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M.A. Thesis

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TEZ ONAY BELGESİ

İKTİSAT (İNGİLİZCE) Anabilim Dalı İKTİSAT (İNGİLİZCE) Bilim Dalı TEZLİ YÜKSEK LİSANS öğrencisi Gökhan Aktaş'nın COMPARISON OF TWO CONSUMER PRICE INDICES FOR ISTANBUL EMPLOYING UNCONVENTIONAL METHODOLOGY adlı tez çalışması, Enstitümüz Yönetim Kurulunun 04.07.2019 tarih ve 2019-20/25 sayılı kararıyla oluşturulan jüri tarafından oy birliği / ~~oy çokluğu~~ ile Yüksek Lisans Tezi olarak kabul edilmiştir.

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ABSTRACT

"COMPARISON OF TWO CONSUMER PRICE INDICES FOR ISTANBUL EMPLOYING AN UNCONVENTIONAL METHODOLOGY"

The main aim of this thesis is to analyze whether prices cohere within a city by considering two different consumer price indices, namely Istanbul. The wavelet coherence technique is implemented as an unconventional methodology in order to analyze the variables both in time and frequency domain. The results based on wavelet coherence have been examined in 8 different fields (general price indices and 7 expenditure groups of CPI) for the relationship between the variables. In this study, monthly CPI data of Istanbul and Turkey between 2003 and 2018 are used for empirical analysis. According to empirical findings, the most significant relationship is observed between TSI Istanbul and TSI Turkey series as expected whereas the relationship between TSI Turkey and ICC Istanbul series becomes relatively stronger in most of the expenditure groups, especially after the financial economic crisis. Both the significant coherence and the causality relation between the variables have changed in the time interval corresponds to early of the financial crisis through the ongoing effect period. The results give the idea that price coherency may change between Turkey and Istanbul CPI in a certain period with an economic crisis and also continues approximately 2-3 years more though it is not permanent. Additionally, one of the most remarkable results is

that ICC Istanbul price movements should be monitored as a leading indicator (both in general level of consumer prices and some of the main expenditure groups such as dwelling and transportation prices) for TSI Turkey and Istanbul prices in the medium term by economic agents within the framework of price stability.

GENEL BİLGİLER

İsim ve Soyadı : Gökhan Aktaş
Ana Bilim Dalı : İktisat (İngilizce)
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ÖZET

"GELENEKSEL OLMAYAN BİR YÖNTEM KULLANARAK İSTANBUL İÇİN İKİ TÜKETİCİ FİYAT ENDEKSİNİN KARŞILAŞTIRILMASI"

Bu tezin asıl amacı, iki farklı tüketici fiyat endeksini göz önünde bulundurarak bir şehir içindeki, yani İstanbul'daki fiyatların bağdaşık (veya tutarlı) olup olmadığını analiz etmektir. Değişkenleri hem zaman hem de frekans alanında analiz etmek için geleneksel olmayan bir yöntem olan dalgacık bağdaşımı tekniği uygulanmıştır. Değişkenler arasındaki ilişkinin dalgacık bağdaşımına dayalı sonuçları 8 farklı alanda (genel fiyat endeksleri ve 7 Tüfe harcama grubu) incelenmiştir. Bu çalışmada, ampirik analiz için İstanbul ve Türkiye'nin 2003 ve 2018 yılları arasındaki aylık Tüfe verileri kullanılmıştır. Ampirik bulgulara göre, beklendiği üzere en önemli ilişki TÜİK İstanbul ile TÜİK Türkiye serileri arasında gözlenirken, TÜİK Türkiye ile İTO İstanbul serileri arasındaki ilişki ise özellikle finansal ekonomik kriz döneminden sonra çoğu harcama grubunda görece güçlenmiştir. Hem bağdaşıklık hem de değişkenler arasındaki nedensellik ilişkisi finansal krizin başından, etkilerinin devam ettiği döneme denk gelen zaman aralığında değişmiştir. Sonuçlar, herhangi bir ekonomik krizle Türkiye ile İstanbul TÜFE'si arasında fiyat bağdaşıklığının belli bir dönemde değişebileceği ve kalıcı olmasa da yaklaşık 2-3 yıl daha devam edeceği fikrini vermektedir. Ayrıca, dikkat çeken en önemli sonuçlardan biri de İTO İstanbul fiyat

hareketlerinin TÜİK Türkiye ve İstanbul fiyatları için orta vadede öncü bir gösterge olarak (hem tüketici fiyatlarının genel düzeyinde hem de konut ve ulaşım fiyatları gibi bazı ana harcama gruplarında) ekonomik çevreler tarafından fiyat istikrarı çerçevesinde takip edilmesi gerektiğidir.

To My Family

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İstanbul, 2019 Gökhan Aktaş

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LIST OF ABBREVIATIONS

ACCRA	American Chamber of Commerce Researchers Associations
ADF	Augmented Dickey-Fuller
AR	Autoregressive
CBRT	Central Bank of the Republic of Turkey
CMS	Cecchetti et al.
COI	Cone of Influence
COICOP	Classification of Individual Consumption by Purpose
CPI	Consumer Price Index
CPL	Comparative Price Level
DOLLAR	Exchange Rate of Dollar
ECB	European Central Bank
EMU	European Monetary Union
EU	European Union
EURO	Exchange Rate of Euro
ICC	Istanbul Chamber of Commerce
NER	Nominal Exchange Rate
NUTS	Nomenclature of Territorial Units for Statistics
PPP	Purchasing Power Parity
SNA	System of National Account
TSI / TURKSTAT	Turkish Statistical Institute
U.S. / U.S.A.	United States of America
WTC	Wavelet Coherence

1. INTRODUCTION

There are many types of market structures in a real economy such as consuming market, producing market, import market, or export market. The general level of prices may vary market to market in any economy. The general level of prices which means the average value of the goods and services in commerce of a market at a certain period is interpreted as inflation.

Price indices are used to calculate inflation in today's world. The price indices are constituted under internationally determined standards. Although there may some differences among countries in the scope of price indices, the same method should be used for calculation under the general standards. These differences may be caused by a wide range of reasons from customs to climate differences of those countries. The bottom line is to use the same method for calculation rather than the scope of price indices. In addition to this, the scope of price indices is determined in accordance with the most important product range of the household expenditures and consumption patterns for each country.

The Consumer Price Index (CPI) is a measure that examines the weighted average prices of a basket of consumer goods and services for a certain period (Church, 2016, p. 1). In order to calculate CPI, a base year is used for determining the change in the general level of prices of consumer goods and services. It is almost impossible to monitor the entire goods and services tradable in the market. Hence, the goods and services which have the most share in households' spending are included in the scope and they are naturally grouped such as food, clothing, medical care, transportation, and housing.

There may be regional differences in the prices because of the following reasons; consumption patterns, customs of the society, geographic location, climate differences, etc. Therefore, the goods and services in a certain group are sorted descended in terms of consuming weight and those which higher than a certain point are included in the scope of CPI. Moreover, those weights are updated over the years according to some surveys.

Inflation calculation methodology as of CPI methods is examined in various academic studies and faced a challenge on its accuracy. Additionally, price convergence in a country among the cities is also a widely researched topic in economics. Because price movements have vast importance as an indicator for central banks in view of the price stabilization in an economy.

The CPI of Turkey is calculated by the Turkish Statistical Institute (TurkStat or TSI) which is the official statistical institution of the country. TSI publishes CPI not only for Turkey but also for regional basis. And also, another institution namely Istanbul Chamber of Commerce (ICC) publishes Istanbul CPI. In this respect, there are two institutions that calculate and announce CPI on the record for Istanbul city.

Istanbul consumer price indices published separately by both TSI and ICC. However, TSI's and ICC's indices have differences in terms of their scope and weight. These discrepancies might presumably extend to the businesses which are selected for surveys and measurement. Both indices are recognized by government agencies and are widely respected. For amplification, the households of Istanbul may prefer both indices, especially in house leases.

The main aim of this thesis is to consider a further point beyond all the previous studies. In uncharted territory, we try to analyze whether prices are coherent within a city by considering two different consumer price indices, namely Istanbul.

This study has a special approach and important new ideas for the literature in three aspects. Firstly, the analysis of two different price indices comparison for one city is a new topic to investigate. Secondly, the evaluation of price coherency between a city and Turkey is analyzed by an unconventional methodology in order to obtain results in a time and frequency space. Accordingly, we got the opportunity to analyze the cases in more detail and locally for certain time periods with the direction and causality of the relationships. Lastly, we constructed the series of the 4 groups regarding analyzed fields to obtain more meaningful

and consistent findings[1]. These features of our study may provide new ideas for price stability according to the results of the empirical analysis.

This dissertation consists of a brief literature survey on price convergence among cities of a single country or monetary union members due to the lack of comparison of two price indices in a single city. In the third part of the paper, the CPI is explained in detail both for TSI and ICC methodologies. The dataset which has critical importance for the empirical analysis is introduced in part four. The unconventional empirical method, i.e. wavelet coherence, is described in part five. Then, the findings of the analysis are given in detail in the sixth part and discussed with respect to both technically and economically. Lastly, we have concluded the thesis with the estimates and recommendations for further studies.

[1] Details of the subject are clearly explained in the "research data" section of the thesis.

2. LITERATURE REVIEW

Generally, both economic circles and international organizations (especially rating companies and creditors) are closely interested in inflation expectations for debtor countries. Although the relationship between actual and expected inflation is worth to analyze[2], this paper is aimed to investigate the actual inflation rather than the inflation expectations. In fact, the actual inflation in local or in general terms and the method of its calculation are equally important for consistent inflation expectations. In this context, price convergence among cities has been the subject of many academic studies regarding the importance of predictable and achievable inflation targeting. From this point of view, for the city of Istanbul, which is the most prosperous city in Turkey, it has been examined the relations of two different price indices (ICC and TSI indices) and these indices (separately) with Turkey prices in order to make better prediction for the tendency of general inflation and its subcomponents in this thesis.

In the literature, the researchers have focused on the comparison and convergence of price movements among cities in a country or among European member states in many analyzes. However; we do not try to estimate the degree of relative price dispersion or price convergence/divergence of a selected city group. Our aim in this paper is to analyze the price behaviors within Istanbul city by considering two different consumer price indices which are estimated by different institutions. This comparison differentiates our study from others in the literature.

Yet, due to the lack of literature on this issue, we had to examine the price convergence between cities which could be acceptably similar to our research topic. In this way, it has been achieved important ideas and knowledge in order to evaluate our analysis more accurately. Hence, we have reviewed examples of studies in the literature concerning

[2] See Celik and Gürcan (2016) for more details about the household's inflationary expectations for Turkey.

the United States (U.S.), Eurozone, some other developed and developing countries, respectively.

Cecchetti et al. (2002) (hereafter CMS), study price index dynamics among major U.S. cities by using a panel econometric model. The dataset is a set of annual observations about the CPI for 19 U.S. cities over the 1918-1995 period. The main question is whether price indices in those cities have a common trend; also if there is a local shock how those price indices revert to that trend in time.

Their main motivation to start this study is to find convergence or divergence of the inflation levels among selected cities. Due to lack of data for European prices, they study for those cities in the U.S. rather than the Euro area. They refer the similar regional diversity between U.S. cities and Euro-area in terms of the monetary union but emphasize that the U.S. has a larger common currency region. This similarity provides a better understanding of the inflation convergence on Eurozone.

The study comes up with the results of nine years as a half-life of the price index persistently whereas it diverges temporarily across U.S. cities. Actually they have expected more rapid price convergence across cities in a single country because of a better integration in terms of market products, labor, and capital; however, according to their findings, relative price levels among cities mean revert at a slow rate and half-life of convergence to be near nine years by using different panel tests.

Cecchetti et al. try to explain the slow rate convergence by three hypotheses; the effect of the distance (transportation costs), different size of shocks and the involvement of nontraded goods prices in the general price index. There is a remarkable conjecture that the differentials of the city inflation rates could impact on resource allocations within a common currency zone because of the real interest rate differentials.

The study suggests that the deviation between U.S. cities are almost the same persistency level as European countries' because cities' log price index shows no tendency

behavior to revert the common mean of inflation. However, almost a decade is necessary for reverting the adjustment of inflation.

Gutierrez et al. (2006) also estimate the price convergence within the major U.S. cities by using panel nonstationary method. The main motivation hereby is the question that CMS (2002) asked: whether there is a common trend in price levels between these big cities or not.

Gutierrez et al. applied nonstationary panel data analysis and used the same dataset as CMS (2002), but they divided the local price dynamics into common and unique components. It is seen that more than %95 of the total variance is estimated by the common components. This means that unique components of local prices could be eliminated to detect convergence rate. Besides, in this study Gutierrez et al. found a higher rate of local price convergence after a shock, unlike CMS (2002).

Although the local prices have more than %95 nonstationary common factors, Gutierrez et al. estimated the half-life statistic on average 5 years which is lower than CMS (2002) study.

According to Gutierrez et al. (2006), when we consider the extent of the deviation in the local price indices and how long it will last, focusing on the measurement of the total inflation is more important instead of the local prices. Thus, they referred with those findings that the European Central Bank (ECB) has to put more emphasis on aggregating inflation target rather than influencing local prices.

Chmelarova and Nath (2009) use annual CPI data to explain convergence and half-life estimation. Univariate Augmented Dickey-Fuller (ADF) test and panel data estimation are used for 17 major U.S. cities between 1918 - 2007 periods. According to their findings, 3 of those cities have convergence in relative prices; 6 of the cities' common factors are nonstationary while 3 of the cities' stationery. They explain different behavior of relative prices with the choice of city group. Moreover, the half-life for 1918 - 2007 period is

estimated averagely 9.5 years while for 1918 - 1995 period is estimated averagely 6 years. They try to compare the results with CMS (2002) study and found a shorter half-life time. This difference is explained by the number of city group (2 cities less) and different estimation of autoregressive (AR) coefficients.

Sonora (2009) used the annual average CPI data in the same period with CMS (2002), the years linked between 1918 and 1997, to analyze relative U.S. city price convergence. In the analysis, 20 major cities were covered and panel unit root tests with structural breaks were applied. Sonora showed that using two structural breaks provided higher convergence speed in terms of convergence rates. While it was calculated below 2 years on average, half-life time corresponded 2.3 years which is lower than what CMS (2002) found.

Basher and Silvestre (2011) re-examine the analysis of CMS (2002) by controlling for the structural breaks and they found that half-life of convergence estimation is lower.

Basher and Silvestre use the structural breaks in 1929, 1971, mid-1980 and early 1990s which are big economic events to influence the prices in U.S. "The breakpoints are estimated around the years of the 1929 Great Depression, World War II, the collapse of the Bretton Woods system (1971), the oil shocks (1973, 1979), the great moderation (the mid-1980s), and the early 1990s economic crisis"[3]. Hence, the results show that half-life is estimated between 1-3 years for the majority of cities but it is overlooked that the local economic variation could also cause city price divergence.

In that study, it is emphasized that the lack of structural breaks estimation could cause a slow rate of convergence in price levels for a long term analysis period. Besides, they give an example of Cecchetti and Nath who used long term period and found longer half-life time for city price convergence in their studies.

[3] Basher, S. A., & Carrion-i-Silvestre, J. L. (2011) p.5

Yazgan and Yilmazkuday (2011) try to find city price convergence level and estimate half-life for U.S. 52 cities prices between 1990 - 2007 years by a quarterly period. Their data includes 32 final goods and 16 non-tradable (services) goods prices from 52 cities and 28 states[4]. Authors use pair-wise relative prices instead of determining a reference city to analyze convergence degree. They get quicker convergence rates especially in tradable goods and estimated shorter half-life than previous studies using a similar analysis period. They argue that the different results may have been caused because of the difference in methodologies or in data sets.

Nath and Hegwood (2013) analyze the convergence of relative prices using annual CPI for 17 major U.S. cities between 1918 - 2010 periods. They get better results by including structural breaks and bias correction in panel unit root test in this study. The findings show that using structural breaks provides a faster convergence on relative prices and shorter half-life estimation over cities in opposition to no structural break in panel studies. The main differences concerning the results in the paper with the previous studies (especially Nath (2009)) are that having longer periods and including structural break which is endogenously determined a single break in 1985 in the analysis. Also, there is a remarkable point that the breakpoint in 1985 refers to the macroeconomic stability in the U.S.A. "The Great Moderation from the mid-1980s to 2007 was a welcome period of relative calm after the volatility of the Great Inflation"[5]. So, we can see that lower inflation rate and economic stability are critically important for the relative price convergence according to Nath and Hegwood (2013).

Nath explains the importance of studying on relative price convergence with two reasons. Firstly, they point out that some factors such as tariff barriers, diversity of consumption baskets and the volatility of exchange rates cause the breakdown of the international purchasing power parity (PPP) hypothesis. Therefore, it is easier to understand

[4] The American Chamber of Commerce Researchers Associations (ACCRA) establishes 75 goods prices of 632 cities originally. This is because the lack of some observations in the original data.
[5] https://www.federalreservehistory.org/essays/great_moderation

divergence from PPP by analyzing the data for city prices. Secondly, the movements of relative prices carry weight with real macroeconomic indicators such as real wages, interest rates and also labor-capital flows. Besides, CMS (2002) also emphasize that the differentials of the city inflation rates may impact on resource allocations due to the real interest rate differentials.

Guerreiro and Mignon (2013) analyze the price level convergence in Eurozone covering eleven countries for 1970:01 and 2011:07 terms by using transition regression models. Their main motivation is the existence of both inflation rate and real interest rate divergence within the European zone where the monetary union has been implemented after 2002. Here they prefer to use comparative price level[6] (CPL) instead of CPI to get a better understanding of the level of prices.

According to the findings, there is no linear price convergence across the sample countries. But, when the price differences between members surpass a certain threshold, price convergence has been observed for most of the member countries. The differential of price convergence speed is tried to explain by different technological levels and competitiveness factors like production or labor force productivity. Especially in countries with low technology and efficiency, there is a tendency to high inflation. From this point of view, they argue that such diversity on relative prices could explain the sovereign debt crisis in some countries despite monetary union in Eurozone.

Estrada, Galí, and López-Salido (2013) try to investigate the macroeconomic convergence over the European Monetary Union (EMU) countries. Relatively weak monetary stability and economic compliance have been seen after the transition to the euro as currency, unlike the expectation. In view of the 2008 financial crisis and the ongoing state

[6] CPLi,t = (PPPi;t ÷NERi;t) * 100; where PPPi,t stands for the PPP conversion factor for private final consumption of country i relative to the United States at time t, expressed in euros per U.S. dollar, and NERi,t is the euro/dollar exchange rate at time t.

debt crises in some Eurozone countries, the effects of the monetary union have begun to be questioned.

The aim of the writers is to find out whether the common currency provides monetary stability in Eurozone, or leads to deviations in macroeconomic areas. They analyze the monetary convergence under four main titles as unemployment rate, inflation differentials, relative prices, and current account balance, respectively.

Both Euro area members and other developed countries are compared between 1985 and 2012 years for better understanding. When we look at the results regarding inflation rate and relative price levels, while the convergence of inflation rates is not fully connected with the monetary union, the convergence of relative prices, particularly for tradable goods, is getting stronger after monetary union among the euro area countries.

Hiernaux and Guerrero (2015) aim to investigate whether there is price level convergence among the EMU countries or not. To analyze this they use relative prices by quarterly terms from IV/2001 to II/2011 which refers to the start of the transition to euro monetary union. Actually, it is expected that there should be an integration due to the monetary union, but it is a questionable fact.

According to empirical findings, there is no convergence in the long term and this implies that monetary policy is poorly effective in member countries. While many countries' price levels don't converge, 13% of the relative prices have stable convergence path. The most significant convergence of bilateral relative prices is seen for France and Germany.

They suggest that the ECB should differentiate the inflation target (by measuring and controlling) with respect to price level convergence in means and variance to decrease economic heterogeneities in the EMU countries.

Also, it is stated in the study that while the implementation of a single monetary policy may fail, the multi-monetary policy could bring inefficiency and cause instability. Therefore, price stability is a necessity to determine the most appropriate monetary policies.

Although the prices vary country by country, there are common factors that affect prices and are the same for each country. Political authorities can control monetary policy by analyzing it well.

Halka and Leszczyńska-Paczesna (2018) investigate the price convergence in the European Union (EU) countries from 1999 to 2016 by using relative price level indices. There are 3 more countries in the database, Switzerland, Iceland, and Norway, except the EU countries. Their analysis divides two periods before and after 2008. This corresponds to the global financial crisis in which the inflation rate and exchange rate volatility have increased.

According to results, there is price convergence for all consumption categories until 2008; but after that year, the price convergence is seen for only transport equipment across EU countries. This is explained by various reasons such as EU regulations and international trade conditions. There is a significant finding that the price divergence has been seen for durable goods in the period 2008 and 2016 and this is explained with the high elasticity of demand for those goods to inflationary fluctuations and exchange rate volatility.

The price convergence topic has been studied predominantly for developed countries in the literature. Therefore, we examine it not only for the Eurozone countries and the U.S. mentioned above but also for some other developed countries such as Canada, Australia, and Japan. Besides, price convergence of the housing market which is a relatively new topic is also reviewed for the Paris districts and the Australian cities separately.

Dayanandan (2005) investigates the price convergence in Canadian cities and provinces by applying panel unit root test in the term between 1978 and 2001 by quarterly periods. In the study, ten provinces and fifteen cities are included for the consumer price index for some goods and services. According to the findings, especially after 1990, when the inflation targeting has been implemented in Canada, price convergence is observed among the selected cities and provinces. The author also gets different results for both states and cities separately. While the half-life of states differs between 6.5 and 10.5 years in respect to price groups, the half-life of cities has been estimated as 7.3 years.

Nath and Sarkar (2014) also use CPI data to investigate relative price convergence in Australian cities. 7 cities are involved in the study and panel unit root test is applied for the period in 1972-2011 years by quarterly periods. 3 structural breaks are determined endogenously in the analysis period, and this provides for getting shorter half-life which is calculated approximately between 2 and 4 years. When that paper is compared with the previous studies which did not involve structural breaks, the authors emphasize the importance of both bias corrections and structural breaks for getting shorter half-life for city relative prices.

Ikeno (2014) explores the convergence of relative binary city price levels in Japan over the period 1952-2011 annually base. In this study, the data can be accessed in 46 state capitals are included and applied both the pairwise approach and bootstrapping rather than panel unit root tests for the analysis. The results show that there is a limited convergence for local price levels in Japan, i.e., the convergence is failing within all binary cities which are studied in the analysis.

The author states that the difference in the convergence at local price levels is related to the population growth and transportation costs, not related to the income level and competitiveness in retail sectors as expected. On the other hand, it is also stated that making new studies are necessary in order to understand which factors are more effective in the convergence rate.

Holmes et al. (2017) study the house price convergence in Paris covered 20 districts by using a quarterly dataset between the term of 1991 and 2014. This study differentiates from the others with two aspects by considering only intra-city prices across the districts and also the house prices which is a sub-group of CPI for the researching of price convergence. Both the weightiness of the house expenditures in the personal sector portfolio and the effect of the relative housing prices on the regional economic activity are the main reasons of the writers for investigating this topic. They try to explain the relative price differentials instead

of price levels due to determine whether the house prices move together or not in the long-run.

In order to get better results, a pair-wise approach based on the unit root testing has been applied instead of panel unit root testing in this paper. It is observed that the convergence of relative house price differentials is negatively affected by unemployment differentials, demographic differences, and supply-side specifications. Yet, unemployment differentials, distance, and housing stock are separately determinants of the half-life of shocks and have a statistically significant and positive relationship between it. The unemployment rate is expected as an important variable of half-life shocks in the housing market while the distance is a striking and notable variable in terms of both price convergence and speed of adjustment for the examining relative house price convergence in one city.

Churchill et al. (2018) try to investigate whether there is a convergence club or unique common component of house prices in Australian capital cities by applying panel data model (the methodology of *log-t* regression test). The methodology is formulated as a nonlinear time-varying factor model instead of conventional unit root convergence and co-integration tests in order to allow for heterogeneity and transitional dynamics. The writers used the residential property price index for the years between 2003 and 2017 in quarterly periods for the eight Australian cities.

Both the importance of house prices on global financial markets and the knowledge deficiency regarding the dynamics of long-run house prices in Australia are the main motivations of implementing this study. The results of the *log-t* regression test indicate that house prices do not converge within the 8 cities over analyzing term. It is revealed that the global financial crisis has an important impact on housing price convergence. Namely, an equilibrium path of housing prices over Australian cities has been detected between 2008 and 2015 while a change has occurred in 2015 with regards to sub-convergence.

On the other hand, the findings of club-merging analysis illustrate that one non-convergent group (between Melbourne and Sydney), and two sub-convergent groups

(between 4 city-club and 2 city-club) occur. The results sign that the convergence of house prices in Australian cities differs and the formation of sub-convergent groups is more remarkable especially after 2014.

In addition to the above-mentioned studies, similar studies have been conducted in developing countries such as Mexico and Turkey. The common features of these countries are that they face high inflation and the results indicate that there is a general convergence.

Sonora (2005) researches price convergence for 35 cities of 7 regions in Mexico. The research period was 1982-2000 and according to the results of the panel unit root test; relative city prices are stationary. Moreover, the pace of convergence of the prices is faster in comparison to the results of the developed countries.

The half-lives of relative price convergence among cities came out approximately 1-2 years. The research of Sonora indicates that the price convergence in Mexican cities is shorter than some developed countries like the U.S. and Canada. In this respect, the study carries significant results in terms of the half-life speed and convergence degree for a developing country's city prices which is experiencing relatively high inflation, such as Turkey.

Özçiçek (2007) concludes a survey using a univariate ADF test and panel unit root methods which is aimed to check whether a CPI-based price convergence among 19 Turkish cities exists or not. In this survey, 1994 based monthly CPI used which include 1994-2003 years period. The study results with no price convergence among cities and calculates the half-life as 13 years which is relatively high.

If we compare the analyses term with the others, it seems shorter time period. Nonetheless, the results of Sonora (2005) show that a higher inflation rate is not the only reason for the price divergence. The study explains why there was no convergence among cities as the short analyzing period, high-inflation rate in that period and almost no market union existed.

Bilgili (2016) investigates the consumer price index convergence between 18 cities in Turkey. The analysis term covers between 1994:01 and 2004:12 periods. The analysis term is not continued for the next years due to the lack of city-based CPI data in Turkey. After 2004, the TSI has published the city price indexes base on regional rather than individually. Bilgili uses the ADF unit root tests and also apply minimum Lagrange multiplier unit root tests with 2 structural breaks. When we look at the results, price index convergence among most of the selected cities has been seen in the long term and the half-life is lower relatively (0.95 months on average). It means that the deviation from the long term equilibrium is temporary due to any shocks.

We have examined the studies on this topic regarding the U.S., Eurozone, some other developed countries and finally some developing countries, respectively. To evaluate the literature in general, the main reasons for failing to adjust the prices among countries are logistic costs, tariffs, distance, and unstable exchange rates. Therefore, the prices in the regions and/or cities which are economically integrated and politically unified are thought to be convergent to each other. However, it has been seen that the findings in the literature obtained notably vary according to the chosen analysis period, empirical method and data scope, even for the same regions.

3. CONSUMER PRICE INDEX AND THE RELATION WITH TURKISH ECONOMY

CPI denotes the change in the prices of a certain (selected) group of goods and services, which are consumed by regular individuals (households) at a certain reference period. By decontaminating the effect of the changes in the quality and the number of goods and services contained by the index basket, it is assured that the index is to reflect only the changes in the prices. Retail price changes and the impact of that changes on individuals namely inflation rate is called CPI change rate. Taxes are included but deposits and installments are not within the retail prices (Turkish Statistical Institute, 2008).

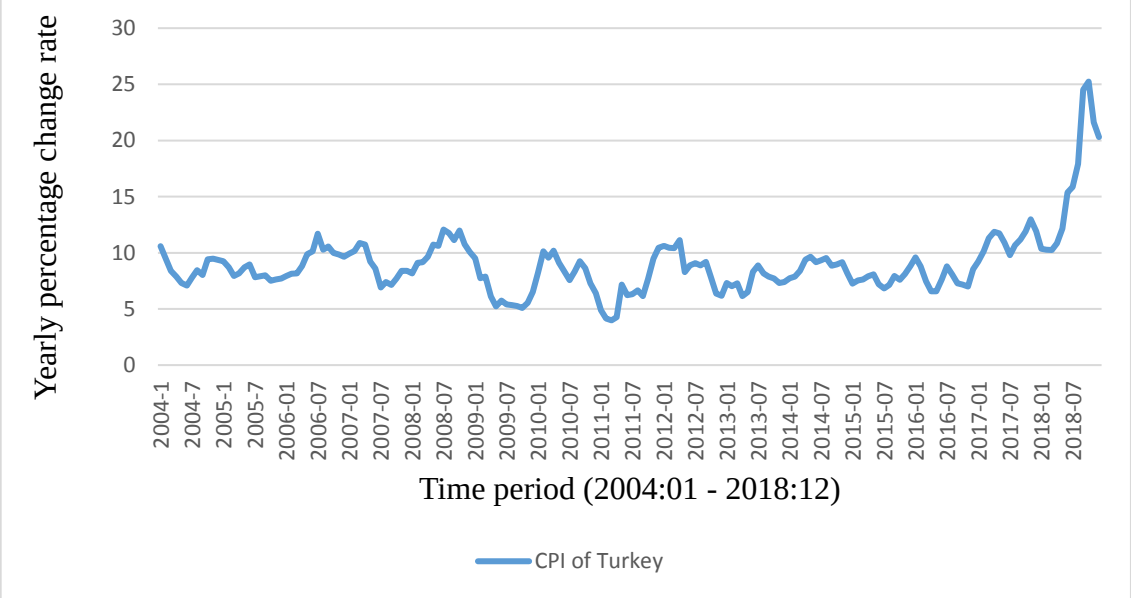
Over a certain time interval, CPI indicates the difference from the initial date to the end date of the purchased prices of retrial goods and services. The indicators for which used to specify the CPI is also using in the construction of monetary policy and inflation tendencies. The CPI supplies clarity and predictability on the estimation of future inflation.

CPI is an important macroeconomic indicator and used for a wide range of purposes; some of the most important ones are sortable as calculating the inflation rate and guiding the commercial activities for adjusting the wage and prices, determining the policies of governments on country economies and also studying any price analysis.

The main goal of CPI is to calculate the inflation rate by indicating the change in the prices of goods and services for a certain period consumption. In addition, purposefully all monetary expenditure including households, tourists, and individual consumption expenditures within the institutional population are taken into account for calculating the CPI (Turkish Statistical Institute, 2008, p. 22). This concept left the owner-occupied property and expenditures from household production out of the coverage from the consumption expenditures. Therefore all the final consumption expenditures in the market are considered for CPI calculating.

CPI is calculated by the TurkStat, Turkey's official statistical institute, both for Turkey and for regional basis. Besides, ICC, the first formal reporter of the price index in Turkey (Güzel, 1998, p. 24), reports CPI by the name of the cost of living index for wage earners in Istanbul.

The yearly percentage change rate of CPI for Turkey and Istanbul with a separate chart are shown below:



Graphic 1: Consumer Price Index for Turkey

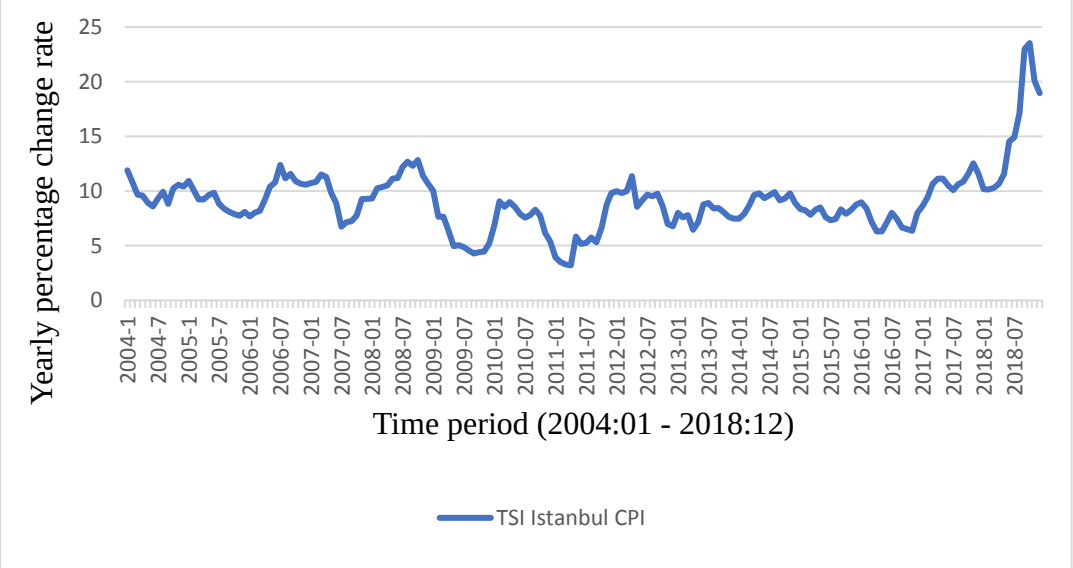
While the inflation rate of Turkey increased by over 10% with the global financial crisis in 2008, it decreased by nearly 5% along with the current account deficit in 2009. In Turkey, the foreign trade deficit is also decreasing when the gross domestic product falls due to the high dependence on intermediate goods in production.

Nonetheless, inflation and growth rate increased due to the base effect in 2010. The Turkish economy has grown by an average of 6.3 percent between the years 2010-2016 whereas the inflation rate has fluctuated nearly between the rates of 5~10 percent. Turkey's

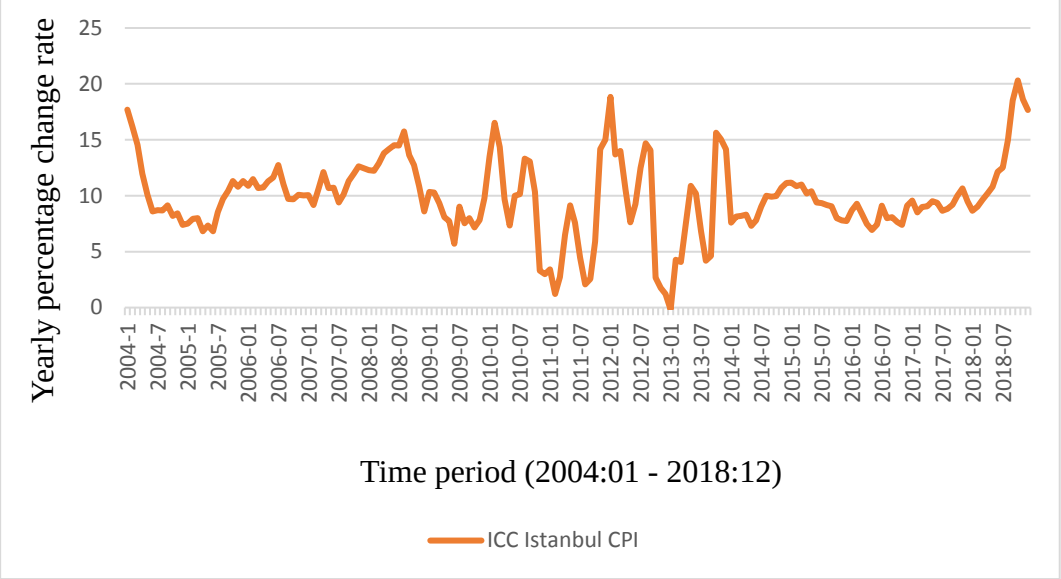
economy was contracted by around 1 percent in the third quarter of 2016 due to the latest coup attempt.

On the other hand, the exchange rate began to increase in 2017 caused inflationary pressure in the economy. In 2018, the fluctuations in the exchange rate have increased the fragility of the economy in financial terms. The rise in cost-based inflation has adversely affected the real economy and brought economic shrinkage. The economy shrank by 3 percent in the last quarter of 2018.

Even in the crisis years of 1994 and 2001, the current account deficit was closed due to the decline in the foreign trade deficit. Accordingly, the current account deficit decreased sharply with the negative growth rate due to shrinkage in the first three quarters of 2009. However, when we look at the inflationary outlook at that crisis term, 2009 crisis was better than the previous ones in terms of the CPI level. The probable reason of this situation is 1994 and 2001 are the internal crisis unlike 2009 one. Moreover, 2018 exchange rate crisis also an internal crisis and it has caused an inflationist leap. The increase in production costs due to the exchange rate is one of the main factors triggering inflation as we observe from the graphs.



Graphic 2: Consumer Price Index of TSI for Istanbul



Graphic 3: Consumer Price Index of ICC for Istanbul

When we look at the inflation outlook of Istanbul, which is the province with the highest population density, we see that the changes in the "CPI of Turkey" graphic look like very similar with the price movements in Graphic 2. However, a higher rate of fluctuation is observed in the inflation calculated by ICC than TSI Istanbul CPI between the years of 2009-2014. This indicates that the price stabilization has been disrupted not only in times of economic crisis but also in the next few years.

To calculate the inflation rate with respect to the change in prices of goods and services available in the market, 2003 based CPI is used by TSI in Turkey. On the other hand, ICC uses 1995 as a base year for calculating CPI in Istanbul. Both of the institutions i.e. TSI and ICC, calculate the CPIs with Laspeyres formula[7] considering consumption weights. The details of how calculating CPI by whom are mentioned below respectively.

[7] Laspeyres index formula is commonly used throughout the world. The formulation is: $CPI_L = \frac{\sum_i P_{it} \cdot Q_{i0}}{\sum_i P_{i0} \cdot Q_{i0}} \times 100$ where P_{it} is the price of item *i* at time *t*; P_{i0} is the price of item *i* at time *0* (the base period); Q_{i0} is the quantity consumed of item *i* at time *0*.

3.1. The Consumer Price Index Calculation by the Turkish Statistical Institute

CPI using 2003 as a base year is calculated for 26 regions[8] in Turkey and according to classifying Ankara, Istanbul, and İzmir constitute a region on their own. Details can be seen in Appendix 1.

In order to calculate the CPI, one needs a basket of goods and services, the expenditures for these goods and services, a base year, and the prices of these goods and services for a current month. The monthly prices of the goods and services, which are contained in CPI, are followed through the selected sellers in all the city centers and some other selected settlements.

While the CPI across Turkey is calculated via Turkey prices, the regional prices are compiled from the regional settlements in order to calculate regional CPI (Turkish Statistical Institute, 2008, pp. 33-34).

It is compiled by TurkStat through household consumption expenditures with a budget survey (Continuous Household Budget Survey). The methodology does not classify the people in turns of demography or economic classification. The survey is conducted monthly and consists of questions about household consumption expenditures, such as food, garment, health, transportation, real estate, household goods, et cetera.

The household members who are 15 years old and older make an entry of all the daily expenses into the individual and shared entry books. While those entries are compiled by the survey takers, the consumption expenditures of tourists and corporate population are detected through special surveys conducted by TSI. Thus, the information on final consumption expenditures in Turkey can be obtained on the basis of goods and services.

[8] In order to reduce development differences among territorial regions by doing socio-economic analysis of the regions and to produce comparable data with the E.U., TurkStat has begun to implement a version of NUTS (nomenclature of territorial units for statistics) is named statistical regions with the decision of the cabinet of ministers after 2002.

The fundamentals of classification of goods and services are to collect subjects having as possible as a similar type of price volatility and type of production and consumption processes. In addition, in order to calculate the index and compare it with the international index standards, the types of subjects and group of goods and services are required to be classified.

The classification using by TurkStat is “Classification of Individual Consumption by Purpose (COICOP)”, which is a sub-study of “System of National Accounts (SNA)” (Turkish Statistical Institute, 2008, p. 23) and also an international standard. The classification begins with the type of item and continues via eight steps through main expenditure groups until Turkey CPI. These steps are collocated as item type index, item index, subgroup index, group index, sub-main group index, main group index, region index and lastly Turkey index.

In order to determine the weights and to calculate the index, COICOP is used and these classification expenditures are organized in 43 sub-groups and 12 major groups accordingly. The main groups of classification of individual consumption by purpose are shown in Table 1 and 2 with the weights and the coverage information by numbers separately from 2016 to 2019 years.

Table 1. Main Expenditure Group Weights in CPI (2003=100), 2016:2019 (%)

Main Expenditure Groups	2016	2017	2018	2019
1. Food and non-alcoholic beverages	23.68	21.77	23.03	23.29
2. Alcoholic beverages and tobacco	4.98	5.87	5.14	4.23
3. Clothing and footwear	7.43	7.33	7.21	7.24
4. Housing, water, electricity, gas and other fuels	15.93	14.85	14.85	15.16
5. Furnishing, household equipment, routine maintenance of the house	8.02	7.72	7.66	8.33
6. Health	2.66	2.63	2.64	2.58
7. Transportation	14.31	16.31	17.47	16.78
8. Communication	4.42	4.12	3.91	3.69
9. Recreation and culture	3.81	3.62	3.39	3.29
10. Education	2.56	2.69	2.67	2.40
11. Hotels, cafes, and restaurants	7.47	8.05	7.27	7.86
12. Miscellaneous goods and services	4.73	5.04	4.76	5.15

Source: TurkStat (Terminology is used from the publication of TSI CPI calculations, 2017)

The composition of the index includes 418 products in 2019. Details of the compiled prices are summarized in Table 2 for the aforementioned years.

Table 2. Outlet, Rent, Price and Item Numbers, 2016-2017-2018-2019

CPI	2016	2017	2018	2019
Item Number	417	414	407	418
Variety Number	924	910	895	895
Outlet Number	27 886	27 386	28.015	28.711
Price Number	408 093	400 772	415.000	544.256
Actual Rent Number	4 281	4 275	4.274	4.274

Source: TurkStat

The budget surveys are compiled from TurkStat and they are used for the determination of the expenditure group weights. TURKSTAT compiles the mentioned surveys for three years (a sample consist of 15.000 private households a yearly) belonging to all socioeconomic groups. Furthermore, as can be seen from the details shown in Table 2, a large number of retail prices are compiled from many workplaces in Turkey for calculating the consumer price index. Both the outlets and price numbers could change during the year due to seasonality. On the other hand, the expenditure group weights could change year by year due to the results of surveys.

3.2. The Consumer Price Index Calculation by the Istanbul Chamber of Commerce

Turkey's first formal price index published by the Istanbul Chamber of Commerce in 1927. The index, which was formed for the purpose of following, registering and sharing market prices, was determined as 1914 base year. This index consists of 27 items within four main groups: food, fuel-lighting-cleaning, clothing and house rent (Güzel, 1998, p. 24).

Table 3. Cost of Living Index (July 1914=100)

	Main expenditure groups	Item number	Weights %
1	**Food**	18	51.44
2	**Combustible-lighting-cleaning**	4	10.48
3	**Clothing**	4	22.21
4	**House rent**	1	15.87
	Total	27	100.00

Source: ICC (Price Index Calculation Methods and Applications in Turkey, 1998)

The 1914 based cost of living index scope was extended in 1930. Main expenditure groups and the number of items were raised to 6 and 42, respectively. Furthermore, the index was published as 1938 and 1948 basis without changing the structure of the 1930 based index. In this way, the 1914 based year index's scope was used for 1930, 1938 and 1948 based year indices. The details of the (January-June) 1914 index could be seen in the below Table 4:

Table 4. Cost of Living Index (January-June 1914=100)

	Main expenditure groups	Item number	Weights %
1	**Food and drink**	24	35.85
2	**Combustible-lighting-cleaning**	5	10.25
3	**Clothing and house furniture**	5	21.50
4	**House rent**	1	12.83
5	**Miscellaneous goods and services**	6	11.95
6	**Savings or insurance**	1	7.62
	Total	42	100.00

Source: ICC (Price Index Calculation Methods and Applications in Turkey, 1998)

Then the Family Budget Survey which was prepared by the ICC and Istanbul University statistic department's competent in the year of 1953, has been started to use in

order to conduct a new index. According to the consumption patterns, item list, main and sub expenditure groups in the 1963 based cost of the living index were determined by the budget surveys. This index was conducted with 107 items within 10 sub and 5 main expenditure groups. Accordingly, 1968 based year index was formed by preserving the numerical data and weight structure of the 1963 index (Güzel, 1998, p. 28).

Table 5. Cost of Living Index (1963 and 1968=100)

	Main and sub expenditure groups	**Item number**	**Weights %**
1	**Foodstuffs**	**43**	**53.36**
1.1	Essential foodstuffs	37	48.70
1.2	Beverage, tobacco	6	4.66
2	**Heating and lighting articles**	**6**	**5.74**
3	**Clothing and house furniture**	**34**	**14.98**
3.1	Clothing	16	11.04
3.2	House furniture	18	3.94
4	**House rent and maintenance**	**2**	**14.93**
4.1	House rent	1	13.76
4.2	House maintenance	1	1.17
5	**Miscellaneous goods and services**	**22**	**10.99**
5.1	Cleaning-health	11	4.12
5.2	Culture-entertainment	4	2.16
5.3	Transport	4	3.77
5.4	Various services	3	0.94
	Total	107	100.00

Source: ICC (Terminology is used from a monthly publication of ICC price indices)

The 1963 base year index was structurally rearranged due to the change in the socio-economic conditions of the wage earners. Because of this reason, the Istanbul cost of living index for wage earners was extended and weights of expenditure groups are changed according to new surveys. In this way, the 1985 base year index was created using the Laspeyres formula. The 1985 based index consists of 242 items which were determined by the elimination of a larger sample by taking into account the consumption weights of the expenditure groups. The index also includes 8 main, 11 sub expenditure groups which are shown as a list with the item number and weights below:

Table 6. Cost of Living Index (1985=100)

	Main and sub expenditure groups	Item number	Weights %
1	**Foodstuffs**	**96**	**42.49**
1.1	Bread and cereals	10	8.32
1.2	Meat, fish, and poultry	8	6.48
1.3	Oils, dairy, products, and eggs	9	8.77
1.4	Fresh and dried vegetables and fruits	44	8.69
1.5	Various processed foods	14	5.28
1.6	Tobacco, alcoholic and nonalcoholic beverages	10	3.16
1.7	Outside dining	1	1.78
2	**Dwelling expenses**	**10**	**20.72**
3	**Household expenses**	**30**	**8.00**
4	**Clothing expenses**	**58**	**12.78**
4.1	Men's wear	15	3.64
4.2	Women's wear	15	5.39
4.3	Children's wear	15	2.85
4.4	Fabrics	13	0.90
5	**Health and personal care expenses**	**16**	**2.82**
6	**Transportation and communication expenses**	**11**	**5.95**
7	**Cultural, educational and entertainment expenses**	**16**	**4.44**
8	**Other expenses**	**5**	**2.80**
	Total	**242**	**100.00**

Source: ICC (Terminology is used from a monthly publication of ICC price indices)

In order to compile prices, weekly and monthly basis prices are received from various workplaces, supermarket and street markets located in 15 districts of Istanbul. Totally 15.275 prices are compiled in a month due to 1985 basis index from that 15 districts are shown below:

Table 7. Price Compiled Regions in Istanbul

	Regions		Regions		Regions
1	Fatih	**6**	Sarıyer	**11**	Levent
2	Bahçelievler	**7**	Beyoğlu	**12**	Eminönü
3	Beşiktaş	**8**	Kadıköy	**13**	Aksaray
4	Kasımpaşa	**9**	Pendik	**14**	Eyüp
5	Şişli	**10**	Kartal	**15**	Bakırköy

Source: ICC (Price Index Calculation Methods and Applications in Turkey, 1998)

Istanbul cost of living index based 1995 which is the last base year for wage earners is created by taking into consideration the number of items of the 1985 based index. 1995 based index which took into consideration the average prices of 1995, has started to be published since January of 1998. Moreover, the main expenditure groups and subgroups of the 1995 based index have the same groups and subgroups with the 1985 based index which was calculated in the scope of 242 items determined via household budget surveys and the weights of each item.

During the interview with ICC statistical unit official, it has been reported that the index is prepared with weekly and monthly price follow-ups in 15 regions in Istanbul taking into account 242 items. Furthermore, we have demanded 242 items list from the statistical unit official and they shared with us the 1985-based index item list. Lastly, it has been declared that on average 15.000 monthly prices are compiled by ICC.

In light of that information, although it is not certain, it is thought that other numerical information in the 1985 base year index is kept up-to-date in the 1995 base year index. However, ICC officials are currently reluctant to share the weights of the main and sub-expenditure groups. There is a methodological comparison of the cost of living indices according to CPI-based years in Appendix 2.

4. RESEARCH DATA

In this study, CPI of Istanbul announced by both TSI and ICC, also CPI of Turkey announced by TSI are compared separately. Wavelet coherency methodology is implemented to analyze the variables in detail and the series are used over their monthly percentage changes.

TSI used 1968, 1978-1979, 1987, 1994 and 2003 as base years for Turkey while ICC used 1914, 1930, 1938, 1948, 1963, 1968, 1985 and 1995 as base years for Istanbul in their CPI calculations. In this study, the most up-to-date base years are used for each index; 2003 for TSI and 1995 for ICC.

ICC has announced general CPI data only since 2013, and the data of main expenditure groups and subgroups are announced only as monthly and yearly percentage change ratio on its website. Therefore, we have contacted to ICC statistics department and have obtained CPI data series since 2003 for the base year 1995 with details of main expenditure groups and subgroups. This data is also published on electronic data delivery system the official website of CBRT (Central Bank of the Republic of Turkey) and via this channel, it was found the possibility to confirm the data which we have obtained from ICC officials before.

TSI announces CPI data on central dissemination system both for Turkey and regional basis. However, the main expenditure group index data has been announced on the system since 2005 and its weights since 2010. Hence, we have contacted to TSI officials and obtained the weights of data series since 2005 (CPI main and some of the sub expenditure group weights between 2005 and 2018 could be seen in Appendix 3). Moreover, the index data of Turkey in general and Istanbul for the years 2003-2004 have been obtained on the CBRT electronic data delivery system.

Both TSI and ICC has the same calculation method; however, they differ on their scope of the items, main expenditure groups, subgroups, and especially the weights. Initially,

expenditure subgroups are created by the weights of the items; thereafter, main expenditure groups are created by the weight of the expenditure subgroups and ultimately, the general index is created by the weight of the main expenditure groups for the CPI of the TSI and ICC.

TSI's CPI calculation (2003=100) involves 12 main expenditure groups and 43 subgroups while ICC's CPI calculation (1995=100) involves 8 main expenditure groups and 11 subgroups. In the comparison, along with the general index and 7 main expenditure groups; "foodstuffs", "dwelling", "household", "clothing", "health and personal care", "transportation and communication" and "cultural, educational and entertainment" expenses which refer to ICC's 7 main expenditure groups are included. By courtesy of this scope, 7 of 8 main expenditure groups in ICC's CPI are included in the analysis. Coupled with the general index and 7 main expenditure groups; 8 fields are compared in the analysis.

Four of the indices which are subjected to the comparison (general index and 3 main expenditure groups which are "dwelling", "household" and "clothing") are studied as of the 2003 year basis. In order to make the data comparable and adjusted with the data of TSI, the general index and 3 main expenditure groups of ICC with the base year 1995 are adjusted to 2003=100.

On the other hand, significant differences have been identified among some main expenditure groups which are selected for CPI comparison between TSI and ICC. While these main expenditure groups of CPI are classified as "foodstuffs", "health and personal care", "transportation and communication", and "cultural, educational and entertainment expenses" by ICC, there is not exactly equivalent in TSI. For this reason, some of the main and sub expenditure groups in TSI's CPI are merged, hereby new indices are created in order to make the data comparable and adjusted with the ICC one.

4 new main expenditure groups are recreated in the CPI of TSI both for Turkey and Istanbul which are coherent with above mentioned 4 main expenditure groups in the CPI of ICC. Accordingly, we have created a total of 8 new indices for Istanbul and Turkey with

regards to 4 main expenditure groups. While these new indices are created, some of the main expenditure groups and subgroups are merged considering the yearly weights of them within 2005 – 2018. The main reason for the regrouping is to reduce the differences between the CPI of the TSI and ICC for better conditions to compare those indices. In comparison, the base year is selected as 2005 to enlarge the maximum data period for observation due to lack of 2003 and 2004 years' CPI weights.

The weights of the 1995-based general index and main expenditure groups of the ICC have not been shared by the institution. So, the main expenditure groups of ICC remain unchanged in this analysis. However, since the newly created 4 main expenditure groups for TSI has the base year 2005, the corresponding main expenditure groups of the ICC have also been calculated as 2005=100 and they are reorganized in this manner.

As we mentioned before, our aim here is to try to increase the similarity and equivalence between the groups due to their features and functions in order to get better results. The main and sub expenditure groups of TSI and the main expenditure groups of ICC used in our analysis are demonstrated in Appendix 4.

It is shown in Appendix 5 that the main and sub expenditure groups of TSI which we have combined according to ICC main expenditure groups are classified and paired with arrows. The arrows in the box would be useful to match the corresponding main expenditure groups of each index. The mathematical explanation of those new indices recreated by us is demonstrated in Appendix 6 with the case for foodstuffs CPI of Istanbul.

5. THE WAVELET COHERENCE METHODOLOGY

The method applied to examine the relationship between variables in scientific research is important in terms of reliability and functionality. The Wavelet Coherence (WTC) is one of the non-traditional methods used to determine the relationship between two non-stationary time series. The relationship of two consumer price indices for Istanbul has been investigated by using the WTC on monthly data for the period of 2003-2018[9].

A wavelet function has zero mean and is built in both frequency and time space (Grinsted, Moore and Jevrejeva, 2004). Put another way, the fact that a function can be wavy depends on the conditions where the duration is limited and the average value is zero (Öner et al., 2017). These wave functions are called "wavelets" in the sense of small waves because they do not go on with their movements continuously.

The wavelet analysis technique has various application areas and is preferred for time series analysis in various sciences such as medicine, physics, ecology, meteorology as well as social sciences such as finance and economics. Norsworthy et al. (2000) emphasize that wavelet analysis has remarkable effects in 3 fields which are signal processing, image analysis, and data compression. The signal is analyzed in the time and frequency (period) domain. Namely, the low-frequency information at a long time interval and high-frequency information at a short time interval can be defined (Öner et al., 2017). In this way, as the Torrence and Compo (1998) also underline that wavelet analysis technique is a useful tool for analyzing time series with many different timescales or changes in variance.

Torrence and Compo (1998) point out that wavelet analysis involves two-dimensional time-frequency image rather than one-dimensional time series (or frequency spectrum). It could be analyzed with this method how the relationship of two non-stationary time series changes at different times and frequencies, as well as which one can lead or

[9] In 4 areas 2003-2018, in the other 4 areas 2005-2018 period has been examined. The subject has been explained in detail in the "research data" section of the thesis.

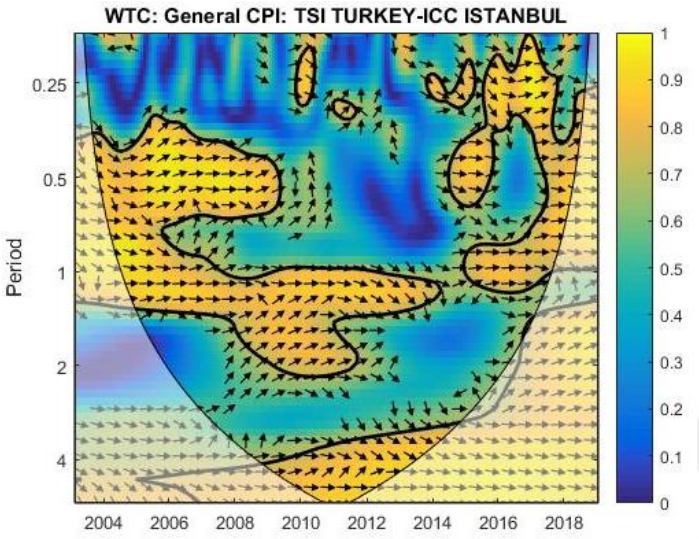
lagging the other. Hence, we can see the correlation in both time and frequency domain between two time-series.

This methodology provides us to understand the degree of correlation between the variables. The detailed mathematical dimension of the methodology is explained by other studies such as Torrence and Compo (1998), Grinsted et al. (2004) and Dar, Bhanja and Tiwari (2014). To touch upon the subject, the implemented wavelet coherence for given two time-series ***x(t)*** and ***y(t)*** is defined as mathematical formulation as follows:

$$R_n^2(s) = \frac{\left|S\left(s^{-1}W_n^{XY}(s)\right)\right|^2}{S(s^{-1}|W_n^X(s)|^2) * S(s^{-1}|W_n^Y(s)|^2)}$$

$\boldsymbol{R^2}$ is localized correlation coefficient in frequency and time-space. $\boldsymbol{S}$ refers to smoothing operator in time and frequency. $\boldsymbol{W^X}$ and $\boldsymbol{W^Y}$ are the wavelets for each time series, and $\boldsymbol{W^{XY}}$ is the cross-wavelet. Lastly, $\boldsymbol{s^{-1}}$ is used to convert to energy density, which is related to the frequency ($\boldsymbol{s}$ = scale, $\boldsymbol{n}$ = time index).

With this formulation, the coherence is calculated from wavelets of each time series. Wavelet coherence is similar to a correlation coefficient varying in time-frequency space. We try to interpret the wavelet coherence features with an empirical output in the below:



Phase arrows pointing:

- To right: variables are in-phase
- To left: anti-phase
- To down: *TSI Tr* leading *ICC Ist* by 90°
- To up: *ICC Ist* leading *TSI Tr* by 90°

Shape 1: Guide to Interpret the Wavelet Coherence Model

- If the wavelet coherence closes to 1 (right side of the figure), the linear relation between two series becomes stronger at a particular time and frequency on the shape. Yellow color refers to high coherency (close to one) while blue color refers to low coherency (close to zero). Likewise, while 1 means perfect correlation (completely coherent) 0 means no correlation (completely incoherent) between variables.
- Vertical axis measures frequencies or scale (measured in years) and the horizontal axis represent the time period studied.
- The cone of influence (COI) indicating the region affected by the edge effects is shown by a lighter black line. The periods inside of COI have statistical confidence but outside of it are not confident and edge effects can be ignored.
- The field in the thick black contour where the 5% significance level of the WTC has to be determined using Monte Carlo simulations and it shows the 95% confidence interval using chi-squared.
- Arrows indicate the phase difference between the two series. If the arrows go to the right, variables are in phase; go to left, then variables are out of phase (anti-phase).
- If the arrows are in phase and go to up, the first variable is lagging; but if the arrows go to down, the first variable is leading.

- If the arrows are out of phase and go to up, the first variable is leading; but if the arrows go to down, the first variable is lagging.
- Variables have a cyclical effect (positively related) on each other if they are in phase; another way they will be having an anti-cyclical effect (negatively related) on each other.
- If there is significant coherence between variables, then phase lag should change slowly and be consistent with each other.

6. EMPIRICAL FINDINGS AND DISCUSSION

The wavelet coherence methodology is used to identify both frequency bands and time interval to explore the relationship between the variables. The results based on wavelet coherence has been examined for general CPI and 7 expenditure groups of CPI. We have analyzed in 8 different fields for the relationship between TSI Istanbul, ICC Istanbul, and TSI Turkey series separately.

First of all, we analyze the general CPI and there is a statistically significant and positive relationship between variables at time scales for 3 different cases. The strongest wavelet coherence is observed for Figure 3 i.e. the relationship between TSI Turkey and TSI Istanbul.

Figures 1 and 2 look very similar while the second one has higher coherency between variables. Both of them have a statistically significant relationship with each other at different time scales. They are in phase, so the variables are positively related as expected. The phase arrows pointing slightly upwards from early 2008 until 2012 at 1~2 month time scale show that ICC Istanbul leads TSI Istanbul positively. This time interval again corresponds to the financial crisis and its effects term.

We can understand from the figures of 1 and 2 that the variables are positively related at a short time scale but there is not exactly leading or lagging effect on each other. However, if there is any financial crisis shock, the significant relationship occurs at 1~2 month time scale with leading effect. Additionally, the power of coherency between TSI Turkey and ICC Istanbul series is higher than the TSI Istanbul and ICC Istanbul.

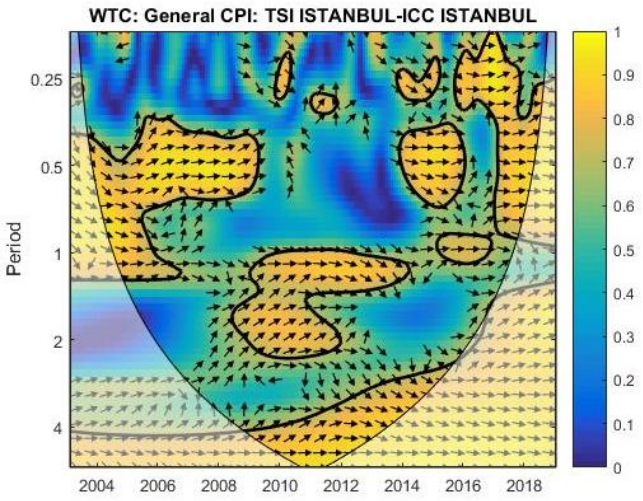


Figure 1: The Wavelet Coherence of General CPI between TSI Istanbul and ICC Istanbul

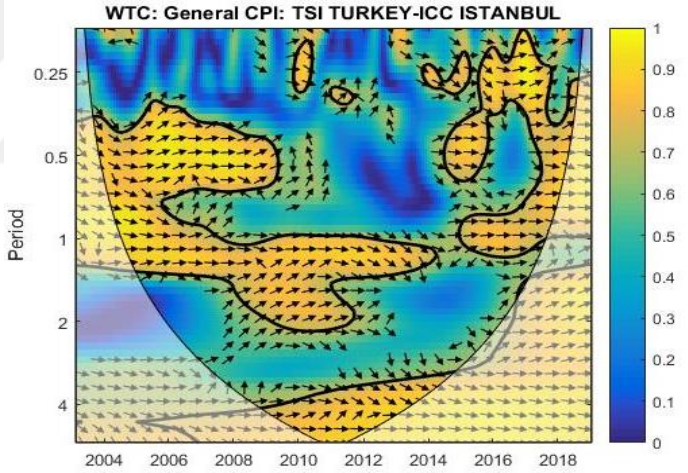


Figure 2: The Wavelet Coherence of General CPI between TSI Turkey and ICC Istanbul

The variables are positively related (in phase) due to the direction of angles at high and low frequencies in Figure 3. This result is already expected due to the same source of the calculation and the population weight of Istanbul within Turkey.

But it is observed that there is an interruption between 2007 and 2012 at low frequencies (3~4 month time scale). The variables seem to be more independent (low coherency) from each other. Moreover, some ephemeral low coherency fields exist at shorter time scales. This interval corresponds to early of the financial crisis and the ongoing effect

period on the Turkish economy. It could be interpreted as price convergence could turn to price divergence between Turkey and Istanbul in a certain period with any financial crisis shocks. However, it is clear that this effect is not permanent.

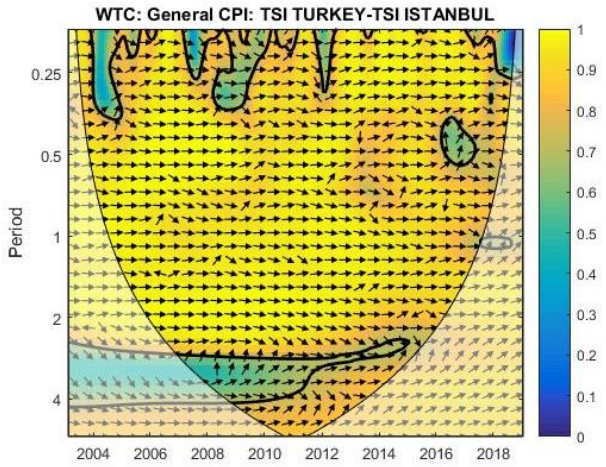


Figure 3: The Wavelet Coherence of General CPI between TSI Turkey and TSI Istanbul

Figure 4:6 display the wavelet coherency analysis of food expenses CPI between the variables separately. Food expenses are the weightiest group within the calculation of CPI. It means that food price changes are very important in the basket of household expenses.

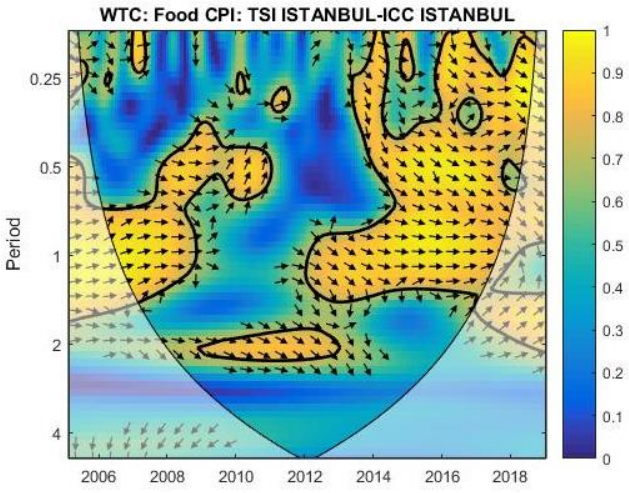


Figure 4: The Wavelet Coherence of Food Expenses CPI between TSI Istanbul and ICC Istanbul

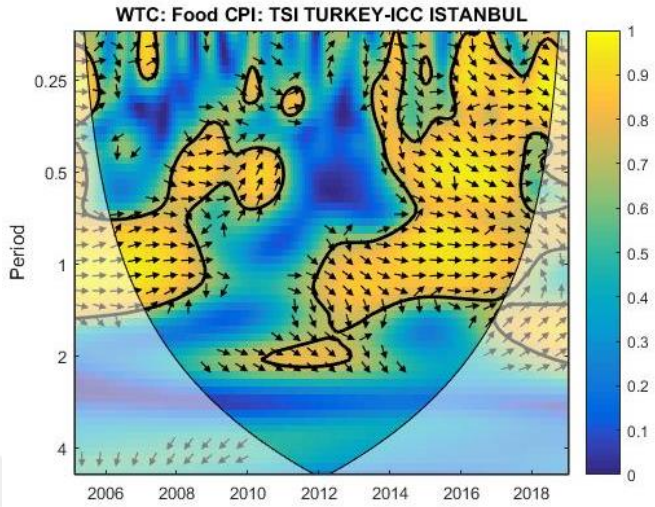


Figure 5: The Wavelet Coherence of Food Expenses CPI between TSI Turkey and ICC Istanbul

Figure 4 and 5 look like similar and TSI Turkey and TSI Istanbul are separately leading the ICC Istanbul after 2012 according to slightly downward phase arrows at different scales (until 2-month time scale).

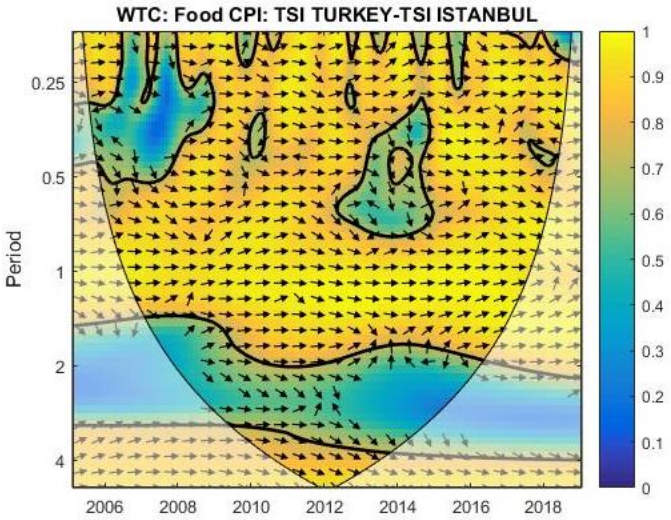


Figure 6: The Wavelet Coherence of Food Expenses CPI between TSI Turkey and TSI Istanbul

3 of the figures show that the variables are in phase (positively related) due to the phase angle indicated by arrows. Especially frequency time scale is expanding and the

strongest wavelet coherence is observed in Figure 6, i.e. TSI Turkey and TSI Istanbul analysis. It is found that the relationship is significant as positively at different frequencies except for lower frequencies, especially at 2~4 month time scale.

On the other hand, ICC Istanbul is leading the other variables according to slightly upward phase arrows from 2007 to 2011. This alteration may be occurred conjecturally by the economic situation. Namely, the consumption behavior of the household changes in spite of the economic crisis effects naturally. Overall, while there is a limited relationship in the long term, a strong relationship is seen between the variables especially in the short term for the food expenses.

Figure 7 and 8 display the wavelet coherency analysis of dwelling expenses CPI between TSI Istanbul-Turkey (separately) and ICC Istanbul. While dwelling expenditure group is third in TSI CPI, is second order group in ICC CPI with respect to weightiness.

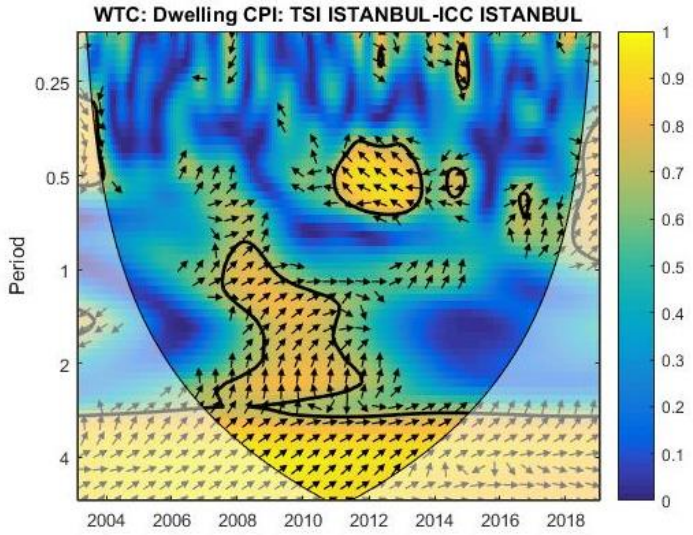


Figure 7: The Wavelet Coherence of Dwelling Expenses CPI between TSI Istanbul and ICC Istanbul data

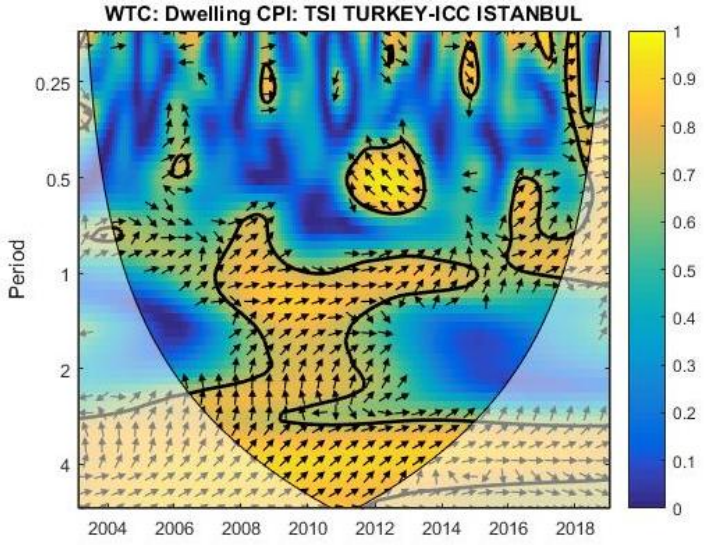


Figure 8: The Wavelet Coherence of Dwelling Expenses CPI between TSI Turkey and ICC Istanbul data

The variables are both in-phase (positively related) and out of phase (negatively related) at different time scales due to the phase angle indicated by arrows. The up and left arrows in the plot indicate that both TSI Istanbul and Turkey are leading the ICC Istanbul negatively between 1,5 and 3 weeks period from 2011 to the last of 2013 although this effect is temporary.

On the other hand, ICC Istanbul is leading the other variables surprisingly at lower frequencies (in the medium and long term). Especially the coherency is expanding in Figure 8 and almost continuous over time with leading effect. The results of the figure indicate that the dwelling prices of Istanbul may have notable importance to take any action about dwelling prices in Turkey. Hence, ICC Istanbul dwelling price data should be followed in order to predict the direction of dwelling prices in Turkey.

Briefly, the wavelet coherence test results signal that TSI Turkey and Istanbul lead separately the ICC Istanbul for an ephemeral time period whereas ICC Istanbul leads the others in the medium and long time period.

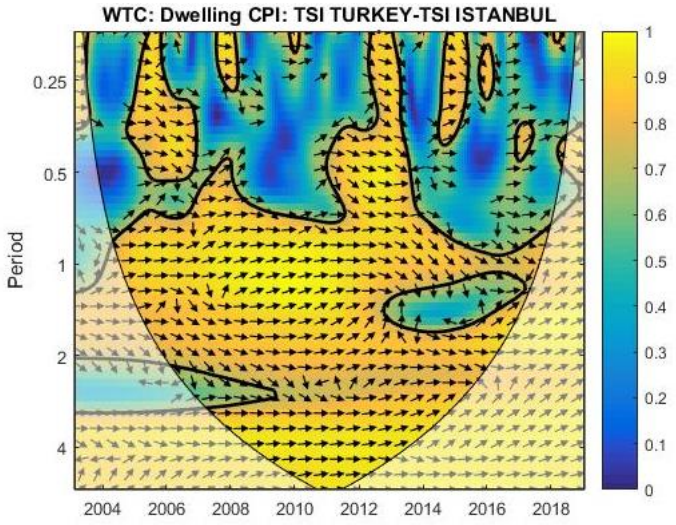


Figure 9: The Wavelet Coherence of Dwelling Expenses CPI between TSI Turkey and TSI Istanbul data

The strongest coherence is observed naturally for the relationship between TSI Turkey and TSI Istanbul as Figure 9 shows. TSI Turkey and TSI Istanbul are positively related and the relationship is significant most of the time between 2003 and 2018 in spite of discrete time intervals at higher frequencies. TSI Turkey dwelling prices are leading the TSI Istanbul according to slightly downward phase arrows at different higher frequencies but the relationship breaks and is not continuous.

Figures 10:12 include the wavelet coherence graphs of household expenses CPI between the variables. The significant fields in Figure 10 and 11 are comparatively less than the previous cases unlike Figure 12. The most striking significant area starts from 2012 to 2014 around the 1-month time scale without any leading or lagging effect both in Figures 10 and 11.

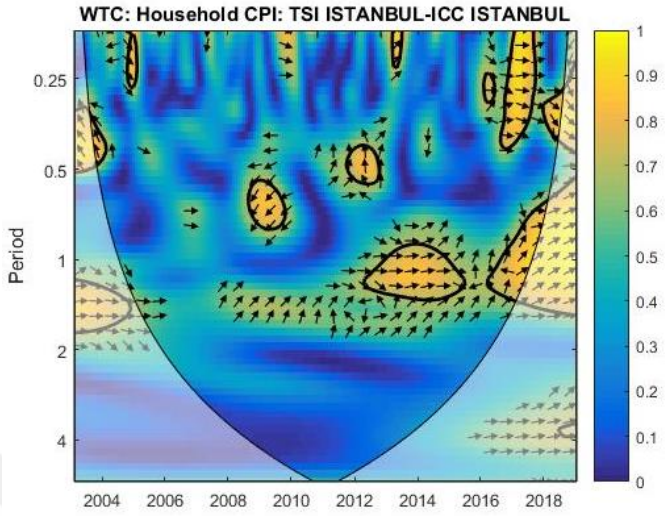


Figure 10: The Wavelet Coherence of Household Expenses CPI between TSI Istanbul and ICC Istanbul data

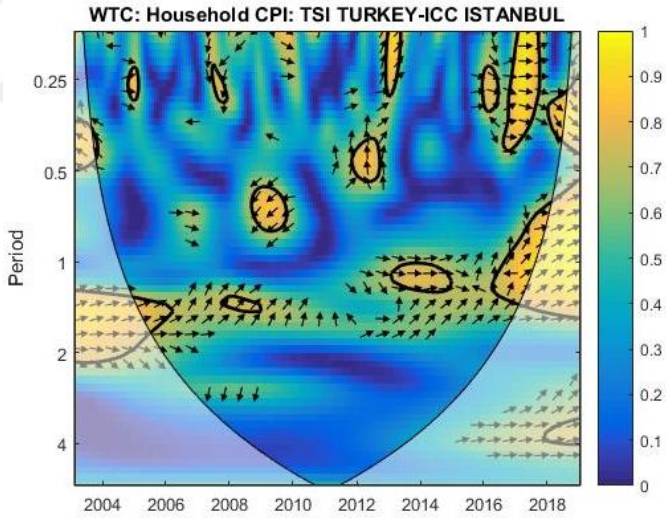


Figure 11: The Wavelet Coherence of Household Expenses CPI between TSI Turkey and ICC Istanbul data

Figure 12 demonstrates that the variables have a significant and positive relationship in a wide range despite it breaks at different time scales after 2013. This incoherent area continues in a narrowing path. This result signs that the price coherency of Turkey and Istanbul in household expenses has differed after the turning to normalization in the

economy. This is may be caused by the different price stickiness levels and the elasticity of demand in household expenses.

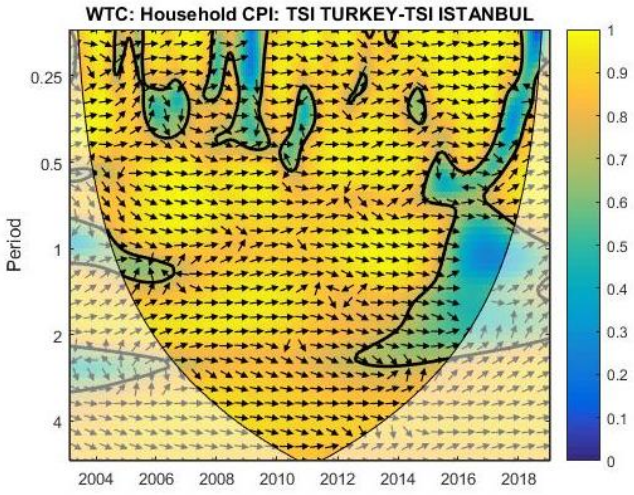


Figure 12: The Wavelet Coherence of Household Expenses CPI between TSI Turkey and TSI Istanbul data

Furthermore, the relationship becomes stronger for all cases in household expenses at different time scales but almost under the 1-month time scale. However, this time interval corresponds to a short period in order to make policy for TSI CPI by considering the ICC CPI in Istanbul or vice versa.

Figure 13:15 indicate the coherency analysis of clothing expenses between the variables. Figure 13 and 14 seem very similar according to the shape of the thick black contour. The phase arrows are in phase (variables are positively related to each other) at different time scales. While there is a statistically significant relationship between TSI Istanbul-Turkey (separately) and ICC Istanbul, the relationship contracts during from 2010 until 2014 and occurs at only 1-month time scale.

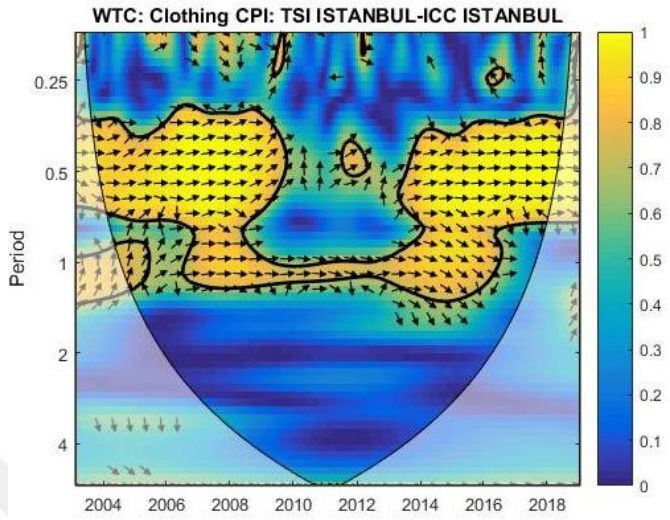


Figure 13: The Wavelet Coherence of Clothing Expenses CPI between TSI Istanbul and ICC Istanbul

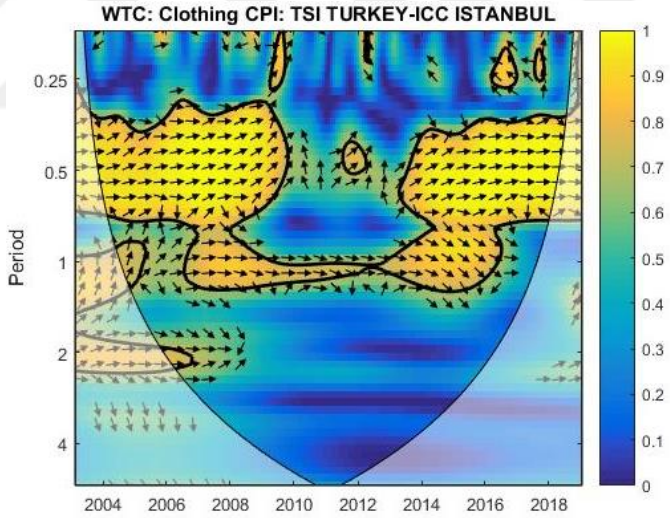


Figure 14: The Wavelet Coherence of Clothing Expenses CPI between TSI Turkey and ICC Istanbul

Both of two figures for clothing expenses display that the variables are positively related with arrows pointing slightly upwards and downwards at different time scales. While ICC Istanbul leads both TSI Turkey and Istanbul until 2010 at 1~3 week time scale; the vice versa effect has been observed at a 3~5 week time scale between 2013 and 2016 years. It is

possible to say that ICC Istanbul is leading the other variables in a short period of time though this effect may be interrupted during any economic crisis.

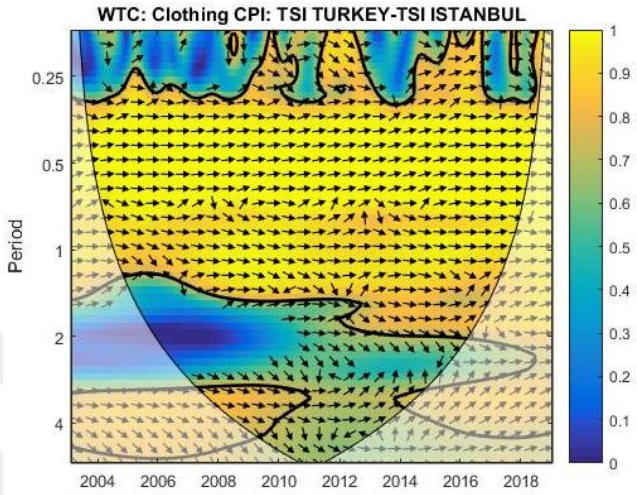


Figure 15: The Wavelet Coherence of Clothing Expenses CPI between TSI Turkey and TSI Istanbul

This time, although the big part of the COI is significant in Figure 15 i.e. the relationship between TSI TR and TSI Istanbul, there are also insignificant fields at low and high frequencies. The variables seem to be independent of each other under 1,5 weeks and above 2-month time scale. The results indicate that the clothing prices of Turkey and Istanbul are very coherent 1,5~7 week time scale despite occurring fluctuations in the very short term.

The phase angle demonstrated by arrows-signals that the two variables are almost positively significant. However, there is not an exactly leading or lagging effect between the variables due to the fast and inconsistent changing of the phase arrows. Hence, it is difficult to imply a definite causality relationship.

Figure 16-18 include the coherency analysis of health and personal care expenses between the variables. This group is another field that we have combined some expenditure groups in TSI CPI to create a more comparable index group. The weighted of the group in CPI is relatively low both in TSI and ICC CPI calculations.

The relationship between TSI Istanbul-Turkey (separately) and ICC Istanbul is rarely significant at different time scales (especially at higher frequencies through analysis period). While the variables are out of phase (negatively related) before 2012, they are in phase (positively related) at high frequencies with both leading and lagging effect after 2012.

The most significant area occurs at frequencies corresponding to the time scales of 3~5 weeks between 2016 and 2018. In that area, TSI Turkey and Istanbul (separately) are leading ICC Istanbul due to the direction of arrows.

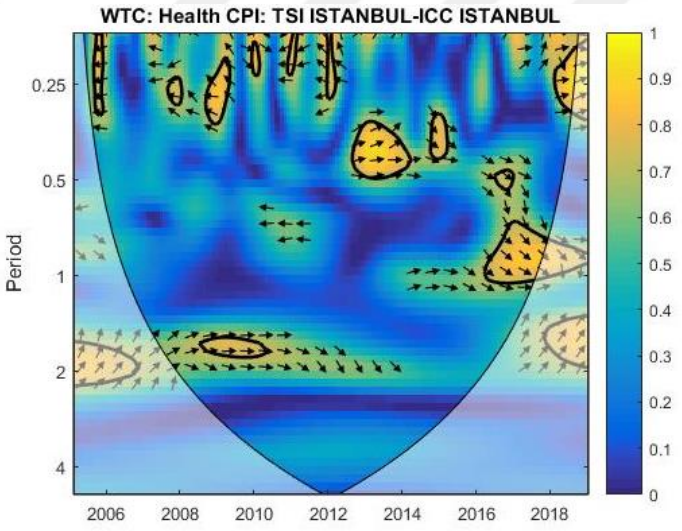


Figure 16: The Wavelet Coherence of Health and Personal Care Expenses CPI between TSI Istanbul and ICC Istanbul

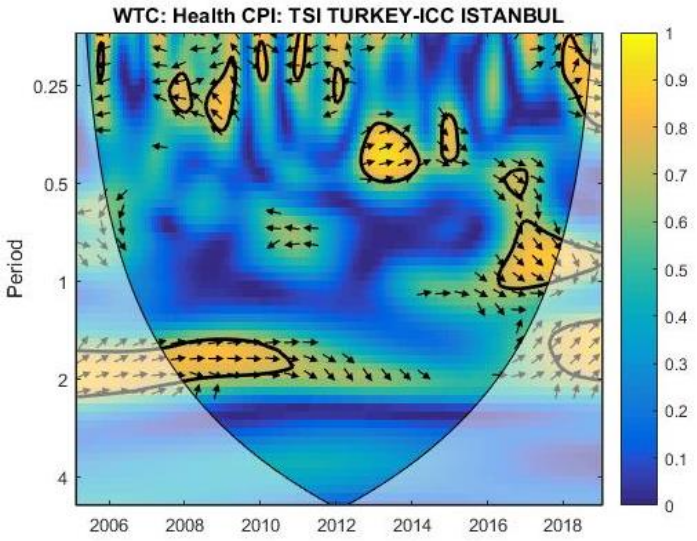


Figure 17: The Wavelet Coherence of Health and Personal Care Expenses CPI between TSI Turkey and ICC Istanbul

To interpret in shortly Figures 16 and 17, there are both positive and negative relationships between the variables. Likewise, it is clear that the significant fields are transitory and have a short term at different time scales.

The result of the wavelet analysis in Figure 18 shows that there is a statistically significant and positive relationship between TSI Turkey and Istanbul at different time scales. The significant relationship continues throughout the analysis period until 2013 but breaks for a short term and occurs again at a 3~7 week time scale between 2014 and 2018 with arrows pointing slightly downwards.

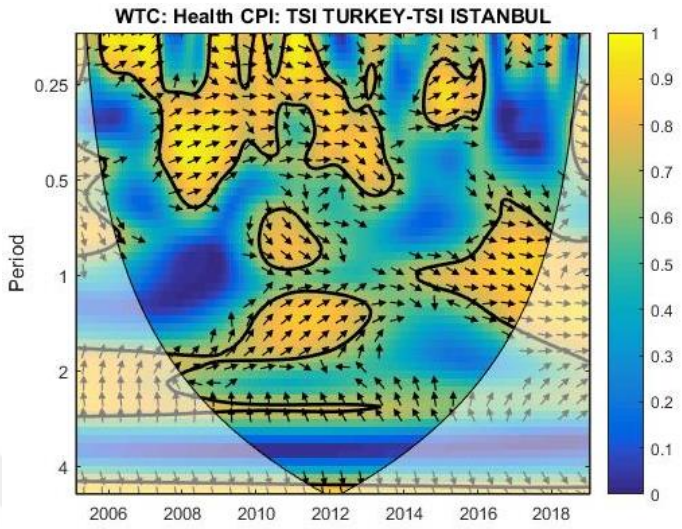


Figure 18: The Wavelet Coherence of Health and Personal Care Expenses CPI between TSI Turkey and TSI Istanbul

The results indicate that health and personal care expenses in Turkey lead the prices of that group in Istanbul CPI in short time period in any economic crisis, but this effect occurs in the medium term in the normalization period.

Figure 19-21 include the wavelet coherency analysis of transportation and communication expenses between the variables (this is another combined group by us). This group's weights are quite different between TSI and ICC CPI calculations.[10]

Figure 19 and 20 look like similar and the significant fields are not widespread or continuous in the charts unlike in Figure 21. The variables are in phase (positively related) almost all in significant areas. While the most significant area reveals at 6~8 week time scale between 2008 and 2012, the other significant areas occur at higher frequencies. Generally, ICC Istanbul is leading TSI Istanbul and Turkey (separately) after 2008 in spite of the transitory significant relationship.

[10] This assumption is made according to the weights in the 1985 based consumer price index since the 1995 based index weights of ICC is not shared with public.

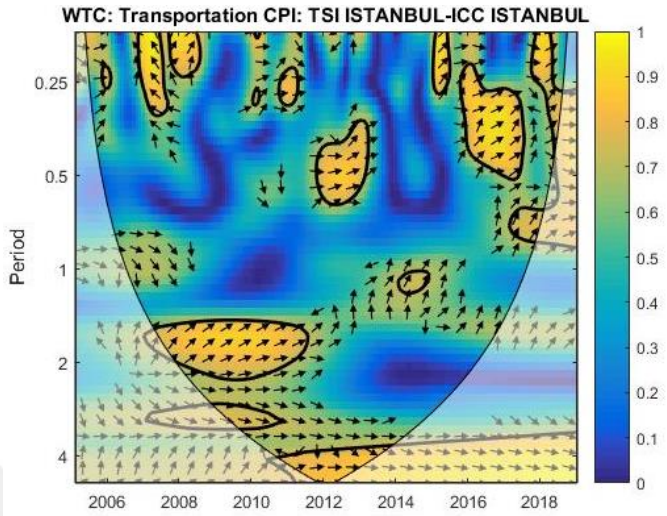


Figure 19: The Wavelet Coherence of Transportation and Communication Expenses CPI between TSI Istanbul and ICC Istanbul

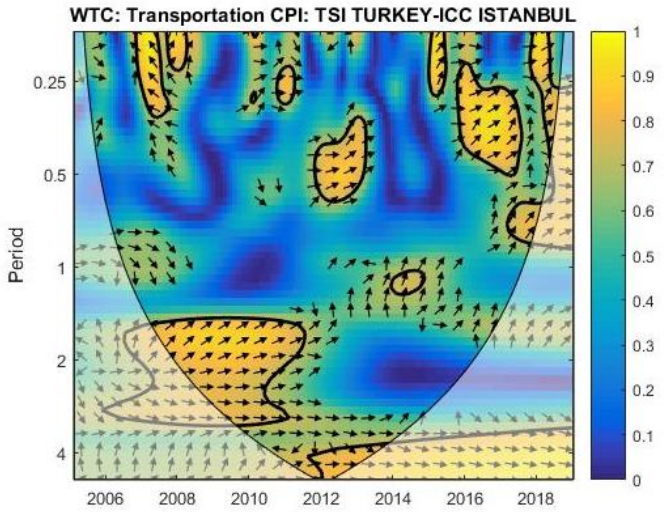


Figure 20: The Wavelet Coherence of Transportation and Communication Expenses CPI between TSI Turkey and ICC Istanbul

Additionally, there is a significant relationship between TSI Turkey and Istanbul at different time scales as Figure 21 demonstrates. The relationship is positive in sign and TSI Istanbul is leading TSI Turkey especially after 2010 at 1~2 month time scale. Conversely, TSI Turkey is leading for a short term in 2012 at 2-month time scale.

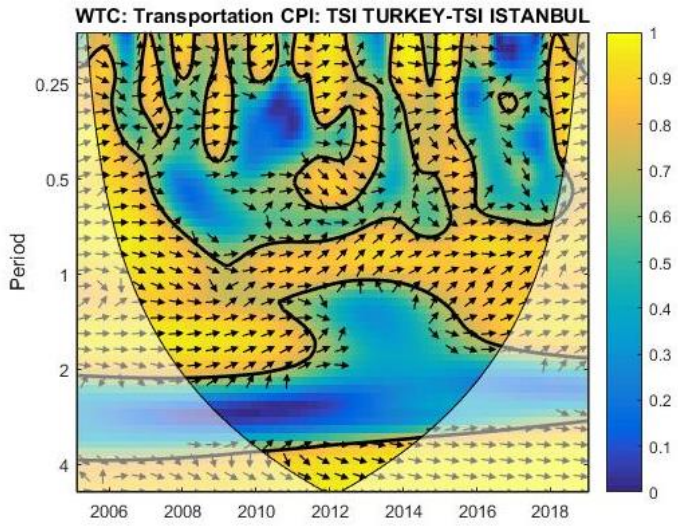


Figure 21: The Wavelet Coherence of Transportation and Communication Expenses CPI between TSI Turkey and TSI Istanbul

Although there is a significant but transitory relationship at high frequencies, continuously relationship has been seen at different time scales (especially at 3~7 week time scale). This result signs that transportation and communication prices of Turkey have a strong effect on Istanbul prices of that group in the medium term.

Finally, Figure 22:24 display the wavelet coherence analysis of cultural, educational and entertainment expenses between the variables. This group represents the last combined group by us to make a better comparison between TSI and ICC CPI.

The significant relationship breaks in 2012 in Figure 22 and 23. Before that year, there are both positive and negative relationships in the sign at different time scales, but ephemeral relations do exist at very short time scales. This is probably due to the variation of the item list in the group of TSI and ICC CPI.

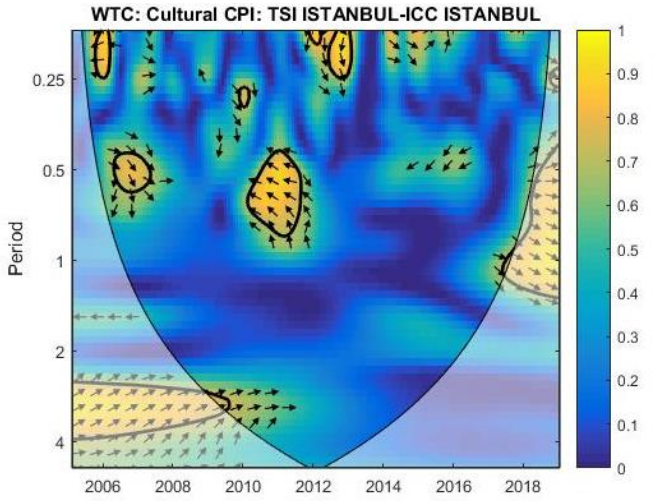


Figure 22: The Wavelet Coherence of Cultural, Educational and Entertainment Expenses CPI between TSI Istanbul and ICC Istanbul

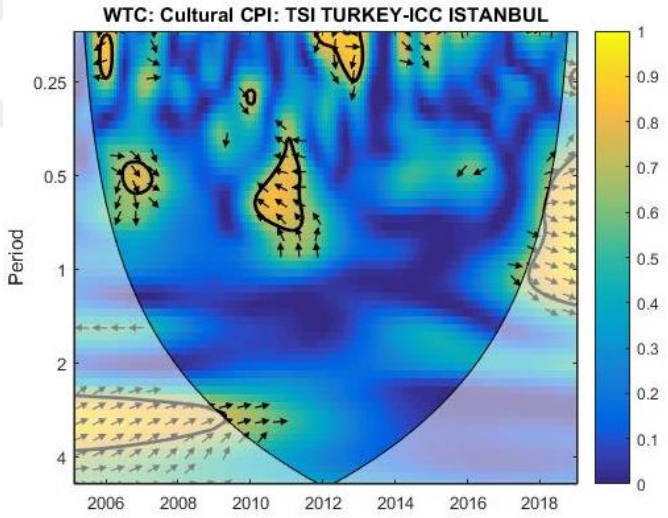


Figure 23: The Wavelet Coherence of Cultural, Educational and Entertainment Expenses CPI between TSI Turkey and ICC Istanbul

Like many previous cases, the relationship between TSI Turkey and Istanbul is positive and significant at different time scales within the analysis period. There are both leading and lagging effect at higher frequencies (until 1-month time scale) between the variables. Besides, TSI Istanbul is leading TSI Turkey after 2012 at 2-month time scale. The

cultural, educational and entertainment prices of Istanbul could affect the Turkey prices in that group only medium term.

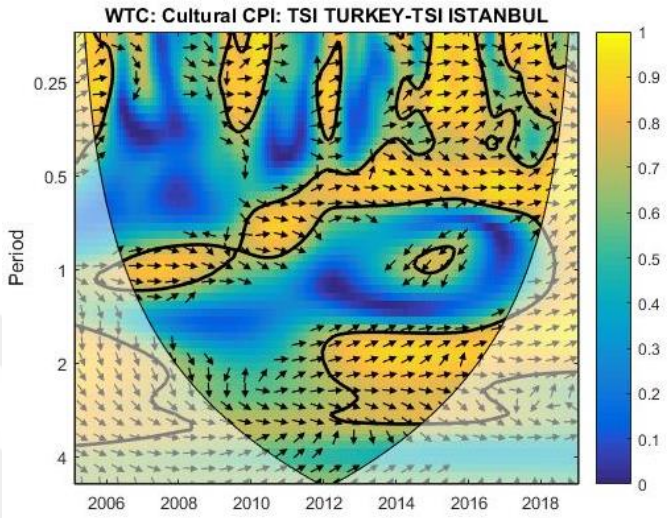


Figure 24: The Wavelet Coherence of Cultural, Educational and Entertainment Expenses CPI between TSI Turkey and TSI Istanbul

To evaluate all empirical findings in general, the statistically significant relationship is found in 7 of 8 fields, including the general CPI, at different time scales throughout the analysis period. Almost all variables are in phase (positively related) and leading or lagging effect differs according to the type of expenditure group and the time scales.

The most significant relationship is observed between TSI Istanbul and TSI Turkey. This corresponds that there is a price convergence between Turkey and Istanbul in terms of both general prices and main expenditure groups. On the other hand, ICC CPI is not only coherent with TSI CPI but also dissociated from each other on some expenditure groups.

In more detail, TSI Turkey and Istanbul (separately) lead ICC Istanbul in food expenditures, which is one of the main expenditure group in CPI, especially in short term; while ICC Istanbul prices are leading the others in dwelling expenditures, is another important expenditure group in CPI, and also in general price index in the medium term.

Those findings are important for economic agents to make a better policy for predicting the price movements and managing price stabilization on the household's expenditure groups. For example, ICC Istanbul CPI is leading both TSI Turkey and Istanbul CPI in the medium term. Especially this effect is seen in dwelling and transportation prices. Accordingly, the prices of those main groups should be followed specifically by economic agents in order to take measures in case of any remarkable price increase.

7. CONCLUSION

CPI is known as a very important area in the Turkish economy since it is closely related to the households regarding the cost of living and consumption behaviors. Both in terms of its population and economic charm, Istanbul has an important and special position in Turkey. In this respect, the announcement of CPI by two different public institutions in Istanbul is attention-grabbing and worthwhile to study on this subject.

Although the researches in the literature focused on the convergence of the prices among cities, in this study we analyzed two different price indices for the same city. The relationship between the two CPI series is investigated not only in one city but also compared with the price movements in Turkey. Besides, the reflections of the international economic crisis period are carefully examined with respect to price indices coherency.

When we look at the empirical findings briefly, ICC Istanbul leads TSI Istanbul in the groups of dwelling, household, and transportation-communication expenses whereas TSI Istanbul leads the ICC Istanbul in the groups of food, and health and personal care expenses, respectively. In clothing expenses group, there is no causality for the most part of the significant areas. On the other hand, it has been observed that the relationship in cultural, educational and entertainment expenses has broken since 2013.

The variables are almost positively related among themselves. The most significant relationship is observed between TSI Istanbul and TSI Turkey series due to the same source of the CPI calculation and the weightiness of Istanbul population in Turkey. However, it is seen that the relationship between TSI Turkey and ICC Istanbul becomes stronger in most of the expenditure groups, especially after the financial economic crisis.

It is also observed that both the significant fields and the leading or lagging effect between the variables changes from early of the financial crisis through the ongoing effect period in the Turkish economy. This gives the idea that price coherency may change between

Turkey and Istanbul CPI in a certain period with an economic crisis and also continues approximately 2-3 years more though it is not permanent.

Regarding aforementioned reasons, this study is pretty dissimilar compared to other studies in the literature by examining two different consumer price indices for one city, and important to forecast price movements in Turkey during any economic shock considering the place of Istanbul in the country's economy. This issue is very critical both for monetary policymakers and the politicians interested in the cost of living in Istanbul which is the most crowded city in Turkey.

Since it is not plausible to be authorized for accessing the whole specific information about the calculation of TSI and ICC CPI, results of the empirical findings are based upon some assumptions. But it is surely clear that the meaningful and apparent results of the coherency analysis are very important for the economic agents.

This thesis will serve as an example to similar future studies at three important aspects. First of all, the issue of city-based separation may be discussed in the inflation targeting of the CBRT by analyzing the general level of prices with the some cities' prices in Turkey or the price convergence among those cities.

Secondly, ICC price movements might be considered as a leading indicator despite a limited area. In this way, efficiency could be increased in the fight against inflation within the framework of fiscal policies such as tax relief or incentive in terms of the main expenditure groups which we have analyzed.

Finally, the dramatic depreciation of Turkish Lira against the U.S. Dollar as from the second half of 2018 so-called currency crisis which triggered high inflation could be analyzed in more detail with regards to the coherency of city prices. Thus, it will be possible to observe closely how price movements change during an internal economic crisis compared with an external one. It is because we have already analyzed an external crisis which is the 2008 global financial crisis effects on the variables in this paper.

In line with those considerations, we believe that future studies on a similar issue will provide valuable contributions to make more effective monetary and fiscal policy production.

APPENDICES

APPENDIX 1.

Nomenclature of Territorial Units for Statistics

Code	Definition
TRA1	ERZURUM, ERZİNCAN, BAYBURT
TRA2	AĞRI, KARS, IĞDIR, ARDAHAN
TRB1	MALATYA, ELAZIĞ, BİNGÖL, TUNCELİ
TRB2	VAN, MUŞ, BİTLİS, HAKKARİ
TRC1	GAZİANTEP, ADIYAMAN, KİLİS
TRC2	ŞANLIURFA, DİYARBAKIR
TRC3	MARDİN, BATMAN, ŞIRNAK, SİİRT
TR10	İSTANBUL
TR21	TEKİRDAĞ, EDİRNE, KIRKLARELİ
TR22	BALIKESİR, ÇANAKKALE
TR31	İZMİR
TR32	AYDIN, DENİZLİ, MUĞLA
TR33	MANİSA, AFYONKARAHİSAR, KÜTAHYA, UŞAK
TR41	BURSA, ESKİŞEHİR, BİLECİK
TR42	KOCAELİ, SAKARYA, DÜZCE, BOLU, YALOVA
TR51	ANKARA
TR52	KONYA, KARAMAN
TR61	ANTALYA, ISPARTA, BURDUR
TR62	ADANA, MERSİN
TR63	HATAY, KAHRAMANMARAŞ, OSMANİYE
TR71	KIRIKKALE, AKSARAY, NİĞDE, NEVŞEHİR, KIRŞEHİR
TR72	KAYSERİ, SİVAS, YOZGAT
TR81	ZONGULDAK, KARABÜK, BARTIN
TR82	KASTAMONU, ÇANKIRI, SİNOP
TR83	SAMSUN, TOKAT, ÇORUM, AMASYA
TR90	TRABZON, ORDU, GİRESUN, RİZE, ARTVİN, GÜMÜŞHANE

Source: TurkStat NUTS, 2005

APPENDIX 2.

The methodological comparison of ICC Istanbul cost of living indices for wage earners

Base year	**1914**	**1963**	**1985**
Item number	27	107	242
Main and subgroup number	4	5 main, 10 subgroups	8 main, 11 subgroups
Consumption unit	A middle-income family of 5 people (Mother, father, three children aged 1.5 - 7 and 15 years old)	The average number of family members is 3.56	Instead of the family unit, the number of standard individuals is taken into consideration and the average number of standard individuals is 3.11
Price compilation number	27	237	15.275
Number of price compiled regions	1 region from Istanbul	3 regions from Istanbul	15 regions from Istanbul
Base year prices	Prices compiled as of July 1914 were used.	The average prices of 1963 were used.	The average prices of 1985 were used.
Weighting method	The total cost of fuel (for heating) and clothing in a year was taken into account, divided into the twelve months of the year to determine the fixed expense for the other items.	As a result of the Family Budget Survey of 1953, fixed weights were used for the subjects of the index.	In 1985 Family Budget Survey, variable weight was used for fresh and dry fruits and vegetables, meat, fish and poultry, and clothing. For all the other groups, fixed weight was used.
Shopping place weights	-	-	For food and clothing, a load of grocery stores, supermarkets, and department stores were taken into consideration.
Index calculation stages	3-stage: Substance - main group - general	4-stage: Substance - subgroup - main group - general	5-stage: Shopping weighted item price substance - subgroup - main group - general
Calculation of index	The general index is determined by multiplying total cost volume by the main group index achieved by dividing the total sums that were multiplied one by one by the current and base year price consumption volume into each other.	Current/base year price reveals the item index. It determines the subgroup index when evaluated with item volume; main group index when evaluated with subgroup index. And the main index is reached with the share of the main group in the total expenditure.	Item index determined by the current/base year price of the Shopping item was evaluated with: - the item weight to determine the subgroup - the subgroup weight to determine the main group index - the main group weight in the total expenditure to find the general index.

Source: ICC (Price Index Calculation Methods and Applications in Turkey, 1998)

APPENDIX 3.

Main and Some of Sub Expenditure Group Weights in CPI (2003=100), 2005:2018 (%)

Weights by main expenditure groups and some of sub expenditure groups consumer price index (CPI)

Main expenditure group	Years													
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
01 Food and non-alcoholic beverages	29,42	27,68	28,47	28,62	28,03	27,60	26,78	26,22	24,09	24,45	24,25	23,68	21,77	23,03
02 Alcoholic beverages and tobacco	4,67	5,62	5,06	5,00	4,58	5,31	5,90	5,21	5,07	5,29	4,82	4,98	5,87	5,14
03 Clothing and footwear	8,09	8,28	7,85	8,07	7,22	7,30	7,22	6,87	6,83	7,17	7,38	7,43	7,33	7,21
04 Housing	16,90	16,29	16,62	16,60	18,63	16,83	16,46	16,44	16,68	16,41	15,79	15,93	14,85	14,85
05 Furnishings, household equipment	6,47	6,89	7,22	7,41	7,53	6,78	6,93	7,45	7,28	7,52	7,78	8,02	7,72	7,66
06 Health	2,71	2,54	2,66	2,54	2,50	2,55	2,40	2,29	2,22	2,44	2,57	2,66	2,63	2,64
07 Transportation	10,42	10,48	11,60	12,59	12,64	13,90	15,15	16,73	17,99	15,54	15,38	14,31	16,31	17,47
08 Communication	4,82	4,55	4,41	4,30	4,60	4,94	4,64	4,60	4,64	4,70	4,38	4,42	4,12	3,91
09 Recreation and culture	3,60	3,63	3,16	2,81	2,54	2,83	2,70	2,98	2,95	3,36	3,54	3,81	3,62	3,39
10 Education	2,15	2,41	2,15	2,24	2,47	2,48	2,32	2,18	1,91	2,26	2,53	2,56	2,69	2,67
11 Hotels, cafes and restaurants	5,87	6,75	6,40	5,64	5,47	5,51	5,89	5,63	6,18	6,58	6,98	7,47	8,05	7,27
11.1 *Restaurants*	*56,09*	*57,89*	*90,27*	*89,99*	*91,76*	*91,70*	*92,66*	*91,19*	*90,37*	*89,01*	*88,97*	*89,01*	*87,97*	*86,99*
11.2 *Hotels*	*43,91*	*42,11*	*9,73*	*10,01*	*8,24*	*8,30*	*7,34*	*8,81*	*9,63*	*10,99*	*11,03*	*10,99*	*12,03*	*13,01*
12 Miscellaneous goods and services	4,87	4,90	4,39	4,16	3,79	3,97	3,61	3,40	4,16	4,28	4,60	4,73	5,04	4,76
12.1 *Personal care*	*41,66*	*45,42*	*50,38*	*51,84*	*52,33*	*54,01*	*54,60*	*57,00*	*52,75*	*57,49*	*56,48*	*55,38*	*48,11*	*49,98*
12.2 *Personal care products (non-classified)*	*49,17*	*33,42*	*28,99*	*25,73*	*27,44*	*27,60*	*29,36*	*26,49*	*26,92*	*19,39*	*21,02*	*21,05*	*32,48*	*31,65*

Source: TurkStat, CPI (2003=100)

APPENDIX 4.

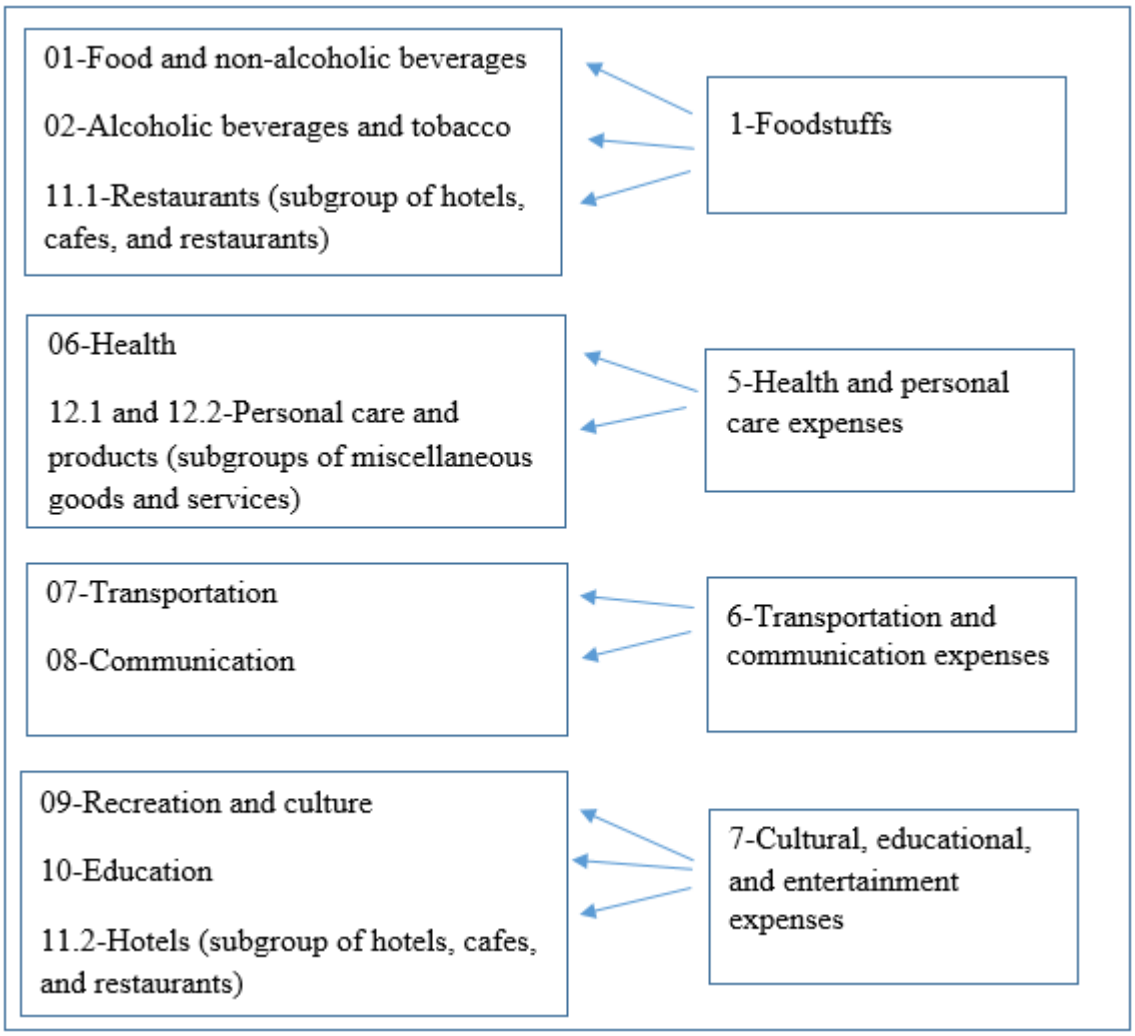
The CPI's Some Expenditure Groups in TSI and ICC

Expenditure Groups of TSI	**Main and Sub Expenditure Groups of ICC**
1. Food and non-alcoholic beverages	**1. Foodstuffs**
2. Alcoholic beverages and tobacco	*1.1. Bread and cereals*
3. Clothing and footwear	*1.2. Meat, fish, and poultry*
4. Housing, water, electricity, gas and other fuels	*1.3. Oils, dairy, products, and eggs*
5. Furnishing, household equipment, routine maintenance of the house	*1.4. Fresh and dried vegetables and fruits*
6. Health	*1.5. Various processed foods*
7. Transportation	*1.6. Tobacco, alcoholic and nonalcoholic beverages*
8. Communication	*1.7. Outside dining*
9. Recreation and culture	**2. Dwelling expenses**
10. Education	**3. Household expenses**
11. Hotels, cafes, and restaurants *11.1 Restaurants* *11.2 Hotels*	**4. Clothing expenses**
12. Miscellaneous goods and services *12.1 Personal care* *12.2 Personal care products (non-classified)*	*4.1. Men's wear*
	4.2. Women's wear
	4.3. Children's wear
	4.4. Fabrics
	5. Health and personal care expenses
	6. Transportation and communication expenses
	7. Cultural, educational and entertainment expenses
	8. Other expenses

Source: ICC and TSI (Terminology is used from ICC and TSI CPI sub-breaks)

APPENDIX 5.

Reorganized Main and Sub Expenditure Groups of TSI according to ICC Groups



APPENDIX 6.

The Mathematical Explanation of the Recreated Index

(A case for foodstuffs CPI of Istanbul)

	A	B	C	D	E	F	G	H	I	J	K	L
1		Index			Weight					Index		
2	TERM	*Food and non-alcoholic beverages*	*Alcoholic beverages and tobacco*	*Hotels, cafes, and restaurants*	*Food and non-alcoholic beverages*	*Alcoholic beverages and tobacco*	**Restaurants*	*Hotels, cafes, and restaurants*	***Restaurants (%)*	Foodstuffs	Foodstuffs (2005=100)	*The coefficient for 2005=100*
27	Jan-05	114.74	122.62	123.12	29.4207	4.6673	**3.29246539**	5.87	56.0897	**43.53403783**	**97.73679138**	2.245066074
28	Feb-05	116.85	125.75	125.6	29.4207	4.6673	**3.29246539**	5.87	56.0897	**44.38255423**	**99.64176677**	
29	Mar-05	116.6	126.18	129.91	29.4207	4.6673	**3.29246539**	5.87	56.0897	**44.47097713**	**99.84028201**	
30	Apr-05	114.29	126.3	131.5	29.4207	4.6673	**3.29246539**	5.87	56.0897	**43.84930992**	**98.44459805**	
31	May-05	115.05	126.34	132.75	29.4207	4.6673	**3.29246539**	5.87	56.0897	**44.11592998**	**99.0431777**	
180	***	***	***	***	***	***	***		=(B27*E27/100)+(C27*F27/100)+(D27*G27/100)		***	=J27*L27
188	Jun-18	418.53	568.1	512.12	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**157.9787174**	**354.6726587**	
189	Jul-18	418.96	573.38	522.8	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**159.0245534**	**357.0206296**	
190	Aug-18	420.82	575.61	538.08	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**160.5341346**	**360.4097392**	
191	Sep-18	449.42	576.41	563.68	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**168.7824903**	**378.9278428**	
192	Oct-18	463.61	577.76	568.59	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**172.4309981**	**387.1189838**	
193	Nov-18	456.06	578.79	569.71	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**170.8156585**	**383.4924398**	
194	Dec-18	463.55	579.82	571.25	23.0343	5.1358	**6.326013779**	7.2723	86.9878	**172.6912469**	**387.7032597**	
195												
196	*	**The weights of the sub-expenditure group calculated by us**						**i) The bold numbers are calculated by us.**				
197	**	**The sub-expenditure group share in "hotels, cafes and restaurants" main expenditure gorup.**										
198	***	**The term between 2005:06 - 2018:05 is hidden for this sample.**						**ii) Foodstuffs refers the new index.**				

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