzhumashev, and Schneider,

[2] In this context, economic activities based on crime are being assessed; nevertheless, it is worth noting that this aspect has not been considered within the scope of this study.

2017). This phenomenon varies depending on the development level of countries (see Baklouti and Boujelbene, 2020). The rationale behind this variation may be attributed to the fact that developed countries tend to experience a higher tax burden and increased bureaucratic hurdles, which can stimulate unregistered economic activities and subsequently raise the incidence of unregistered employment (Eralp, 2022: 1030). Also, as it is mentioned above, the relationship between the registered and unregistered economies can lead to a situation where growth in the registered economy contributes to an increase in unregistered employment. According to this perspective, products manufactured within the registered economy may enter the unregistered economy, potentially as consumer goods, and vice versa and an expansion of the registered economy is likely to result in a rise in unregistered employment (Ilgın, 1999: 21–22). Adam and Ginsburg (1985) and Schneider and Hametner (2014) assert that the informal economy can stimulate economic growth. As evident, the connection between economic growth and the rate of unregistered employment can fluctuate based on the underlying economic structure.

Unemployment can be defined as the difference between the labor force and employment levels. Within this conceptual framework, assuming a constant rate of job creation within an economy, the extent of unemployment is contingent upon both the growth rate and the skills of the labor force. When the growth rate of the labor force surpasses that of employment and when the labor pool lacks the requisite skilled labor force, unemployment tends to rise. It has been indicated that during periods of elevated unemployment, individuals often turn to unregistered economic activities (see Bajada and Schneider, 2009; Arsić, Arandarenko, Radulović, Ranđelović, and Janković, 2015; Mauleon and Sarda, 2017; Poufinas, Galanos, and Agiropoulos, 2021). The Fight Against Unregistered Employment project (KADİM, 2006) has stated that unemployment in the Turkish economy has an impact on the prevalence of unregistered employment. In this context, assuming a constant growth rate of employment, the unskilled labor force and accelerated growth of labor force both contribute to the proliferation of unregistered employment. Additionally, the expansion of the unregistered economy can mitigate unemployment rates as it generates opportunities for unregistered employment (see Sahnoun and Abdennadher, 2019).

The labor supply may turn to unregistered employment to increase their income due to the erosion in their real earnings during periods of high inflation in the economy. Furthermore, businesses grappling with financial difficulties resulting from increased interest rates spurred by high inflation may choose informality to navigate these challenges, potentially leading to a surge in unregistered employment. In this context, the detrimental impact of inflation on both labor supply and demand can contribute to a rise in unregistered employment (Ilgın, 1999: 25). Also, Castillo and Montoro (2012) show that the unregistered economy can mitigate the effects of demand shocks on inflation. Beyond exploring the influence of inflation within the purview of the unregistered economy and the labor market, inflation can also be employed as a fiscal instrument. Governments, to compensate for the loss of tax revenue stemming from the unregistered economy, may choose to augment existing taxes or explore new revenue streams. Consequently, inflation becomes an incentive for governments to shift their revenue sources from taxation to inflation. In this context, the escalation of the inflation rate is closely tied to the expansion of the unregistered economy (Baklouti and Boujelbene, 2019: 679–680). Mazhar and Meon (2017) have reported in their study that the unregistered economy contributes to increased inflation in both developing and developed countries. However, Baklouti and Boujelbene (2019) found that the unregistered economy has a notably positive impact on inflation, solely within the context of MENA countries within the OECD and MENA countries.

II- LITERATURE REVIEW

Owing to the inflow of income generated from unregistered economic activities into the registered economy, there is a simultaneous increase in both the registered economy and tax revenues (see Adam and Ginsburgh, 1985; Eilat and Zinnes, 2002; Bovi and Dell'Anno, 2010; Hatipoğlu and Özbek, 2011; Baklouti and Boujelbene, 2018; Medina and Schneider, 2018; Saunoris, 2018; Wu and Schneider, 2019). However, unregistered employment results in a loss of tax revenue, which can slow economic growth because fewer public expenditures are made as a result (see Loayza, 1997; Johnson, Kaufmann, and Zoido-Lobaton, 1998; Friedman, Johnson, Kaufmann, and Zoido-Lobaton, 2000; Schneider, 2010). If we considered the demonstration of Baklouti and Boujelbene (2018), which shows a bidirectional relationship between the registered and unregistered economies within developed countries, it is possible to say the direction of this relationship is not clear.

In the literature, there is a view of the impact of elevated unemployment rates on the proliferation of unregistered economic activities (Baklouti and Boujelbene, 2020: 153). However, empirical investigations by Bajada and Schneider (2009) challenge the assumption that a high prevalence of unregistered economic endeavors invariably corresponds to heightened unemployment rates. Bajada posits that a substantial portion of unregistered economic engagements are undertaken by individuals who are employed in them, thus not classified as unemployed. Moreover, the expansion of unregistered economic pursuits generates employment opportunities, subsequently contributing to a decrease in the officially recorded unemployment rate. In Germany, Dell'Anno and Solomon (2008) state an increase in the unregistered labor force from approximately 8–12% during the period spanning 1974–1982 to roughly 19–23% from 1997–1998. Parallel to this, the unregistered economy expanded from 10.6% to 14.7% during the same period, claiming this may be the cause of persistent unemployment. Individuals involved in unregistered work may also opt out due to insufficiently low wages. Furthermore, the frequency of insecure job situations and poor working conditions may discourage people from engaging in unregistered labor.

The depreciation of wages due to high inflation can propel individuals toward an unregistered economy or unregistered employment (Ilgın, 1999: 25), particularly evident in economies implementing progressive income tax structures (Yurdakul, 2008: 214). It is commonly perceived that inflation contributes to the expansion of the unregistered economy (see Canzoneri and Roger, 1991; Koreshkova, 2006; Goel and Nelson, 2016). Additionally, the empirical findings of Castillo and Montora (2012) indicate that the unregistered economy acts as a mitigating tool against inflationary pressures in the presence of demand shocks. However, Baklouti and Boujelbene (2019) reveal a bidirectional positive relationship between inflation and the unregistered economy for all sample.

Schneider (2005) demonstrates that the expansion of the unregistered economy triggers a contraction of the formal economy in developing nations while fostering growth in the formal sector within transitioning economies. Dreher and Schneider (2010) delve into the correlation between corruption and the unregistered economy, yielding divergent outcomes for high-income and low-income countries. Hence, Baklouti and Boujelbene (2020) underscore the

significance of considering economic differences when investigating the unregistered economy. This highlights the necessity of acknowledging these disparities in regional studies, particularly in contexts characterized by pronounced regional differences.

When we examine the empirical studies for Türkiye in this context, Saraç (2012) analyzed the dynamic interplay between the informal economy and unemployment in Türkiye, spanning from 2001M1 to 2011M2, employing a structural VAR model. The results of this study indicate a positive long-term influence of the informal economy on unemployment. Also, Topçu and Koç (2017) run a VAR model to demonstrate the impact of unregistered employment on the number of unemployed individuals during the period 2005M1 to 2016M8. Similarly, Bölükbaş (2018) explored the interrelation between unregistered employment, youth unemployment, and economic growth from 2010M1 to 2017M9, employing the VAR model and obtaining similar outcomes. Evidently, the informal economy and unregistered employment have an impact on the discussed macroeconomic factors.

As a result, based on all these literature review, no study has specifically delved into the dynamic interplay between unregistered employment and its impacts on economic growth, unemployment, and inflation while considering regional variations. With this motivation, the dynamic interactions between unregistered employment, economic growth, unemployment, and inflation are examined in this study within the framework of a panel VAR model that takes regional heterogeneities into account.

III- DATA AND METHODOLOGY

A- Data

The Republic of Türkiye Social Security Institution (SSI) defines unregistered employment as the situation in which individuals engaged in lawful employment fail to furnish complete or accurate information to the relevant public institutions regarding their workdays and earnings. According to the Turkish Statistical Institute's (TURKSTAT) delineation, unregistered employment pertains to individuals working without formal registration with any social security institution. It is important to note that while the definitions of unregistered employment provided by SSI and TURKSTAT exhibit disparities, they do not encompass employment activities falling under the purview of criminal economic activities. The data for the unregistered employment rate was obtained from SSI's open data sources, and it covers the years 2009 to 2021.

The vector autoregressive models (VAR) have an important role in time series analysis and especially they are frequently used to examine dynamic interactions in the econometric literature. The unregistered employment rate is available for the same time period at the NUTS 2 regional level, albeit not having the necessary number of observations for a time series analysis. As a consequence of this information, it is possible to assemble a panel dataset spanning the period from 2009 to 2021. This data characteristic leads us to utilize panel VAR analysis to investigate dynamic interactions. Unregistered employment varies according to gender, age, education, household size, firm size, and sector (see Williams and Horodnic, 2018). Within this context, male and female unemployment rates are considered in the study. Descriptions, abbreviations, and sources for variables used in the analysis are presented in Table 1.

Table 1. *Variables and Abbreviations*

Variables	Abbreviations	Source
Unregistered employment rate	UNREG	SSI
Unemployment growth rate	UNEMP	TURKSTAT
Male unemployment growth rate	MUNEMP	TURKSTAT
Female unemployment growth rate	FUNEMP	TURKSTAT
Economic growth rate	GROWTH	TURKSTAT
Inflation rate (CPI)	INF	TURKSTAT

B- Panel VAR Model

Time series vector autoregressive (VAR) models were developed by Sims (1980) as an alternative to simultaneous equation models and have been frequently used in applied macroeconometrics. VAR models have been adapted for panel data sets by Holtz-Eakin, Newey, and Rosen (1988) and have started to be used (Abrigo and Love, 2016: 778). Panel VAR models do not require determining the entire structure of the economy and can be used as an important tool to answer relevant economic problems (Canova and Ciccarelli, 2013: 3).

There are three obvious reasons behind the preference for panel VAR models: first, the variables under consideration exhibit strong interrelationships and interactions. This is articulated by encompassing all variables within the panel VAR model without imposing restrictions on them. As second reason, the panel VAR model incorporates the cross-sectional dimension, enabling the consideration of heterogeneity among units and heterogeneities become particularly significant in cases of regional economic disparities and developmental differences. Therefore, dynamic heterogeneities among regions could be identified with the panel VAR model. The third and the last reason is that the panel VAR model may capture the temporal changes in coefficients and variance of shocks (Ouyang and Li, 2018: 241).

A homogeneous panel VAR model can be written as follows.

$$y_{it} = \beta_0 + \sum_{j=1}^{p} \beta_j y_{i,t-j} + \mu_i + u_{it} \qquad (1)$$

where y_{it} represents a vector[3] of four variables [UNREG, UNEMP, GROWTH, INF]. The subscripts i indicate units, and t denotes time. $y_{i,t-j}$ denotes the lagged term of y_{it} at period j. The term μ_i accounts for unobservable unit effects, and this systematic cross-sectional heterogeneity is modeled as panel-specific fixed effects. The term u_{it} represents the error term. Given the assumption that cross-sectional units share the same data generation process, β_j is assumed to be common across units, rendering the model a homogeneous panel VAR model[4]. Within this homogeneous panel VAR model, $E(u_{i,t})=0$, $E(u'_{i,t}u_{i,t})=\Sigma$ ve $E(u'_{i,t}u_{i,s})=0$ assumptions are established for all t>s.

[3] It is for Model A. For Model B, y_{it} represents a vector of five variables [UNREG, MUNEMP, FUNEMP, GROWTH, INF].
[4] In the study, a homogeneous panel VAR model is used under the assumption that all regions within the country would respond to shocks in the same but different magnitudes.

All equations within the time series VAR model can be estimated by the Ordinary Least Squares (OLS) estimator. Nevertheless, in fixed-effect static panel data models, parameters can be estimated using the OLS method subsequent to the elimination of fixed effects through first-difference transformation. Anderson and Hsiao (1982) suggested that the model can be estimated through the OLS method following the application of first-difference transformation in dynamic panel data models. However, even if the error term is uncorrelated before the transformation, it becomes correlated post-transformation. Besides, in dynamic panel data models, due to the inclusion of a lagged dependent variable on the right side of equation, estimates exhibit bias[5] even with large sample sizes. Despite the bias converging toward zero as T increases, a notable deviation persists, even in cases of T = 30 (Abrigo and Love, 2016: 779).

In light of this, Arellano and Bond (1991) propose that running the generalized moments method (GMM) subsequent to the first-order difference transformation, known as the difference GMM. However, in the process of GMM estimator, it is assumed that the first differences of instrumental variables are uncorrelated with fixed effects. In the GMM system, this assumption is incorporated into the difference GMM estimator, thereby reinforcing its efficiency. Also, this assumption enables the utilization of more instrumental variables and significantly enhances efficiency. As the difference transformation in unbalanced panels may lead to increased gaps within the panel or the potential loss of entire unit data, (forward) orthogonal transformation is employed to eliminate unit effects (Roodman, 2009). Blundell and Bond (1998) point out an issue with GMM estimators, emphasizing their susceptibility to weak instruments when the variable being modeled is near the unit root (Abrigo and Love, 2016: 780). Therefore, it becomes imperative to investigate whether the variables within the panel VAR model have unit roots. On the other hand, determining the suitable lag length for the panel VAR model is essential. This necessitates a simultaneous assessment of the appropriateness of instrumental variables and the criteria for model selection. Andrews and Lu (2001) introduced model selection criteria for empirical studies, relying on Hansen J statistics. Once the model is identified, it becomes imperative to verify its stability. This involves ensuring that all computed eigenvalues are below one and situated within the unit circle.

As each equation within VAR models comprises p lagged values for every endogenous variable, the economic interpretation of the model is often not possible. Consequently, to conduct structural analysis within VAR models, the impulse-response function and forecast-error variance decomposition are employed.

The impulse-response function is used in VAR models to measure the response of endogenous variables to external shocks in the error term. It enables the anticipation of how other variables might react to an external shock. When considering an external shock as indicative of a policy change, such dynamics can be observed. Additionally, its magnitude can be quantified through forecast-error variance decomposition. Within this framework, graphs illustrating the impulse-response functions derived from VAR models and forecast-error variance decomposition tables are used for policy analysis. Consequently, this study explores the potential impact of an unregistered employment shock on economic growth, unemployment, and inflation using impulse-response functions and forecast-error variance decomposition. Also, it seeks to investigate the effects of shocks in economic growth, unemployment, and inflation on unregistered employment.

In analyzing the impacts of external shocks on the system, it is imperative to establish a rank among the variables within the system, prioritizing from external to internal, enabling the derivation of impulse-response functions and forecast-error variance decompositions. Various approaches exist to establish this ranking. One approach involves determining the order based on economic theory, while an alternative approach involves employing causality testing. Frequently, the Granger causality test is utilized for this purpose.

[5] In the literature, it is called Nickell bias or dynamic panel bias.

[6] It is also known as Helmert procedure/transformation.

IV- EMPIRICAL RESULTS

It is crucial to evaluate the stationarity of the variables used in panel VAR models. Panel unit root tests are run on the variables in the panel dataset in order to achieve this. Depending on whether cross-sectional dependence is taken into account, these panel unit root tests are divided into first- and second-generation categories. The selection of an appropriate test depends on whether cross-sectional dependencies exist in the variables. In this study, it is examined the presence of cross-sectional dependencies in the variables using Pesaran (2004) Cross-Sectional Dependence (CD) test. Test outcomes are given in Table 2. According to the Table 2, the null hypothesis of "there is no cross-sectional dependence" for all variables can be rejected at the 1% significance level. Therefore, it has been decided that all variables have cross-sectional dependence.

Table 2. *Pesaran (2004) CD Test*

Variable	Test stat.	p-value
UNREG	47,9110	0.0000*
UNEMP	28,3810	0.0000*
MUNEMP	28,3810	0.0000*
FUNEMP	13,0320	0.0000*
GROWTH	54,4680	0.0000*
INF	66,7210	0.0000*

Note: * Denotes statistical significance at 1% level.

Since each variable has cross-sectional dependence, it is necessary to use second-generation panel unit root tests to determine whether or not the variables are stationary. As the panel data set has a larger unit dimension than the dimension of time, the Pesaran (2007) CIPS test is used in this situation. According to the results, which are shown in Table 3, every variable shows stationarity at the level.

Table 3. *Panel Unit Root Test (CIPS)*

Variable	Without constant	Constant	Constant and trend
UNREG	-1.9720***	-2.2250**	-2.6220*
UNEMP	-3.6130***	-3.5680***	-3.4210***
MUNEMP	-3.6130***	-3.5680***	-3.4210***
FUNEMP	-3.3590***	-3.3390***	-3.5410***
GROWTH	-2.8800***	-2.8970***	-2.9120***
INF	-3.7690***	-3.8130**	-3.9910***

Note: The maximum lag length is set to four. ***, ** and * denote statistical significance at 1%, 5% and %10 levels, respectively.

The panel VAR model can be established within this information, which means cross-sectional dependency and the stationarity. This is lead us to employe two distinct panel VAR models: in the first model, referred to as Model A, it is incorporated the total unemployment variable and then in the second model, referred as Model B, it is included both male and female unemployment variables. This approach allows us to examine the gender-specific aspects of unemployment. For the estimation of these two-panel VAR models, the pvar package is used in the Stata program developed by Abrigo and Love in 2016.

The first step in the specification of the panel VAR model is to determine the appropriate lag length. For this purpose, both model selection criteria and instrument variable suitability should be evaluated together. In this regard, Table 4 presents the results of the J test statistic, its corresponding p-values, as well as information criteria such as MBIC, MAIC and MQIC.

Table 4. *Lag-Order Selection Criteria*

Model A						
Lag	CD	J	J-p value	MBIC	MAIC	MQIC
1	0,9977	58,8854	0,1348	-197,3164	-37,1145	-101,8919
2	0,9991	36,1941	0,279	-134,6071	-27,8058	-70,9907
3	0,9991	15,3045	0,5024	-70,096	-16,6954	-38,2879
Model B						
Lag	CD	J	J-p value	MBIC	MAIC	MQIC
1	0,9976	79,4308	0,3412	-320,8845	-70,5691	-171,7838
2	0,9979	47,2738	0,5834	-219,6031	-52,7262	-120,2027
3	0,9984	26,4308	0,3849	-107,0076	-23,5691	-57,3073

The null hypothesis of the Hansen J test, the instruments are valid instruments, is that the instrumental variables are valid. In Table 4, the null hypothesis is accepted for the J test at all lag lengths for both panel VAR models. Therefore, instrumental variables are valid for all lag lengths. As the lag length that gives the lowest MBIC, MAIC, and MQIC information criteria values are pointed us the first lag, the appropriate lag length is decided as one.

The stability of the panel VAR system should be investigated after determining that a lag length of one is suitable for the panel VAR model. To this end, eigenvalues and modulus are calculated for both panel VAR models, and the results are presented in Table 5 and Graphs 1a–1b. Table 5 reveals that the modulus in both models is less than one and in addition to this these graphs also show that all eigenvalues within the unit circle. Therefore, it can be concluded that the stability conditions are confirmed, and the estimated models are stable.

Table 5. *Eigenvalue Stability Condition*

Model A		
Eigenvalue		
Real	Imaginary	Modulus
0,7431	0,0000	0,7431
-0,2086	0,0000	0,2086
0,0458	-0,0738	0,0868
0,0458	0,0738	0,0868

Graph 1a

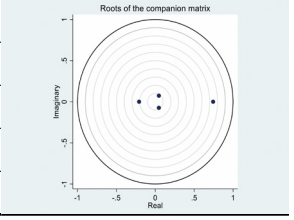
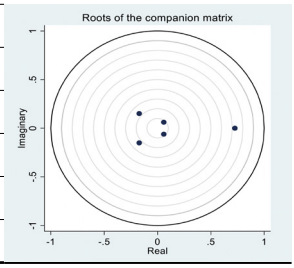


Table 5. *Eigenvalue Stability Condition (Continued)*

Model B			
Eigenvalue			Graph 1b
Real	Imaginary	Modulus	
0,7246	0,0000	0,7246	
-0,1722	-0,1506	0,2288	
-0,1722	0,1506	0,2288	
0,0584	0,0615	0,0848	
0,0584	-0,0615	0,0848	



After determining the appropriate panel VAR model, it is obtained the graphs of impulse-response functions to examining the response of one endogenous variable to the shock in another endogenous variable. For this purpose, it is necessary to impose various restrictions on variables, that is, to sort the variables from external to internal within the system. To determine this order, there are two possible approaches that can be used: the first relies on economic theory, but in this study, causality testing is used as an alternative approach. The second method is attributed to Abrigo and Love (2016) and uses the Granger panel causality test; the results of the Model A and Model B tests are shown in Tables 6 and 7, respectively.

In Table 6, while unemployment, economic growth, and inflation are not Granger causality of unregistered employment, unregistered employment is the Granger causality of economic growth and inflation.

Table 6. *Granger Causality Test for Model A*

Y ↓	X →	UNREG	UNEMP	GROWTH	INF
UNREG	chi2		0,6830	0,0300	2,2690
	p-value		0,4090	0,8620	0,1320
UNEMP	chi2	0,2200		0,2330	0,7450
	p-value	0,6390		0,6290	0,3880
GROWTH	chi2	13,2690	5,4190		0,3290
	p-value	0.0000***	0.0200**		0,5660
INF	chi2	23,9650	5,3210	3,8680	
	p-value	0.0000***	0.0210**	0.0490**	

Note: ***, ** and * denote statistical significance at 1%, 5% and %10 levels, respectively.

According to the findings in Table 7, while economic growth, male unemployment growth rate, and inflation are not Granger causality of unregistered employment, female unemployment growth rate is Granger causality of unregistered employment. Moreover, while unregistered employment is Granger causality of both economic growth and inflation, it is not Granger causality of male and female unemployment growth rates.

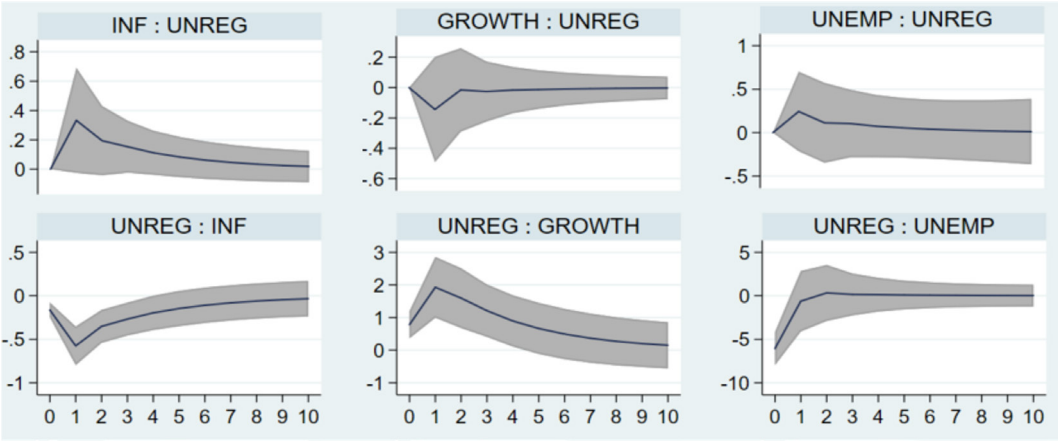
Table 7. *Granger Causality Test for Model B*

Y ↓	X →	UNREG	MUNEMP	FUNEMP	GROWTH	INF
UNREG	chi2		0,0510	4.7740**	0,2270	2,4400
	p-value		0,8210	0,0290	0,6330	0,1180
MUNEMP	chi2	0,3150		1,5140	0,1210	0,6700
	p-value	0,5750		0,2180	0,7280	0,4130
FUNEMP	chi2	0,2650	0,3400		0,1220	2,9340
	p-value	0,6070	0,5600		0,7270	0,0870
GROWTH	chi2	13.642***	5.7100**	1,1270		0,2750
	p-value	0,0000	0,0170	0,2880		0,6000
INF	chi2	24.522***	5.1960**	1,7020	3.3310*	
	p-value	0,0000	0,0230	0,1920	0,0680	

Note: ***, ** and * denote statistical significance at 1%, 5% and %10 levels, respectively.

Based on the insights derived from the Panel Granger causality test, in line with the objective of the study, the graphs of impulse-response functions (IRF) are introduced at a 90% confidence interval for a ten-year horizon. These IRF functions are provided for unregistered employment, economic growth, unemployment, and inflation for Model A in Table 8, and for Model B in Table 9.

Table 8. *Impulse-Response Functions for Model A*

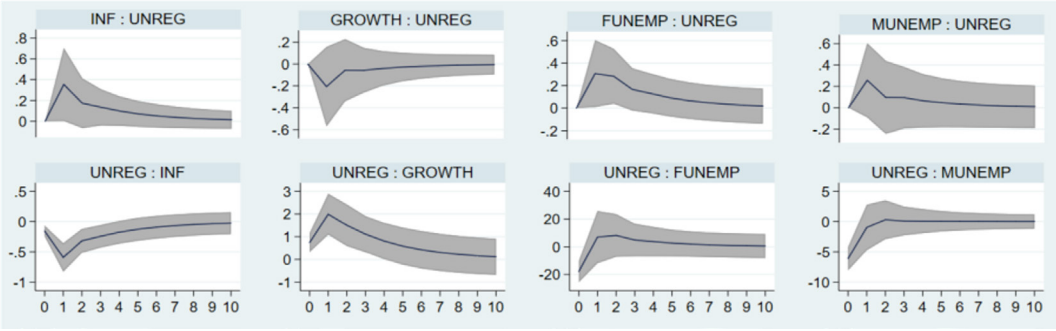


Note: Impulse: Response

Table 8 is interpreted following a sequence from the upper left corner to the lower right corner. The unregistered employment rate does not exhibit statistically significant responses to one standard deviation shock in inflation, economic growth, or the total unemployment growth rate. On the other hand, this can be taken as an evident that inflation, economic growth, and the total unemployment

growth rate do respond significantly when subjected to one standard deviation shock in the unregistered employment rate. Specifically, the inflation rate responds to changes in unregistered employment by initially decreasing to its lowest level in the first period, followed by a subsequent increase. This effect remains consistent for approximately four periods. In contrast, economic growth responds to variations in unregistered employment similarly, but in the opposite direction. As for the total unemployment growth rate, it demonstrates a response to unregistered employment with a noticeable increase, but this effect is limited to just one period.

Table 9. *Impulse-Response Functions for Model B*



Note: Impulse: Response

Table 9 is interpreted in the order from the upper left corner to the lower right corner. In this context, the unregistered employment rate does not respond statistically significantly when subjected to one standard deviation shock in the realms of inflation, economic growth, or male unemployment growth rate. However, a notable finding emerges as a statistically significant response is observed in the case of the female unemployment growth rate, particularly during the second period. Conversely, when the unregistered employment rate is subjected to a one standard deviation shock, inflation, economic growth, and both male and female unemployment exhibit statistically significant responses. Notably, it is crucial to emphasize that changes in unregistered employment not only affect the growing rate of unemployment among women, but also do so more strongly and for a longer period of time. This observation stands out as a significant discovery within the scope of our analysis.

As the next step of the analysis, forecast-error variance decomposition (FEVD) is conducted to assess the extent to which the percentage change in the variable, at the moment the shock transpired, can be accounted for by other variables. The results for Model A are given in Table 10 and the results for Model B are given in Table 11.

When the Table 10 is considered, there is no effect of any variable other than itself on unregistered employment in the first period. At the end of 10 periods, 0.9% inflation, 0.4% overall unemployment growth rate, and 0.1% economic growth explain the changes in unregistered employment. Furthermore, unregistered employment explains 40% of the changes in inflation, 33% of the changes in economic growth, and 9% of the changes in total unemployment growth rate at the end of 10 periods.

Table 10. *Variance Decomposition of Model A*

	UNREG				GROWTH	UNEMP	INF
Period	UNREG	UNEMP	GROWTH	INF	UNREG		
1	1	0	0	0	0,030937	0,097764	0,031065
2	0,987518	0,00388	0,001358	0,007242	0,178418	0,097885	0,275832
3	0,986833	0,003928	0,001144	0,008092	0,256143	0,09808	0,338457
4	0,986199	0,004148	0,001081	0,00857	0,294308	0,098139	0,369546
5	0,985945	0,004228	0,001046	0,008779	0,313601	0,09818	0,385209
6	0,985807	0,004273	0,001028	0,00889	0,323804	0,098201	0,393553
7	0,985735	0,004296	0,001019	0,008949	0,329303	0,098212	0,398057
8	0,985695	0,004309	0,001014	0,00898	0,332301	0,098219	0,400516
9	0,985674	0,004316	0,001011	0,008998	0,333945	0,098223	0,401864
10	0,985662	0,00432	0,001009	0,009007	0,334849	0,098225	0,402606

Table 11. *Variance Decomposition of Model B*

	UNREG					MUNEMP	FUNEMP	GROWTH	INF
Period	UNREG	MUNEMP	FUNEMP	GROWTH	INF	UNREG			
1	1,000000	0,000000	0,000000	0,000000	0,000000	0,100163	0,057754	0,027625	0,027865
2	0,977793	0,004462	0,006388	0,002907	0,008448	0,101175	0,065267	0,183891	0,281248
3	0,974092	0,004333	0,010033	0,002651	0,008888	0,101309	0,076124	0,251000	0,327847
4	0,972937	0,004490	0,010765	0,002630	0,009176	0,101327	0,079946	0,283324	0,353845
5	0,972279	0,004543	0,011238	0,002616	0,009322	0,101340	0,082173	0,299303	0,366415
6	0,971975	0,004568	0,011458	0,002607	0,009389	0,101348	0,083319	0,307341	0,372760
7	0,971817	0,004582	0,011571	0,002604	0,009424	0,101351	0,083918	0,311493	0,376056
8	0,971736	0,004589	0,011629	0,002602	0,009442	0,101353	0,084233	0,313651	0,377769
9	0,971693	0,004592	0,011660	0,002601	0,009452	0,101354	0,084398	0,314779	0,378665
10	0,971671	0,004594	0,011676	0,002600	0,009457	0,101355	0,084485	0,315369	0,379134

According to the Table 11, there is no effect of any variable other than itself on unregistered employment in the first period. At the end of 10 periods, 11% female unemployment growth rate, 0.9 inflation, 4% male unemployment growth rate, and 0.2% economic growth explain the changes in unregistered employment. Furthermore, unregistered employment explains 37% of the changes in inflation, 31% of the changes in economic growth, 10% of the changes in female unemployment growth rate, and 10% of the changes in male unemployment growth rate at the end of 10 periods.

CONCLUSIONS

The phenomenon of informal employment and the informal sector is present in all economies. Losses from taxes resulting from this informal economy reduce public spending and have a negative effect on the amount and quality of services provided by the government. On the other hand, unregistered employment compels individuals to toil under substandard and precarious conditions. So, both the informal economy and unregistered employment are undesirable circumstances. Türkiye has notably emphasized efforts to fight the unregistered economy in the period following 2000. As per the Social Security Institution (SSI) data, the rate of unregistered employment, previously estimated at approximately 50% in 2005, experienced a substantial decrease, declining to 29% in 2021.

In this study, the focus point is taken as the economic factors that are thought to affect unregistered employment. The variables considered are economic growth, unemployment, and inflation. It is known that there may be a bidirectional relationship between these variables and unregistered employment. In addition, the structural process of unregistered employment may differ in countries where regional growth and development levels differ, such as Türkiye. Therefore, it would be appropriate to take regional heterogeneities into account in studies on unregistered employment in Türkiye.

Based on the literature examination it has been realized that there is a gap in the empirical literature concerning Türkiye, specifically in exploring the dynamic interplay between unregistered employment and its impact on economic growth, unemployment, and inflation while accounting for regional disparities. Based on this motivation, this research investigates the dynamic interrelationships between unregistered employment and its effects on economic growth, unemployment, and inflation within the Turkish economy using a homogenous panel VAR model. Furthermore, the analysis incorporates an examination of the connection between gender distinctions in unemployment and unregistered employment. For the analysis it is used annual data from 2009 to 2021 that is obtained from the Turkish Statistical Institute (TURKSTAT) and focuses on the NUTS level 2 nomenclature of territorial units for statistics.

The findings derived from the impulse-response functions reveal that the unregistered employment rate exhibits no statistically significant response to one-standard deviation shocks in inflation, economic growth, and total and male unemployment growth rates. However, a statistically significant response is observed in the second period concerning the female unemployment growth rate. Conversely, inflation, economic growth, and unemployment demonstrate statistically significant responses to a one-standard deviation shock in the unregistered employment rate. Notably, inflation, economic growth, and both male and female unemployment growth rates

exhibit statistically significant responses to a one-standard deviation shock in the unregistered employment rate. The noteworthy observation here is the more prolonged and pronounced response of the female unemployment growth rate to unregistered employment.

According to the findings obtained from forecast-error variance decomposition, it can explain the changes in informal employment with a female unemployment growth rate of 11% at the end of 10 periods. In contrast, the influence of other variables is less than 1%. On the other hand, the effect of unregistered employment on inflation is 37% and 40%, on economic growth is 31% and 33%, and on unemployment (total, women, and men) is 10%.

As a conclusion, the complex nature of unregistered employment is also influenced by regional and sectoral effects. Therefore, addressing policies aimed at fighting unregistered employment solely through legal regulations and inspections seems inadequate due to the economic structure and geographical disparities of Türkiye. To sum up, it is advocated for the development of policies that consider the dynamic interactions between unregistered employment and key macroeconomic indicators with regional disparities.

The analysis conducted reveals that conventional policy frameworks centered on the discussed macroeconomic variables are insufficient for mitigating unregistered employment. This underscores that unregistered employment has become ingrained within the existing economic framework. Thus, rectifying this issue necessitates a restructuring of the current economic production framework to curtail unregistered employment. Notably, while shocks in unregistered employment affect the discussed macroeconomic indicators (excluding the female unemployment growth rate), shocks in these macroeconomic variables do not significantly influence unregistered employment. This observation implies that the unregistered economy now plays a driving role in the relationship between registered and unregistered sectors of the economy.

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