MAKÜ | Journal of Mehmet Akif Ersoy University
Economics and Administrative Sciences Faculty

e-ISSN: 2149-1658
Volume: 12 / Issue: 1
March, 2025
pp.: 271-292

The Relationship Between Health Expenditures and Inflation by Provinces in Türkiye: Wavelet Coherence Analysis

Hülya DİĞER[1], Umut UYAR[2]

Abstract

The aim of this study is to reveal the relationship between inflation and health expenditures in Türkiye. The relationship between inflation, and health expenditures has been frequently analyzed. Existing studies generally prefer to use classical time series analyses for investigation of relationship between inflation and health expenditures. However, these analyses fail to reveal the contagion and interdependence effects. In order to reveal these effects, Wavelet analysis is preferred in this study. In this study, health expenditure for 81 provinces of Türkiye and inflation variables (PPI and CPI) are analyzed with Wavelet coherence analysis for the period 2004-2022. Wavelet coherence analysis allows for the investigation of the contagion and interdependence effects between the variables in short-, medium- and long-term cycles. According to the findings of the study, the relationship between health expenditures and inflation variables differs in seven regions of Türkiye. Moreover, interdependence effects between health expenditures and PPI are observed in almost all provinces. On the other hand, both contagion and interdependence effects are observed between CPI.

Keywords: Health Economics, Health Policies, Health System, Wavelet Coherence Analysis.

1. Asst. Prof. Dr., Erzurum Technical University, hulya.diger@erzurum.edu.tr, https://orcid.org/0000-0002-1737-8195

2. Assoc. Prof. Dr., Pamukkale University, uuyar@pau.edu.tr, https://orcid.org/0000-0001-6217-8283

https://doi.org/10.30798/makuiibf.1505841

Article Type	Application Date	Admission Date
Research Article	June 27, 2024	March 25, 2025

To cite this article: Diğer, H., and Uyar, U. (2025). The Relationship Between Health Expenditures and Inflation by Provinces in Türkiye: Wavelet Coherence Analysis. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, *12*(1), 271-292. https://doi.org/10.30798/makuiibf.1505841

1. INTRODUCTION

Health expenditures are considered as an investment expenditure designed for individuals (Schultz, 1961). The increase in investment expenditures within health expenditures subsequently increases health services, health facilities and employment (Orhaner, 2018). In the historical background of health services in Türkiye, the research on health expenditures between 1996-1998 and the results obtained can be considered as the beginning of taking action to reduce expenditures (Kostekci, 2014). The activities carried out for health expenditures continued in the following processes, and efforts to ensure the balance between scarce resources and unlimited needs were carried out within the scope of the health system.

The recent change/transformation in the health system, including health expenditures (Health Transformation Program), is considered among the studies conducted. Within the framework of the "Health Transformation Program", the issue of financing was examined, and "General Health Insurance" was introduced (Republic of Türkiye Ministry of Health Report, 2003). In addition to general health insurance, the purchasing power of individuals for health services has increased as a result of complementary health insurance and private health insurance. This situation is a determinant of individuals' health expenditures. In this regard, there have been developments in factors such as economy, technology (RateMDs (A platform where patients share their experiences with physicians to help other patients choose a physician), PatientsLikeMe (A platform where patients with the same disease share information and experiences about their treatment)), information level and life expectancy at birth. Accordingly, the concept of the conscious patient has emerged, and this has shaped health expenditure amounts. The fact that conscious patients conduct the necessary research on health services and increase their health literacy levels in this sense can play a decisive role in health expenditures. As a matter of fact, the outputs of the "Health Literacy Survey" recently launched by the Ministry of Health in 15 thousand households support this issue (Gocumlu Calık, 2023). Therefore, many factors determine health expenditures, but especially the economic conjuncture is an important factor that determines the amount of health expenditures (Los, 2016). One of the most important indicators of the economic conjuncture is inflation. Especially for the Turkish economy, it is monitored using the producer price index (PPI) and consumer price index (CPI) variables. The relationship between health expenditures and inflation has long been studied in the economics literature (Russell, 1975; Dikmen, 2004; Hayaloglu & Bal, 2015; Teimourizad et al., 2014; Dunn et al., 2018; Kubar, 2016; Taskaya & Demirkiran, 2016; Turgut et al., 2017; Akobi et al., 2021; Ankara & Zeybek, 2021; Ilgun et al., 2023). Existing studies have generally examined the relationship between health expenditures and inflation variables using econometric methods such as time series analysis, panel data analysis, regression analysis, least squares method, co-integration analysis. Although these methods have been able to reveal the interaction between health expenditures and inflation variables, they carry important assumptions of time series

analysis (e.g. stationarity). However, these methods are not sufficient to explain a contagion or interdependence effect between health expenditures and inflation (Kangalli Uyar, 2021).

This study aims to explain the contagion and interdependence effects between health expenditure and inflation variables, unlike the existing literature. For this purpose, we use Wavelet Analysis, which allows us to analyze the co-movement of economic time series with respect to both frequency and time. In addition, in order to better understand the nature of the relationships between the variables, wavelet coherence analysis will be used, which allows us to examine how the relationships change over time according to different frequencies. Monthly health expenditure data for 81 provinces of Türkiye between 2004 and 2022 and Türkiye's PPI and CPI rates are used as the research dataset. The research findings are expected to provide outputs that will enable the interpretation of the changes in health policies and system in the short-, medium- and long-term. The findings are planned to shed light on the positive/negative consequences of these differences in policy and system.

The next section of the study presents the literature review, while the third section explains the data and methodology. The fourth section interprets the findings of the analysis and the next section discusses the results.

2. LITERATURE REVIEW

The studies in the literature on health expenditures and inflation have been conducted on various topics, target groups and methods. Russell (1975) investigated the effect of inflation on federal health expenditures. Dikmen (2004) investigated the relationship between relative price variability and inflation by expenditure groups in Türkiye. Hayaloglu and Bal (2015) investigated the relationship between health expenditures and economic growth. Teimourizad et al. (2014) investigated the health sector inflation rate and its determinants. Dunn et al. (2018) investigated health expenditures and inflation. Kubar (2016) investigated the relationship between development indicators and economic growth in less developed and developing countries. Taskaya and Demirkiran (2016) investigated the causality relationship between inflation, income and health expenditure. Turgut et al. (2017) investigated the relationship between health expenditures and inflation. Akobi et al. (2021) investigated public expenditures and inflation rate. Ankara and Zeybek (2021) investigated health expenditures and health inflation after health transformation. Ilgun et al. (2023) investigated the impact of health reform, inflation and income on health expenditures.

Studies on the relationship between inflation and health expenditures have been conducted in many countries (Russell, 1975; Dikmen, 2004; Hayaloglu & Bal, 2015; Teimourizad et al., 2014; Dunn et al., 2018; Kubar, 2016; Taskaya & Demirkiran, 2016; Turgut et al., 2017; Akobi et al., 2021; Ankara & Zeybek, 2021; Ilgun et al., 2023). According to the studies on inflation and health expenditures, inflation rate has a negative and significant effect on economic growth (Hayaloglu & Bal, 2015). Health inflation has a significant effect on general inflation. In addition, health inflation has a decreasing role

on general inflation (Ankara & Zeybek, 2021). There is a positive and significant relationship between the rate of increase in inflation and the rate of increase in health expenditures (Turgut et al., 2017). The most relevant measures of the impact of inflation on medical prices are personal health care and personal consumption expenditures (Dunn et al., 2018). Inflation rate and health expenditures positively affect economic growth in low-income countries (Kubar, 2016). There is a positive relationship between health inflation and the number of dentists (Teimourizad et al., 2014). Policies designed to reduce inflation have less impact on health sector inflation (Russell, 1975). Changes in the inflation rate have a very weak effect on the relative price change of health expenditures (Dikmen, 2004). GDP per capita has no effect on health expenditures included in GNP (Taskaya & Demirkiran, 2016). Annual inflation has no effect on health expenditures per capita (Ilgun et al., 2023). Inflation rate has a positive and significant effect on health expenditures (Akobi et al., 2021).

In studies on the relationship between health expenditures and inflation, various econometric methods such as time series analysis (Russell, 1975; Teimourizad et al., 2014; Dunn et al., 2018; Ankara & Zeybek, 2021), panel data analysis (Hayaloglu & Bal, 2015; Kubar, 2016), regression analysis (Dikmen, 2004; Turgut et al., 2017; Akobi et al., 2021), cointegration analysis (Taskaya & Demirkiran, 2016) and ARDL test (Ilgun et al., 2023) have been employed. In classical econometric methods where inflation and health expenditures are investigated, the issue of stationarity plays a decisive role. This situation causes the data to change and transform. In order to test the contagion and interdependence between variables, Wavelet analysis method is preferred in this study. Unlike previous studies, this method dynamically analyzes the relationship between health expenditures and inflation in short-, medium- and long-term economic cycles.

3. DATA AND METHODOLOGY

In accordance with the purpose of the study, Wavelet Multi-Scaling and Wavelet Coherence (WTC) were preferred among Wavelet analyses to examine the relationship between inflation variables (PPI and CPI) and health expenditures. The research will be conducted by using the health expenditures of 81 provinces and PPI and CPI rates of Türkiye. Between 2004 and 2022, monthly health expenditures are obtained from the Republic of Türkiye Ministry of Treasury and Finance dataset, while monthly inflation data for the same period are obtained from the Central Bank of the Republic of Türkiye database. The reason why the dataset starts from 2004 is that the data on health expenditures by provinces have been created since 2004. Descriptive statistics of the data set are presented in the table in Appendix-1.

Least squares estimators provide limited information about the dynamics of the relationship between economic time series indicators. For this reason, wavelet analysis has been widely used in economics for some time to further examine the dynamic relationships between economic time series indicators. Ramsey and Zhang (1997) first used wavelet analysis in economics and finance. Especially

in economic time series analysis, this method can be used to generate short-, medium- and long-term cycles. Additionally, a variety of scaling techniques can provide important information about how indicator behavior differs across business cycles. Wavelet analysis is another type of Fourier transform used in various fields of signal processing and has important applications in scientific fields such as engineering, health sciences, physics, and astronomy. The use of Wavelet analysis in economics and finance can be done by using different sub-techniques of the analysis: General Wavelet Transform, Stationary Process, Denoising, Multi-Scaling, and Coherence.

The main purpose of the wavelet multiscale technique is to achieve time series decomposition by creating a natural platform without loss of data at the highest computable probability frequency. For wavelet analysis, two basic wavelet functions can be defined: father wavelet (ϕ) and mother wavelet (ψ). The father wavelet, or scaling function, contains the low-frequency components of the original data, showing the smooth part of the data, while the mother wavelet contains the high-frequency components of the original data, thus reflecting the details of the data (Nelson, 2008; In & Kim, 2013). In other words, the father wavelet essentially represents the smooth and trend part of the signal, whereas the mother wavelets represent the detailed parts by scale (Crowley, 2007). The father and mother wavelet can be defined in Equation (1) and Equation (2) respectively:

$$\phi_{j,k}(t) = 2^{-\frac{j}{2}}\phi(2^{-j} * t - k)\,, \quad j = 1,2,\dots,J; \quad k = 0,1,\dots,2^j - 1 \tag{1}$$

$$\psi_{j,k}(t) = 2^{-\frac{j}{2}}\psi(2^{-j} * t - k)\,, \quad j = 1,2,\dots,J; \quad k = 0,1,\dots,2^j - 1 \tag{2}$$

The wavelet functions in Equations (1) and (2) depend on the scale or frequency parameter denoted by j and the location parameter denoted by k. The scale parameter controls the length of the wavelet, while the position parameter determines the position of the wavelet (Gallegati & Semmler, 2014). The scale parameter from 1 to J indicates that the time series is divided into J different time scales, where J is the highest-level time scale. ϕ(.) and ψ(.), are real-valued functions defined on the real axis (-∞,+∞) and satisfy the following normalization conditions:

$$\int_{-\infty}^{+\infty}\phi(t)dt = 1 \tag{3}$$

$$\int_{-\infty}^{+\infty}\psi(t)dt = 0 \tag{4}$$

Therefore, the time series $y(t)$ defined in $L^2(R)$ (If $\int_{-\infty}^{+\infty}y(t)^2dt<\infty$, the square of $y(t)$ is called an integrable function) can be described in terms of wavelet functions as follows:

$$y(t) = \sum_{k=0}^{2^j-1} s_{J,k}\,\phi_{J,k}(t) + \sum_{j=1}^{J}\sum_{k=0}^{2^j-1} d_{j,k}\;\psi_{j,k}(t) \tag{5}$$

In Equation (5), $s_{J,k} = \int_{-\infty}^{+\infty}y(t)\phi_{J,k}(t)dt$ and $d_{j,k} = \int_{-\infty}^{+\infty}y(t)\psi_{j,k}(t)dt$ are defined. $s_{J,k}$ is called the smoothing coefficient, and $d_{j,k}$ is called the detail coefficient. These coefficients ($s_{J,k}$, $d_{j,k}$) are usually called wavelet transform coefficients and measure the proportion of the corresponding

wavelet function in the original data. When we rearranged the Equation (5), it can be expressed as in Equation (6):

$$y(t) = S_J(t) + \sum_{j=1}^{J} D_j(t) \quad (6)$$

In Equation (6), $S_J(t)$ can be defined as $\sum_{k=0}^{2^j-1} s_{J,k}\, \phi_{J,k}(t)$, and $D_j(t)$ can me present $\sum_{k=0}^{2^j-1} d_{j,k}\, \psi_{j,k}(t)$, $j = 1,2,\ldots,J$. The expression in Equation (6) contains components of the time series decomposed into different time scales. $S_J(t)$ represents the smooth part of the data because it is the component belonging to the highest-level time scale. $D_j(t)$= $(D_1(t), D_2(t),\ldots, D_J(t))$ is the details of the data fluctuation on the time scale 2-4, 4-8, …, 2^J- 2^{J+1} respectively. Table 1 shows the time horizons used for the multi-scaling technique at different scales: annual, monthly, and daily.

Table 1. Multi-Scales for Different Time Horizons

Scales	Annually	Monthly	Daily
Scale-1 (D1)	2-4	2-4	2-4
Scale-2 (D2)	4-8	4-8	4-8
Scale-3 (D3)	8-16	8-16 (8m-1y4m)	8-16
Scale-4 (D4)	16-32	16-32 (1y4m-2y8m)	16-32 (3w1d-6w2d)
Scale-5 (D5)	32-64	32-64 (2y8m-5y4m)	32-64 (6w2d-12w4d)
Scale-6 (D6)	64-128	64-128 (5y4m-10y8m)	64-128 (12w4d-25w3d)
Scale-7 (D7)	128-256	128-256 (10y8m-21y4m)	128-256 (25w3d-51w1d)
Scale-8 (D8)	256-512	…	…

WTC analysis can be applied to examine how the relationship between two time series evolves over time according to different frequencies. With WTC analysis, all regions in time-frequency space where two time series move together or interact can be identified (Kangalli Uyar, 2021). Accordingly, it enables the calculation of the local correlation coefficient between two time series in time-frequency space. For two time series $x(t)$ and $y(t)$, the WTC measure can be defined as in Equation (7):

$$R(u,s) = \frac{\left|S\left(s^{-1}W_{xy}(u,s)\right)\right|}{S(s^{-1}|W_x(u,s)|^2)^{1/2} * S\left(s^{-1}|W_y(u,s)|^2\right)^{1/2}}, \quad (7)$$

Here, S denotes the smoothing processor at the time scales. Smoothing is a necessary operation for all time scales, without which the wavelet coherence coefficient, $R(u,s)$, would be equal to 1 for each time scale (Rua & Nunes, 2009; Vacha & Barunik, 2012). The squared expression of this coefficient is expressed as in Equation (8). The squared wavelet coherence coefficient takes values between 0 and 1: $0 \leq R^2(u,s) \leq 1$.

$$R^2(u,s) = \frac{|S\left(s^{-1}W_{xy}(u,s)\right)|^2}{S(s^{-1}|W_x(u,s)|^2)*S\left(s^{-1}|W_y(u,s)|^2\right)}, \quad (8)$$

A value of $R^2(u,s)$ close to 0 indicates that the local correlation between the two different time series is weak, while a value close to 1 indicates that it is strong (Rua & Nunes, 2009). By calculating this coefficient for different time scales, the nature of the relationship between two different economic indicators can be analyzed. A significant increase in high frequencies, especially for certain periods (e.g. crisis periods), is considered as an indicator of contagion effects, while a still strong relationship at low frequencies is interpreted as an indicator of interdependence between markets.

The outputs of the WTC analysis can be displayed as heat graphs instead of being presented as tables. The direction of the arrows in the WTC graphs provides information about the direction of the relationship between time series (Tekin et al., 2024; Tekin, 2024; Tekin & Temelli, 2024). Arrows pointing to the right indicate that the relationship between variables is positive, while arrows pointing to the left indicate that the direction of the relationship is negative. The direction of the arrows also allows us to examine the causality between the time series. Arrows pointing upwards indicate that the first time series affects the second, while arrows pointing downwards indicate that the second time series affects the first. The WTC heat plots dynamically present the relationship between variables at different time scales. Therefore, there is a need to compare the results using a benchmark. Correlation coefficients ($\rho_{X,Y}$) are calculated using Equation (9).

$$\rho_{X,Y} = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i-\bar{Y})^2}} \quad (9)$$

where, since X and Y are two random variables, they are inflation and health expenditures in the analyses.

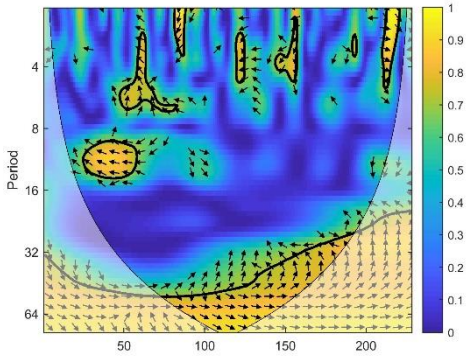
3.1. Findings

According to the results of the analysis, WTC graphs were obtained for each province to evaluate the relationship between variables in the short-, medium- and long term. While analyzing the findings, the WTC graph of one province representing each region was evaluated. Graphs for other provinces are presented in Appendix-2. Considering that the time period of the study was 2004-2021, the provinces representing the regions were determined by considering the number of primary, secondary and tertiary applications in 2021 for each province. According to the statistics of the Ministry of Health for 2021, Istanbul represents the Marmara Region; Samsun represents the Black Sea Region; Izmir represents the Aegean Region; Adana represents the Mediterranean Region (Mersin province could not be included in the evaluation since there is no data in the relevant statistical yearbook); Gaziantep represents the Southeastern Anatolia Region; Van represents the Eastern Anatolia Region; and Ankara represents the Central Anatolia Region (Republic of Türkiye Ministry of Health Ministry of Health Report, 2021). The reason for conducting the analysis over seven provinces representing seven regions is that each region has its own geographical and demographic characteristics. Different structural

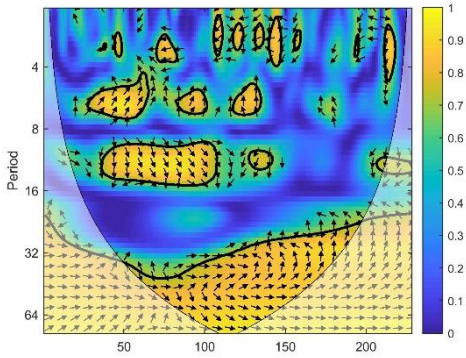
characteristics may lead to different types of diseases and different levels of health expenditure. For instance, Mediterranean anemia and skin cancer, which are common in the Aegean and Mediterranean regions, do not occur with the same frequency in the Black Sea region. Likewise, due to the Chernobyl disaster, cancer diseases that are common in the Black Sea region may be less common in other regions. This situation causes differences in health expenditures. WTC results for these provinces are shown in Figure 1.

Figure 1. The Results of Wavelet Coherence (The 50th, 100th, 150th and 200th observations on the horizontal axis in the graphs refer to February 2008, April 2012, June 2016 and August 2020, respectively)

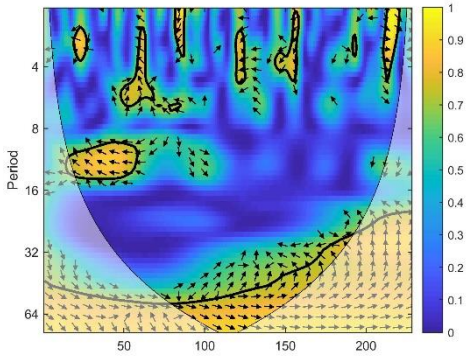
Istanbul Health Expenditures and PPI Relationship



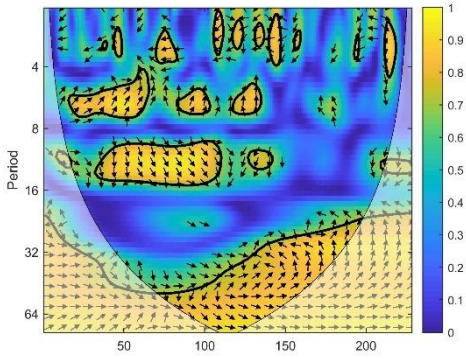
Istanbul Health Expenditures and CPI Relationship



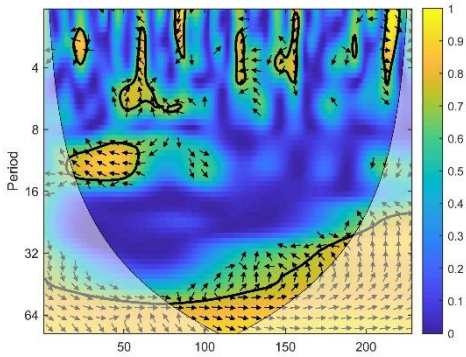
Samsun Health Expenditures and PPI Relationship



Samsun Health Expenditures and CPI Relationship



Izmir Health Expenditures and PPI Relationship



Izmir Health Expenditures and CPI Relationship

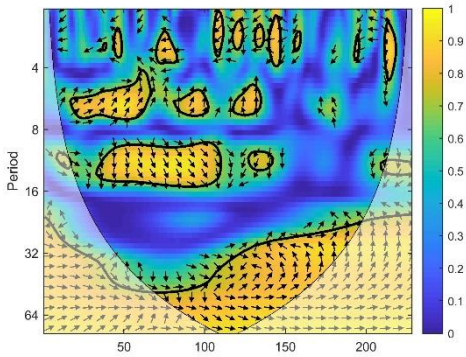
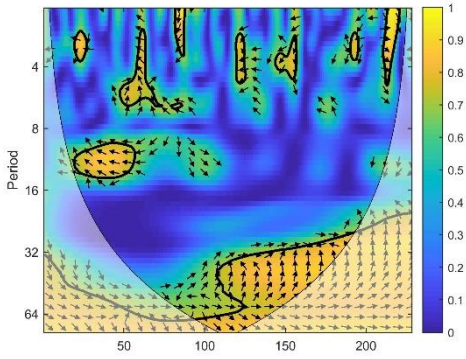
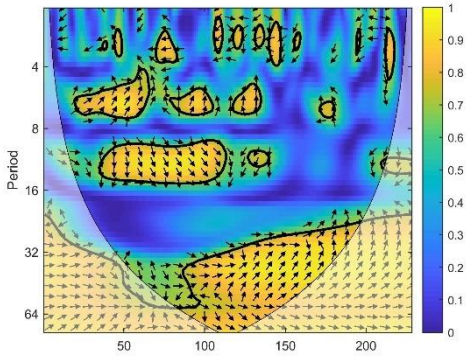


Figure 1 (cont.)

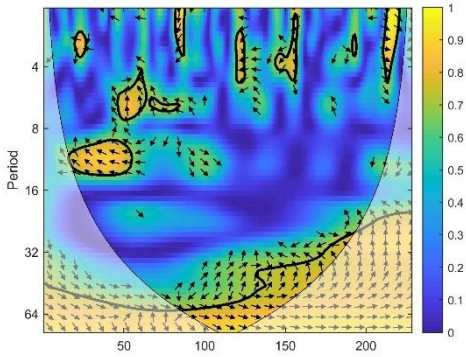
Adana Health Expenditures and PPI Relationship



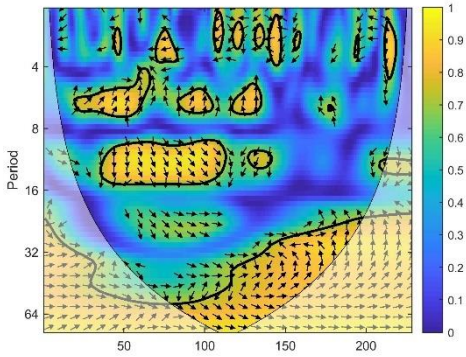
Adana Health Expenditures and CPI Relationship



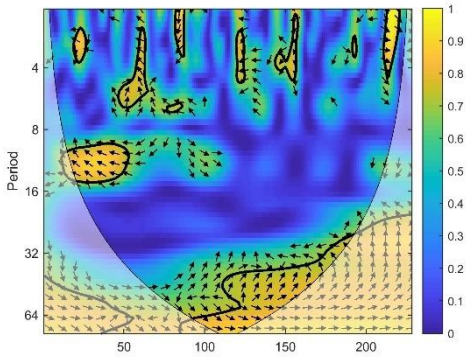
Gaziantep Health Expenditures and PPI Relationship



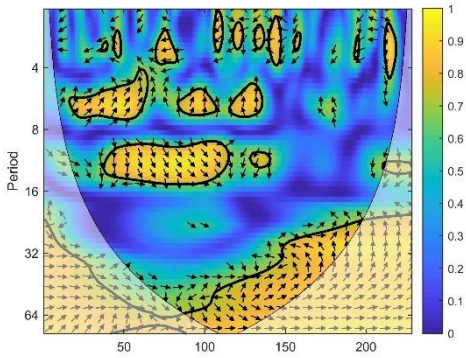
Gaziantep Health Expenditures and CPI Relationship



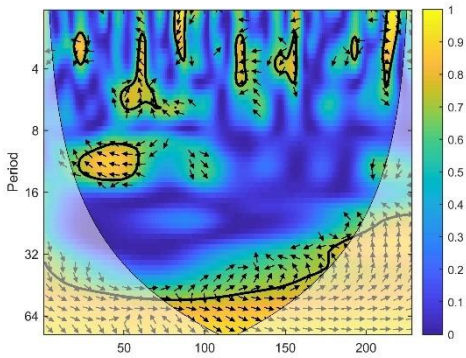
Van Health Expenditures and PPI Relationship



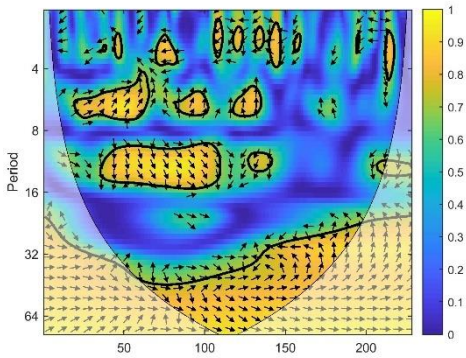
Van Health Expenditures and CPI Relationship



Ankara Health Expenditures and PPI Relationship



Ankara Health Expenditures and CPI Relationship



In Figure 1, the relationship between health expenditures and inflation variables (PPI and CPI) for provinces representing seven different regions is presented using WTC heat graphs. Based on the studies of Gencay et al. (2005), and Torrence and Compo (1998), Wavelet Multi-Scaling and WTC techniques are used in the analyses and the relationship directions and causality links are analyzed at five different scales. D1 and D2 scales are interpreted as short-term, D3 and D4 scales as medium-term, and D5 scales as long-term cycles (or relationships). The faded area outside the u-shape in the WTC graphs represents the region that cannot be interpreted. This region represents the area where there are not enough observations to complete the Wavelet cycles and is excluded from interpretation. The areas delimited by solid lines indicate statistically significant regions. Moreover, arrows pointing to the right indicate that the relationship between the variables is positive, while arrows pointing to the left indicate that the direction of the relationship is negative. On the other hand, arrows pointing upwards indicate that health expenditures affect the inflation variable, while arrows pointing downwards indicate the opposite effect.

When the graphs showing the relationship between health expenditures and PPI are analyzed, it is observed that the results are quite weak for all provinces in short-term economic cycles and cannot be interpreted clearly. In the medium-term economic cycles, a negative correlation is observed between May 2006 and May 2008. The direction of the arrows is mostly upward in statistically significant areas. This implies that there is a causality relationship from health expenditures to PPI. An increase in health expenditures in the period leads to a decrease in PPI, which is an indicator of inflation in producer input prices. This finding may be related to the transformations in the health system in the relevant years. As of 2006, the family medicine system came into effect in Türkiye and accordingly, access to health services became easier. In 2007, according to the Social Security Institution Health Implementation Statement published in 2007, co-payments for examinations and medication were collected from individuals (The Official Gazette Türkiye, 2007). These differences in the health system support the relationship between health expenditures and PPI. An analysis of long-term economic cycles reveals different results across provinces. While no significant relationship is observed for Samsun, Izmir and Ankara in the long-run cycles, a positive correlation is found for Istanbul starting from July 2015, Adana and Van from January 2013 and Gaziantep from September 2014. The causality direction of the relationship is from health expenditures to PPI as in medium-term cycles. The fact that the provinces in the findings are located in different regions of Türkiye leads to a higher prevalence of different diseases. On the other hand, socio-demographic and socio-economic factors, lifestyle, culture, and health literacy also determine individuals' use of health services. This situation takes on a determining role in health expenditures.

When the graphs showing the relationship between health expenditures and CPI are analyzed, short-term relationships can be detected in short-term cycles in all provinces between 2010 and 2015. The sign of these relationships is negative, and the direction is from CPI to health expenditures. It can

be interpreted that an increase in the CPI leads to short-term decreases in health expenditures. It is thought that this finding may be related to the correct management of the health service process of individuals. In this context, the contributions of family physicians in managing the health service process of individuals and their guidance to them are important. Therefore, unnecessary waste of time and cost can be prevented through the patient who can manage/direct the health service process correctly. This has an important role in reducing health expenditures. When the medium-term cycles are analyzed, there is a positive relationship between the variables between 2008 and 2012 for all provinces. The direction of causality is from CPI to health expenditures. It is observed that increases in the CPI within the 8–16-month cycle periods increase health expenditures on a provincial basis. This relationship is not sustained in any province after 2012 in the analyzed data period. It is predicted that the developments in the Turkish health system may explain the relationship between the variables in the medium-term cycles. Accordingly, the signing of agreements between the Social Security Institution and private hospitals in 2010, the closure of the Hygiene Institutes in 2011 and the importation of vaccines, the establishment of the Public Hospitals Union in 2011 and its closure in 2017, and the transition to General Health Insurance in 2012 may be the reason for the positive relationship between CPI and health expenditures. When long-term cycles are analyzed, a positive-sign relationship from health expenditures to CPI is observed for all provinces. The reversal of the relationship from CPI to health expenditures in short- and medium-term cycles to the opposite in long-term cycles is a noteworthy finding. This finding, which is interpreted as health expenditures increasing inflation in long-term economic cycles, is important for policymakers. It is thought that the difference between the cycle periods, especially in the long-term period, may be related to the period 2004-2022, when the study data were collected. Factors such as city hospitals, public hospital unions, family medicine, general health insurance, health literacy level, digital hospitals, differentiation of health perception, information sharing from online platforms for health services, etc., especially the "Health Transformation Program" that came into force as of 2003, which has been experienced in the Turkish health system between these years, may assume a determining role on the general results obtained regarding the variables.

The starting points of the long-term loop relationship vary across regions. For Samsun, Izmir, Adana and Van provinces, there is a continuous relationship starting after April 2012, while for Istanbul there is a continuous relationship starting after July 2010, for Gaziantep after November 2013 and for Ankara after July 2015. This long-term cyclical relationship can be explained by significant changes in the Turkish Health System. In 2011, the era of "Contracted Management" began and managers' salaries were paid from the revolving fund. In 2012, the General Health Insurance system was introduced in Türkiye. General health insurance is a system in which all citizens are covered by health insurance against the risk of disease, regardless of their economic power and will. In 2016, with the establishment of city hospitals, supply elements in health services were increased. The increase in the number of hospitals, beds and personnel also played a role in increasing health expenditures. In 2012, a pilot

scheme for digital hospitals was launched in Ankara. In this regard, the digital/paperless hospital project entered into force. After the effective date of these practices, a positive causality relationship emerges from health expenditures to the inflation variable in long-term economic cycles.

The start of the long-term economic cycle relationship in Istanbul in 2010 can be explained by other structural changes. Istanbul has both the largest population and the highest population density in Türkiye. With its dense population, Istanbul is an attractive location for health tourism. In addition, joint disorders are more common in the metropolitan city than in other regions. There are a total of 10 mental health and illness hospitals in Türkiye, which serve as separate specialty hospitals. There are only two of these hospitals in Istanbul (Bakirkoy Prof. Dr. Mazhar Osman Mental Health and Neurological Diseases Training and Research Hospital and Erenkoy Mental and Neurological Diseases Training and Research Hospital). Therefore, in the referral system, Istanbul's health expenditures increase in mental health services as well as in other areas of health services.

Overall, the findings suggest that there are dynamic correlations between inflation variables and health expenditures in the short, medium and long run. This finding, which is in line with the theoretical expectation, has different relationship directions in different cycles. Moreover, the cycles and directions of the relationship vary across the seven different regions of Türkiye.

4. CONCLUSION

Health services are a type of service whose supply and demand are realized simultaneously, cannot be postponed and cannot be stocked. Expenditures and financing constitute the basis of health services, which have different characteristics. The fact that health expenditures continue to increase day by day is a common denominator of countries globally. In this framework, health systems, especially the level of development of countries, play an important role in shaping expenditures. In this respect, health expenditures are tried to be managed in the desired way by preventing waste in services. To save time and cost, health services are evaluated under three headings: preventive, curative, and rehabilitative health services (Tengilimoglu, 2012). In 2003, Türkiye experienced a transformation in order to solve the problems experienced in health services and the “Health Transformation Program” came into force. In line with the relevant program, many changes have occurred in health services. These changes have enabled similar practices (number of hospitals, family medicine model, public hospitals union, health financing, etc.) to be implemented in Türkiye. As a matter of fact, in Türkiye's health system, this situation is supported by the decision of "effective, gradual referral chain" within the framework of the Health Transformation Program that started to be implemented in 2003 (Akdag, 2008).

In the economics literature, there are many studies on the differences in Türkiye’s health system and the desired management of health expenditures. The findings of each study and the path that it subsequently shows play an important role in ensuring improvements and progress in the health system. However, the methods used in the studies are important in terms of the results to be obtained. Especially,

there are many studies that examine the relationship between health expenditures and inflation. These studies mostly use time series analysis, panel data analysis, regression analysis, least squares method, co-integration analysis. Each econometric analysis serves different purposes and examines the relationship from a different perspective. However, these methods fail to reveal the contagion and interdependence effects between health expenditures and inflation. Contagion refers to the temporary strengthening of economic linkages after a shock to the economy. Interdependence, on the other hand, refers to long-lasting strong linkages between variables that exist before and after any crisis or structural change. The existence of contagion and/or interdependence effects between health expenditures and inflation means providing important information to policy makers who aim to save time and cost in the health system.

In this study, the relationship between health expenditures and inflation is tested with the help of Wavelet coherence analysis for 81 provinces of Türkiye for the period 2004-2022. Yet, for the sake of clarity, one province from each of the seven regions of Türkiye was selected and analyzed in detail. Wavelet coherence analysis is an analysis that allows the examination of mutual relations without the need to apply any transformation to the time series. It allows to analyze the relationships in short-, medium-, and long-term cycles. The findings of the Wavelet coherence analysis allow to reveal and interpret the favorable and unfavorable results of the implementations in the Turkish health system for the analyzed time interval. When the results of the study are evaluated, it is determined that the relationship between health expenditures and inflation variables differs in the short, medium and long run in seven regions of Türkiye. The result obtained is similar to the results of the studies in the literature (Hayaloglu & Bal, 2015; Ankara & Zeybek, 2021; Turgut et. al, 2017; Dunn et. al, 2018; Teimourizad et. al, 2014; Russell, 1975; Dikmen, 2004; Taskaya & Demirkiran, 2016; Ilgun et. al, 2023; Akobi et. al, 2021). This finding supports the variables such as geography, culture, lifestyle and economic status as well as differences in diseases, disease risks and health literacy across regions. Interdependence effects between health expenditures and PPI are observed in almost all provinces, however, both contagion and interdependence effects are observed between CPI. In particular, while there is a negative relationship from health expenditures to PPI in the medium term between May 2006 and May 2008, there is a positive relationship in the long term from January 2013 for Adana and Van, September 2014 for Gaziantep and July 2015 for Istanbul. This result supports some studies in the literature (Hayaloglu & Bal, 2015). However, it is not equivalent to some studies (Ankara & Zeybek, 2021; Kubar, 2016; Akobi et. Al, 2021). While there is a negative relationship from CPI to health expenditures in the short run between 2010-2015, there is a positive relationship in the medium run between 2008-2012 for all provinces. In the long run, there is a relationship from health expenditures to CPI. The significant relationship between the variables is also supported by the studies in the literature (Hayaloglu & Bal, 2015; Ankara & Zeybek, 2021; Teimourizad et.al, 2014; Akobi et al. 2021). In the long run, the relationship between variables differs across regions. There is a continuous relationship in Istanbul as

of July 2010; in Samsun, Izmir, Adana and Van as of April 2012; in Gaziantep as of November 2013; and in Ankara as of July 2015.

Differences between regions in the relationship between health expenditures and PPI reveal the role of PPI on health expenditures. On the other hand, the differences between provinces support the fact that the policies designed for the effective management of health services and the improvements made in the system cannot achieve the expected results in the same manner in each region. Therefore, it is believed that the results determined for the provinces representing the seven regions will be instructive for policy makers. Furthermore, the results obtained between health expenditures and the CPI provide a general framework for interpreting the changes and transformations in the Turkish health system. Particularly, it is observed that the services that were introduced at certain dates, especially in the area of health financing, and which are now being implemented in the health system in that way, have a different impact on each province, especially in long-term cycles. This makes it possible to monitor the positive/negative results of the practices in the system that differentiate services, together with the differences between regions. In line with the results obtained in this respect, it is envisaged that improvements can be made in the system by examining the health systems of other countries.

Based on the results obtained in the study, the following suggestions can be made for future studies:

- The health literacy level of each province/region can be determined and its role in health expenditures can be analyzed.
- Studies on the relationship between health expenditures and inflation can be conducted comparatively before and after the pandemic.
- Comparative evaluations can be made with countries with similar health policies in terms of health financing.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

REFERENCES

Akdag, R. (2008). *Türkiye saglikta dönüşüm programı ilerleme raporu.* Turkish Republic Ministry of Health.

Akobi, K. C., Umeora, C. E., & Atueyi, C. L. (2021). Government expenditure and inflation rate in Nigeria. *International Journal of Business Systems and Economics*, *13*(4), 276-293.

Ankara, H. G., & Zeybek, D. O. (2021). Saglikta donusum sonrasi saglik harcamalari ve saglik enflasyonu: Zaman serisi analizleri. *Suleyman Demirel Universitesi Vizyoner Dergisi*, *12*(32), 1078-1093. https://doi.org/10.21076/vizyoner.808283

Crowley, P. M. (2007), A guide to wavelets for economists. *Journal of Economic Surveys*, *21*(2), 207-267.

Dikmen, N. (2004). Türkiye'de harcama gruplarina gore nispi fiyat degiskenligi ve enflasyon iliskisinin ekonometrik analizi. *Trakya Universitesi Sosyal Bilimler Dergisi*, *6*(2), 46-56.

Dunn, A., Grosse, S. D., & Zuvekas, S. H. (2018). Adjusting health expenditures for inflation: A review of measures for health services research in the United States. *Health Services Research*, *53*(1), 175-196. https://doi.org/10.1111/1475-6773.12612

Gallegati, M., & Semmler, W. (2014). *Wavelet applications in economics and finance*. Springer.

Gencay, R. F., & Selçuk, B. Whitcher (2005). Multiscale systematic risk. *Journal of International Money and Finance*, 24, 55–70.

Gocumlu Calık, B. (2023, March 10). *Saglik okuryazarlığı araştırması.* AA. https://www.aa.com.tr/tr/saglik/15-binden-fazla-hanede-saglik-okuryazarligi-arastirmasi-baslatildi-/3070928

Hayaloglu, P., & Bal, H. C. (2015). Ust orta gelirli ulkelerde saglik harcamalari ve ekonomik buyume iliskisi. *Isletme Ve Iktisat Calismalari Dergisi*, *3*(2), 35-44.

Ilgun, G., Konca, M., & Sonmez, S. (2023). The relationship between the health transformation program and health expenditures: Evidence from an autoregressive distributed lag testing approach. *Value in Health Regional Issues*, *38*, 101-108. https://doi.org/10.1016/j.vhri.2023.08.003

In, F., & Kim, S. (2013). *An introduction to Wavelet Theory in finance: A Wavelet multiscale approach.* World Scientific.

Kangalli Uyar, S. G. (2021). Uluslararasi döviz piyasalarinda finansal bulaşicilik ve karşilikli bağimlilik: Wavelet uyum analizi. *Finans Politik ve Ekonomik Yorumlar Dergisi*, (656), 115-147.

Kostekci, A. (2014). *Türkiye'de saglik hizmetlerinin sunumunda kamu ve ozel sektor ortakliginin analizi.* [Unpublished Master's Thesis]. Dumlupinar Universitesi Sosyal Bilimler Enstitusu.

Kubar, Y. (2016). Az gelismis ve gelismekte olan ulkelerin kalkinma gostergeleri ile ekonomik buyume arasindaki iliski: Bir panel veri analizi (1995-2010). *Ardahan Universitesi Iktisadi Ve Idari Bilimler Fakultesi Dergisi*, *2*(4), 65-99.

Los, N. (2016). Saglık ekonomisi çerçevesinde saglık hizmetleri ve sağlık harcamalarının karşılaştırmalı analizi: OECD ülkeleri ve Türkiye örneği. [Unpublished Doctoral Thesis]. Istanbul Üniversitesi Sosyal Bilimler Enstitusu.

The Official Gazette. (2007, May 25). *Sosyal guvenlik kurumu saglik uygulama tebligi.* Number: 26532.

Torrence, C., & Compo, G. P. (1998). A practical guide to wavelet analysis. *Bulletin of the American Meteorological society*, *79*(1), 61-78. https://doi.org/10.1175/1520

Orhaner, E. (2018). *Türkiye'de sağlık sigortası.* Siyasal Kitabevi.

Ramsey, J. B., & Zhang, Z. (1997). The analysis of foreign exchange data using waveform dictionaries. *Journal of Empirical Finance*, *4*(4), 341-372. https://doi.org/10.1016/S0927-5398(96)00013-8

Republic of Türkiye Ministry of Health Ministry of Health Report (2021). *Saglik istatistikleri yilligi*. Ministry of Health. https://dosyasb.saglik.gov.tr/Eklenti/45316/0/siy2021-turkcepdf.pdf

Republic of Türkiye Ministry of Health Report (2003). *Saglikta donusum raporu*. Ministry of Health.

Rua, A. & Nunes L. N. (2009). International comovement of stock market returns: A wavelet analysis. *Journal of Empirical Finance*, *16*(4), 632-639.

Russell, L. B. (1975). The effects of inflation on federal health spending. *Medical Care*, *13*(9), 713-721. https://doi.org/10.1097/00005650-197509000-00001

Schultz, T. W. (1961). Investment in human capital. *The American Economic Review*, *51*(1), 1-17.

Taskaya, S., & Demirkiran, M. (2016). Enflasyon, gelir ve saglik harcamasi arasindaki nedensellik iliskisi. *Taf Preventive Medicine Bulletin*, *15*(2), 127-131.

Teimourizad, A., Hadian, M., Rezaei, S. & Rad, E. H. (2014). Health sector inflation rate and its determinants in Iran: A longitudinal study (1995–2008). *Iranian Journal of Public Health*, *43*(11), 1537-1543.

Tengilimoglu, D. (2012). *Sağlık Hizmetleri pazarlaması.* Siyasal Kitabevi.

Tekin, B., & Temelli, F. (2024). The credit volume and its relations with money supply in Turkey: The Bai-Perron and Wavelet coherence analysis. *Ekonomski pregled, 75*(5), 363-379. https://doi.org/10.32910/ep.75.5.1

Tekin, B. (2024). Structural breaks and co-movements of Bitcoin and Ethereum: Evidence from the COVID-19 pandemic period. *Journal of Central Banking Theory and Practice*, *13*(2), 41-70. https://doi.org/10.2478/jcbtp-2024-0012

Tekin, B., Temelli, F., & Dirir, S. A. (2024). Co-movement of bitcoin and gold, USD, oil, VIX: Evidence of wavelet coherence and DCC-GARCH from the pandemic period. *Serbian Journal of Management*, *19*(2), 243-273. https://doi.org/10.5937/sjm19-45753

Turgut, M., Agirbas, I., & Aldogan, U. (2017). Relationship between health expenditure and inflation in Turkey. *Akademik Sosyal Arastirmalar Dergisi*, *5*(50), 289-299.

Vacha, L., & Barunik, J. (2012). Co-movement of energy commodities revisited: Evidence from wavelet coherence analysis. *Energy Economics*, *34*(1), 241-247. https://doi.org/10.1016/j.eneco.2011.10.007

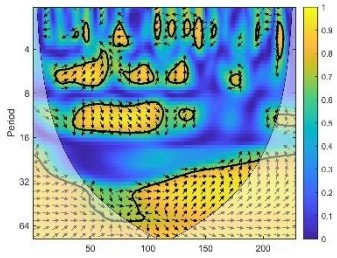
Appendix 1. Descriptive Statistics of Variables

Variable	Mean	St. Dev.	Min.	Max.
TUFE	0, 010608	0,015482	-0,0144	0,1358
UFE	0,01344	0,023978	-0,0354	0,1908
Adana	549160,8	777334,5	10278	5192185
Adıyaman	140057	160867	2922	1182198
Afyon	140444,1	170207,6	4336	1238551
Agri	88290,87	102875,9	1187	772977,3
Aksaray	71873,03	92596,59	1909	678407
Amasya	84051,21	97219,74	2750	707411
Ankara	1523655	2375624	26748	1,78E+07
Antalya	365293,4	463567,6	10557	3330126
Ardahan	27305,25	33761,96	551	237645,5
Artvin	49638,75	58010,45	1981	420500,3
Aydin	209128,6	257447,8	6541	1867791
Balikesir	231225,5	292300,9	7090	2090870
Bartin	39792,45	48771,02	1069	353599,6
Batman	113001	145138,1	825	1058764
Bayburt	26770,29	35645,54	597	245877,8
Bilecik	55701,58	93922,88	746	625221
Bingol	76463,15	89610,54	1615	656359,9
Bitlis	79236,25	98527,98	1150	722003,7
Bolu	72146,27	91308,48	2447	659004,5
Burdur	71257,83	95447,93	2473	761646,3
Bursa	522106,5	812112,5	7445	5548699
Canakkale	117629,6	15898,4	3244	1170277
Cankiri	46657,36	58231,15	1725	432905,9
Corum	122698,1	145130,7	3633	1067232
Denizli	185483,5	233242,1	4707	1737677
Diyarbakir	329453,9	383935,8	6391	2847918
Duzce	64918,76	84253,41	1424	616135,7
Edirne	98416,74	120152,3	3118	865937,8
Elazig	240785,8	363798,7	4344	2363090
Erzincan	61219,35	78084,99	1648	567509,9
Erzurum	230898,9	270169,6	4228	1943168
Eskisehir	268924,7	422969,2	5219	2722440
Gaziantep	273357,9	350801,9	3620	2535007
Giresun	110825	141460,4	3769	1048154
Gumushane	40972,93	52599,36	1262	407796,5
Hakkari	57878,11	70642,06	921	548016,9
Hatay	238355,2	303343,5	3160	2212885
Igdir	37934,52	44857,55	699	329430,6
Isparta	200792,1	290024,6	4805	1849268
Istanbul	2060082	3186608	37893	2,29E+07
Izmir	753475,3	905596,5	25560	6677298
Kahramanmaras	218693,9	252168	2757	1791926
Karabuk	56380,87	70796,52	1534	511049,5
Karaman	51214,42	66498,79	1221	489039,7
Kars	65533,79	80113,72	1014	578154,2
Kastamonu	84581,16	100629,1	2852	731242,8
Kayseri	384346,4	659721,4	6680	4391263
Kirikkale	77458,19	85387,58	2982	629897,3
Kirklareli	71827,5	149552,5	1805	1901593
Kirsehir	59353,05	72575,37	1369	531935,4
Kilis	39843,19	60860,74	567	468207,7
Kocaeli	254565,1	341829,4	5155	2447419
Konya	469815	731203,3	8917	5143339
Kutahya	113409,2	140611	2857	1007813
Malatya	200607	237479,2	3969	1736869
Manisa	308100,5	436971,5	6556	2940877

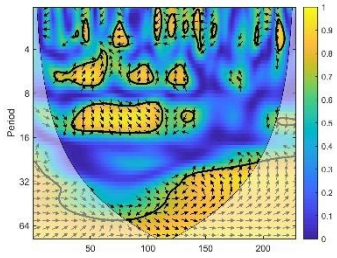
Mardin	142473,8	182182,9	2452	1340710
Mersin	444440,8	624906,1	6566	4138135
Mugla	159388,1	202622,7	5774	1477731
Mus	76282,72	88256,69	1000	643993,7
Nevsehir	62300,65	75414,68	2185	548950,3
Nigde	72083,59	85973,98	2184	633860,4
Ordu	150035,6	182898,5	4383	1336605
Osmaniye	96385,17	118042	2778	900004,4
Rize	74710,74	91886,68	1770	671485,6
Sakarya	147988,2	208406,5	3315	1513310
Samsun	294060,2	355386	9450	2623097
Siirt	677727,78	83009,6	1281	607978,4
Sinop	55140,06	69513,41	1708	505226,9
Sivas	162474,6	209958,7	3309	1557767
Sirnak	84363	112062,3	771	837656,2
Tekirdag	159312,3	267450,1	3142	1878278
Tokat	146141,6	164920,7	4263	1204339
Trabzon	212432,5	254785,2	6919	1865589
Tunceli	31772,24	39131,35	106	292609,7
Urfa	287483,1	368949,8	3428	2661606
Usak	75445,2	91759,18	2472	668160,5
Van	209342,2	243539,8	2907	1775728
Yalova	44207,91	61141,96	961	446380,4
Yozgat	153054	212641,8	2423	1371842
Zonguldak	116233,3	137881,5	2648	999819,6

Appendix 2. Health Expenditure and TUFE Relationship WTC Results for All Provinces of Türkiye

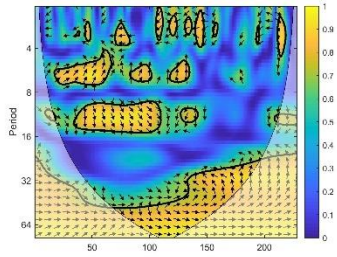
Adana



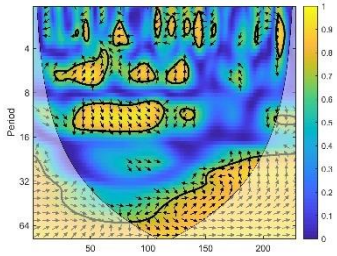
Adiyaman



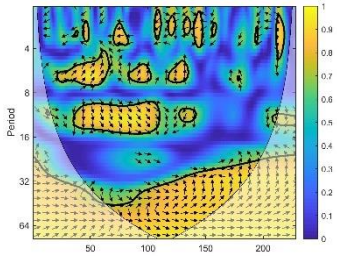
Afyon



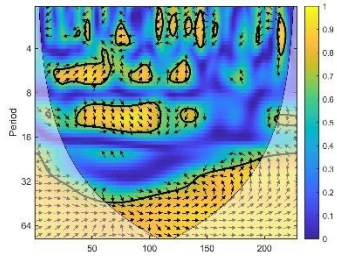
Agri



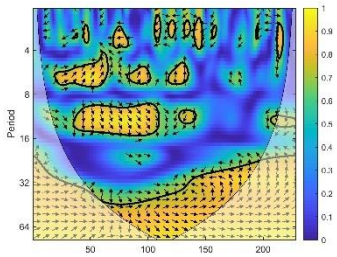
Aksaray



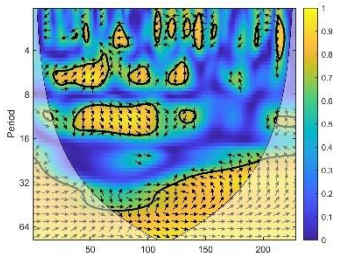
Amasya



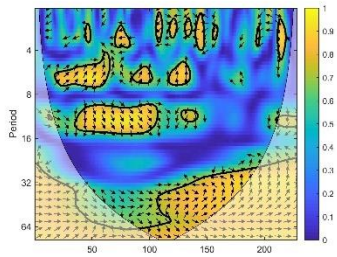
Ankara



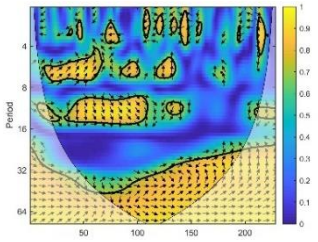
Antalya



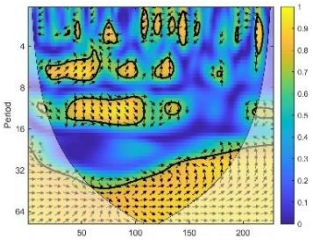
Ardahan



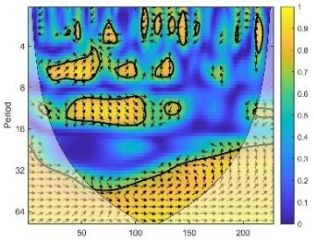
Artvin



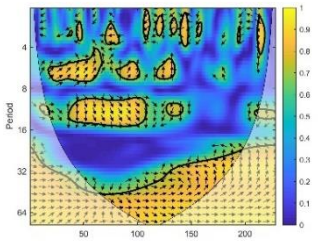
Aydin



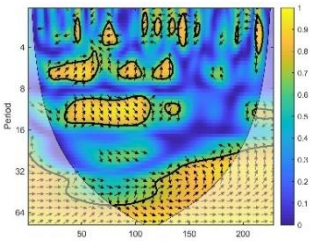
Balikesir



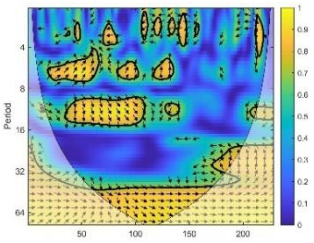
Bartin



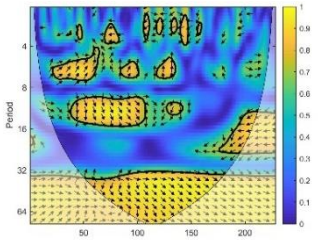
Batman



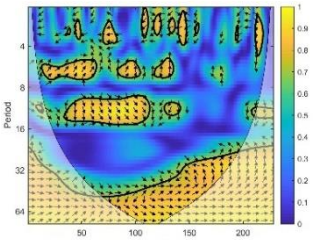
Bayburt



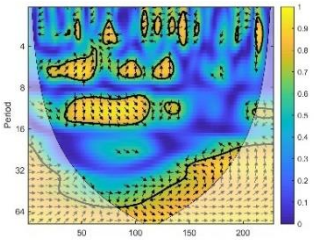
Bilecik



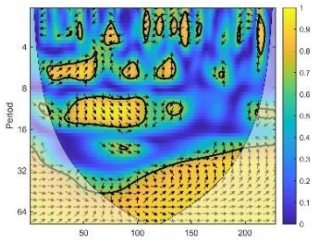
Bingol



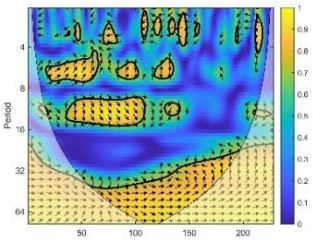
Bitlis



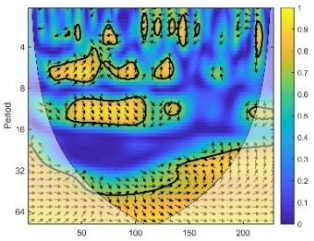
Bolu



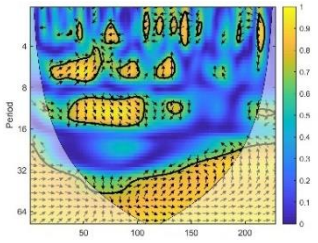
Burdur



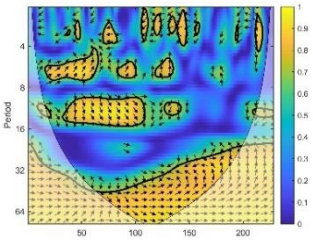
Bursa



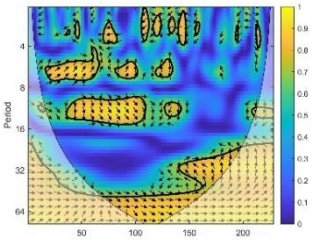
Canakkale



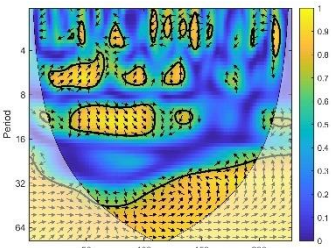
Cankiri



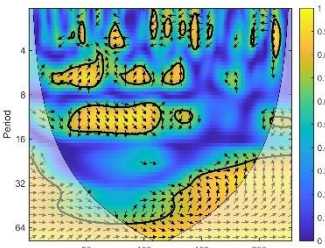
Corum



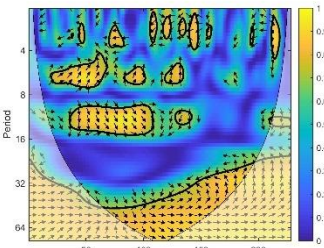
Denizli



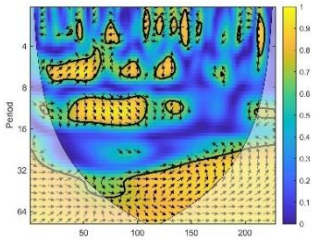
Diyarbakir



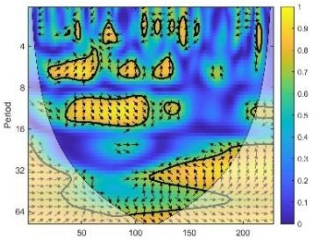
Duzce



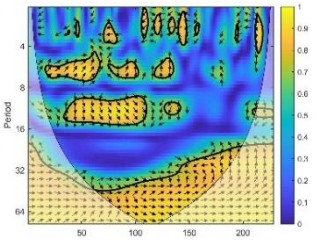
Edirne



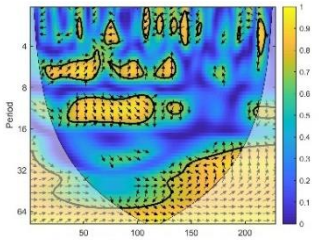
Elazig



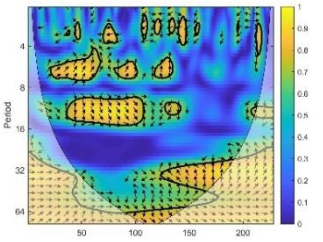
Erzincan



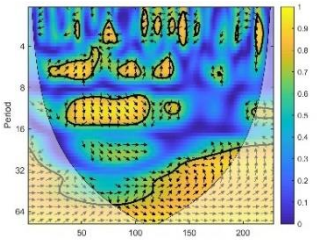
Erzurum



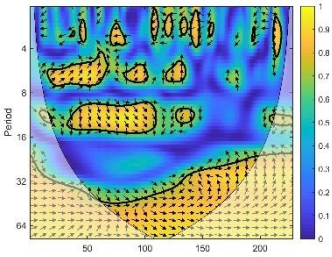
Eskisehir



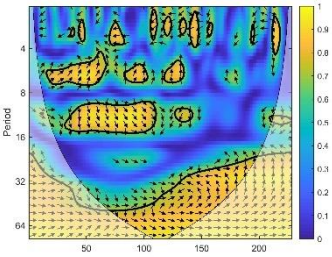
Gaziantep



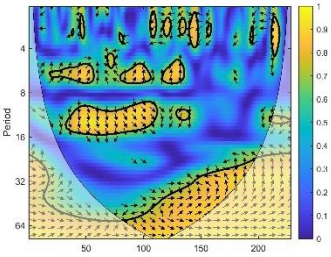
Giresun



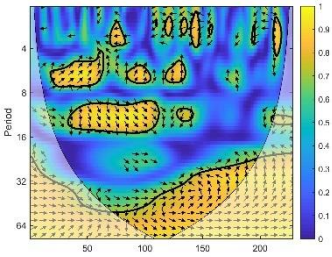
Gumushane



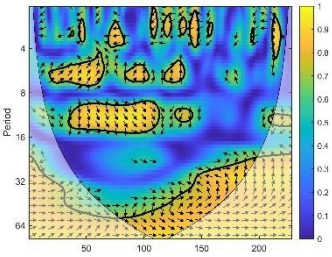
Hakkari



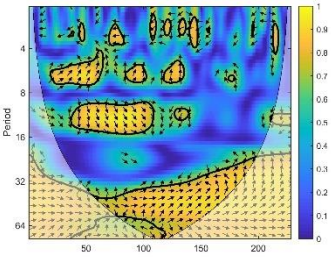
Hatay



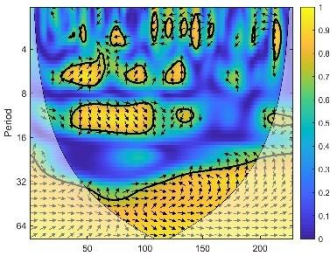
Igdir



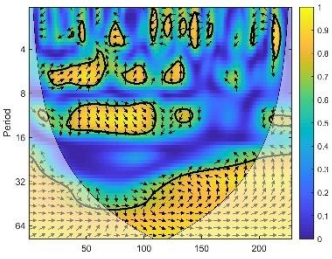
Isparta



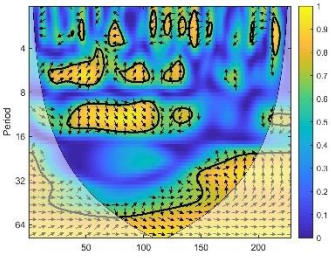
Istanbul



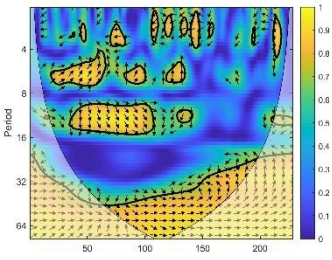
Izmir



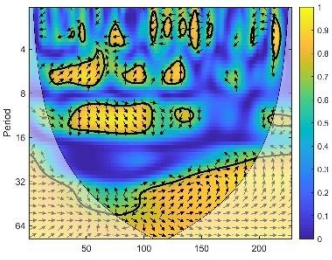
Kahramanmaras



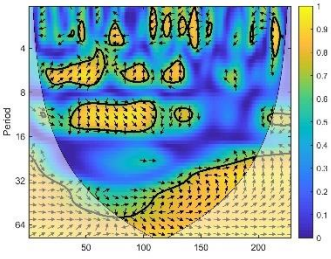
Karabuk



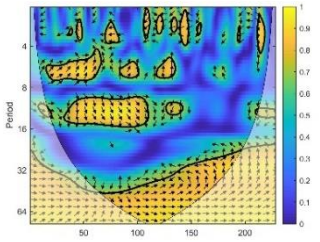
Karaman



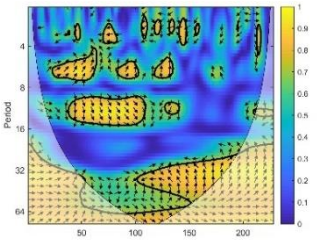
Kars



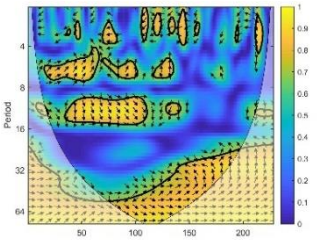
Kastamonu



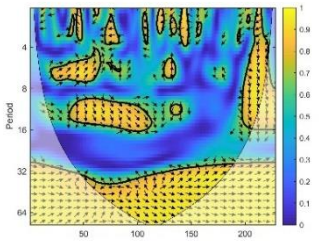
Kayseri



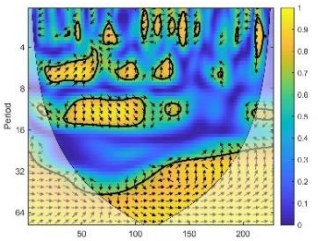
Kirikkale



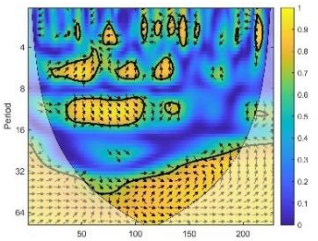
Kirklareli



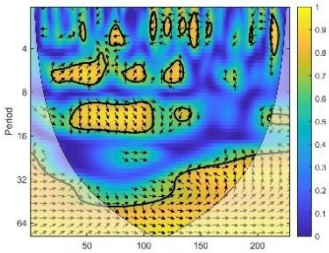
Kirsehir



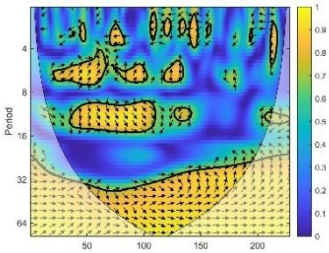
Kilis



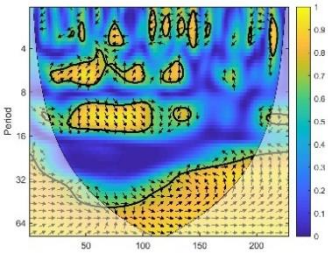
Kocaeli



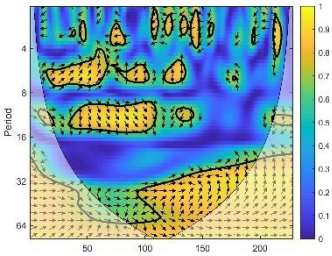
Konya



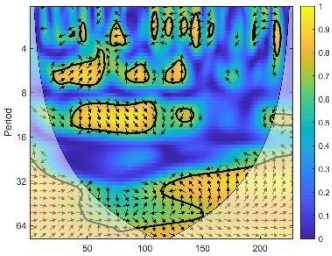
Kutahya



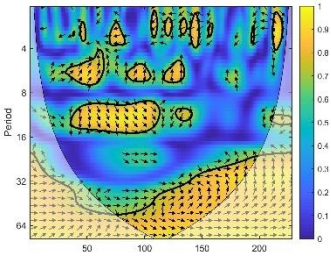
Malatya



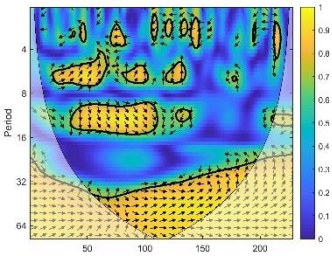
Manisa



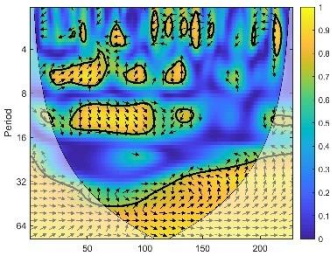
Mardin



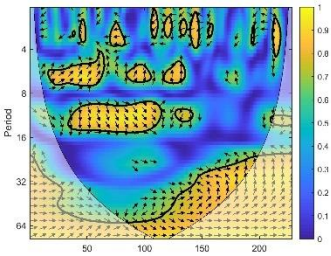
Mersin



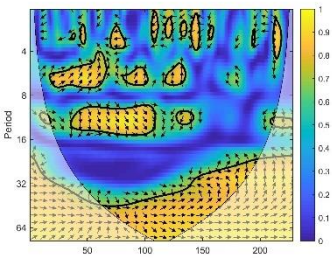
Mugla



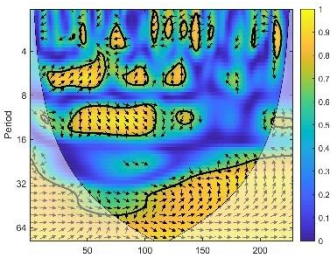
Mus



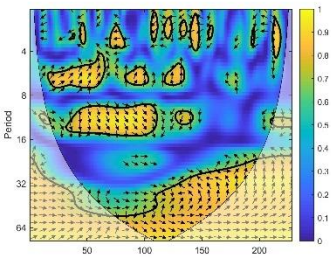
Nevsehir

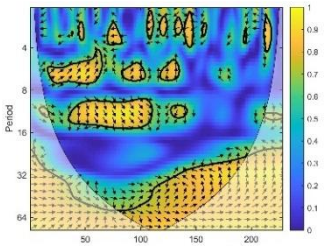
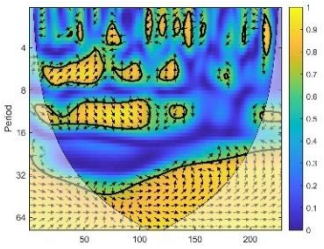
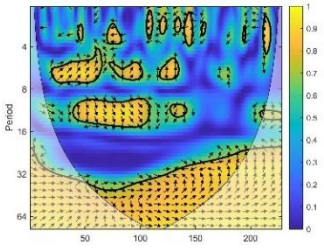
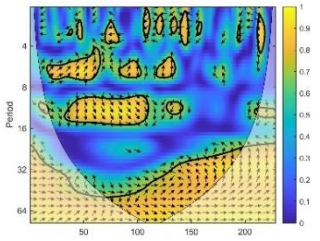
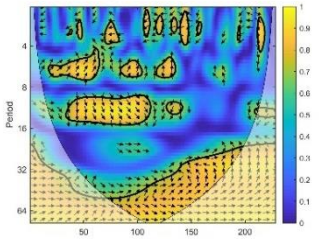
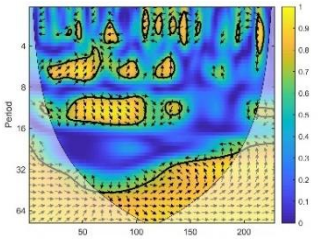
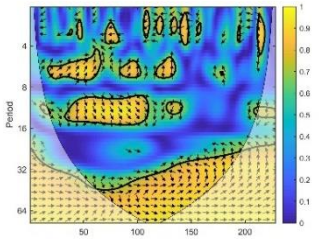
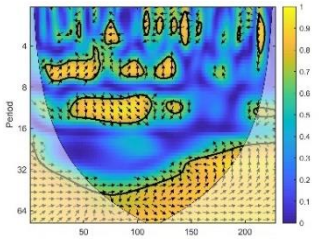
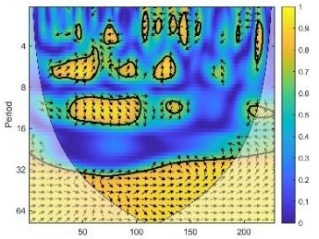
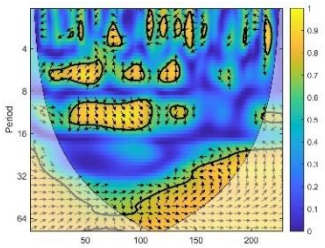
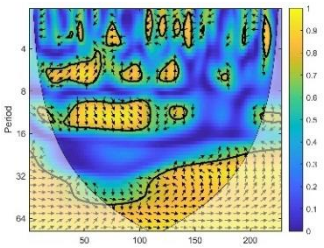
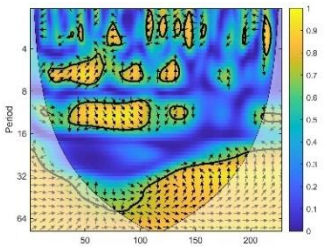
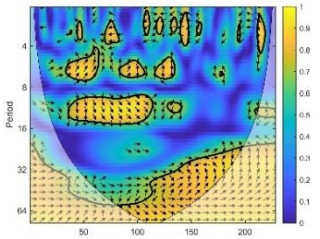
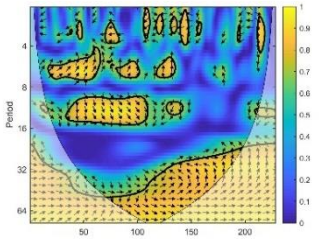
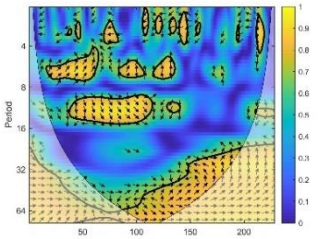


Nigde



Ordu



Osmaniye	Rize	Sakarya
		
Samsun	**Siirt**	**Sinop**
		
Sivas	**Sirnak**	**Tekirdag**
		
Tokat	**Trabzon**	**Tunceli**
		
Urfa	**Usak**	**Van**
		
Yalova	**Yozgat**	**Zonguldak**