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Seasonal Unit Root: An Application to Turkish Industrial Production Series*

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Abstract: *The aim of this study is to investigate the seasonal patterns of five Turkish manufacturing industry series which have the main characteristics of Turkish economy during the 1977:1-2008:4 periods. Many economic time series are often subject to systematic fluctuations within the year such as seasonal movements. All the studies concerning time series methods are useful only when the series do not show seasonal patterns or the methods that care of seasonal patterns used. For this reason, it is important to investigate the seasonal patterns of the series when working with economic time series data. The analysis is conducted using the HEGY approach developed by Hylleberg, Engle, Granger and Yoo (1990). It is important to determine what kind of seasonality is present in the data. For this reason, we search for the seasonal unit root with five different models that concern, trends, constant and seasonal dummies. We provide evidence on the presence of seasonal unit roots in the Turkish manufacturing industry series. The main finding is that there are both deterministic and non -stationary stochastic seasonality in the series.*

Keywords: Seasonality, Seasonal Unit Root, HEGY Test Approach, Turkish Industrial Production Series

JEL Classification: C01, L60

1. Introduction

The role that the manufacturing industry plays in the economy is one of the basic indicators in a country's economic development process, and perhaps the most significant one. The manufacturing industry has a special place and importance in this respect in that it shows the production, employment and innovativeness capacities of countries. In addition, the scale of the industry indicates the economic development performance of economies. In other words, rapid development and growth performance has a direct relation with and proportion to the existing industrial scale of the country in question. Therefore, the examination and analysis of the manufacturing industry and the related fields are of vital importance for understanding the economic system in a country and for developing and implementing the suitable strategies and policies.

International competition in the world economy has a direct and/or indirect effect on the national economies and their manufacturing industries. Having a significant human capacity as far as industrialization is concerned, the Turkish economy naturally experiences her share of such effects and reaps their proceeds in her own way. If we examine the economic development of Turkey, we can see that there are two most important periods in

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the history of industrialization. The first of these is a period dominated by import-substitution industrialization strategies. The following period, meanwhile, was predominated by export-based industrialization strategies shaped by foreign expansion policies that were implemented. An increase in exports was, thus, made possible thanks to the implementation of outward-oriented industrialization strategies in the 1980s and thereafter. This policy change came in the footsteps of the abandonment of the import-substitution industrialization strategies as a result of the economic depression and uncertainties experienced in the 1970s and of the liberalization of foreign trade. In the process of this foreign expansion and exportation, the manufacturing industry once again proved its importance.

The economic crises experienced in the Turkish economy have always caused a shrinkage in the manufacturing industry. Yet this shrinking trend changed in time, varying also the reactions to and consequences of crises. As Doğruel and Doğruel (2008:39) expressed briefly: "*The shrinkage in the manufacturing industry which took place in the crises of 1979-1980 and 1994 was of a higher rate than that of the whole economy. On the other hand, the circumstances (were) reversed in (the) crises of 1999 and 2001 and the shrinkage in the manufacturing industry remained low in comparison with the whole economy. Based on this evaluation, it will not be wrong to say that there has been a recovery in the body of the manufacturing industry. The manufacturing industry represent(s) that strong side of (the) economy especially when there is no crisis.*"

One of the prerequisites for the proper selection and implementation of the correct strategies and policies for the country's economy is the exact determination, understanding and pure analysis of the seasonality in the deterministic time series indicators of the economic system. McDougall (1995) has investigated the seasonality using the test which is commonly preferred in the literature and referred to as HEGY method as it was developed by Hylleberg, Engle, Granger and Yoo (1990) for New Zealand macroeconomic variables. McDougall (1995) implies that Using standard ADF tests many quarterly macroeconomic time series for New Zealand appear to exhibit stochastic non-stationary, with the exception of a few which appear stationary. Seasonal adjustment was found to alter the results for some of the variables indicating that the treatment of seasonality can affect the outcome of the tests. Ünsal (1997) has investigated the seasonality in the time series of the number of tourists coming to Turkey between 1985-1995 and, after the determination of the seasonal effect, has developed a new quarterly data grouping other than the conventional season approach (spring, summer, autumn, winter). With the new grouping method based on the study, the results of the regression analysis performed in order to explain the variation in the number of tourists were better as compared to those obtained by the analysis using the conventional season approach. Yamak and Yamak (1999), studying the type and extent of the seasonality in Turkish economy, have analyzed 22 macroeconomic time series. Based on this study, it was determined that a majority of the series exhibited a characteristic of seasonality and that the seasonal characteristics determined were deterministic, not stochastic as expected. The result obtained in the studies of Yamak and Sivri (1998) analyzing seasonality in Turkish industrial production shows that private sector production series have a predominantly deterministic seasonal characteristic and public sector series are predominantly stochastic.

Osborn et.al. (1999) have investigated seasonality in monthly industrial production in important sectors of the German, French and UK economies. Results are shown to exhibit very strong seasonality, such that typically 80% or more of the variation in monthly growth can be attributed to seasonal effects. Seasonal unit root test results imply that most of these series should be modelled using conventional first differences with the inclusion of monthly dummy variables, rather than as specifications involving other levels of differencing. Osborn et.al. (1999) examine the impact of updating coefficient estimates and model respecification within the forecast period. Martin-Âlvarez et.al. (1999) present a methodological proposal of the way integration and cointegration analysis can best be used to test if the level of aggregation of an index is adequate. Writers, using this proposal, enquire the extent to which a Spanish aggregate farm price index captures the behavior of its components. According to study an important result of analysis is that there are two basic stochastic trends, one corresponding to FOP and the other to the remaining three series. Martin-Âlvarez et.al. (1999) argue that it could be possible, therefore, to obtain an index representing the behaviour of the latter three series. Alper and Arıoba (2001) investigated the seasonality due to religious holidays in Turkey and their effects, and determined that religious holidays have seasonality. According to Ayvaz (2006), investigating the seasonal structure indicated by GNP, consumption, export and import series in the Turkish economy, the consumption series involve stochastic seasonality, while GNP and export series involve deterministic seasonality. Furthermore, no unit root is observed in the import series with by semi-annual and annual frequencies. In a study conducted by Çavdarlı (2007), the unit root test was applied to payment per employment in public and private sector, investment, input, output, added value, export and import series in the Turkish manufacturing industry, and the long-term relationship between the relevant series was investigated using cointegration analysis. Polat and Uslu (2010) who analyzed the seasonal structure of export and import time series in Turkey determined that both deterministic and non-stationary stochastic seasonal components existed in export and import series. The literature also contains studies which investigate seasonality in the income-for-life hypothesis for Turkey (Çağlayan, 2003; Sivri, 2009). Ayvaz Kızılgöl (2011) tests seasonal unit root in GDP, export, consumption and investment series for Turkey economy between 1987 and 2007 with using quarterly data. According to HEGY test results, there is no any cointegration relationship between the series zero-frequency and semi-annual frequency. If there are seasonal dummy and constant term in the quarterly frequency, cointegration relationship between GDP and consumption series is seen.

In the study where the seasonal mobility of Industrial Production series with economic significance formed the motivational point, the industrial production index estimated by the Turkish Statistical Institute (TURKSTAT) is analyzed. Based on the definition of International Standard Industry Classification (ISIC) and on the data compiled by the Turkish Statistical Institute (TURKSTAT), the Turkish Industrial Production Series basically covers (i) the mining industry, (ii) the manufacturing industry, (iii) electricity, gas and water sectors under ISIC Rev. 3. Of these sub-sectors, the manufacturing industry carries a proportion of 86.92% of the total, mining 4.89% and electricity, gas and water sector 8.19%. In the study, seasonal effects were investigated in each of the three sub-sectors and in the overall Industrial Production index.

Though there are various methods used in literature for seasonal modelling, the most commonly preferred HEGY test developed by Hylleberg, Engle, Granger and Yoo (1990) was used in this study to investigate the seasonality in the Industrial Production between 1977-2008. In this context, the seasonal behaviour as for seasonal unit root of the seasonally unadjusted quarterly Turkish Industrial Production Index and sub-sectors are analysed.

2. Methodology

In empirical literature, seasonality in time series analysis can be categorised into three different types as deterministic seasonality, stationary seasonality and seasonal unit root process (Lei; 1998). The deterministic seasonality results from systematic effects and the shocks effecting the system, fade away after a certain period. Deterministic seasonality is modelled by means of seasonal dummy variables. The data generating process for y_t in deterministic seasonality is as follows;

$$y_t = \alpha + \beta_1 S_{1t} + \beta_2 S_{2t} + \beta_3 S_{3t} + u_t \quad (3.1)$$

Here, S_{it} represents the seasonal dummy variables, despite the fact that if time series follow a seasonal deterministic process, the absence of seasonal dummy variables will lead to model under specification (Leong, 1997).

The path to follow for stationary seasonality is standard and is modelled by an autoregressive process. However, the non-stationary seasonal process involves one or more unit roots in seasonal frequencies (Leong, 1997). This type of seasonality usually follows a random process, although it emerges at certain times of the year. The presence of seasonal unit roots, in other words, if the time series follow non-stationary stochastic processes, it has necessitated to perform seasonal integration and cointegration analysis.

Time series can follow a deterministic or stochastic seasonal process and they can involve both of these. Various methods have been developed in the literature with regard to testing the series as to whether they include seasonal unit root. The DHF test developed by Dickey, Hazsa and Fuller (1984) and the HEGY test developed by Hylleberg, Engle, Granger and Yoo (1990) are the most commonly used methods in the literature. While The DHF test analyzes only the seasonal unit root in series, the HEGY test also provides information as to what frequencies the seasonal unit roots are at (Polat and Uslu; 2010). The tests developed by Franses (1990) and Beaulieu and Miron (1992) have investigated seasonality in monthly frequencies.

Dickey, et al.(1984), who developed the study of Dickey and Fuller (1979), have investigated seasonal time series for monthly series using the regression below (Rodrigues ve Osborn; 1999);

$$\Delta_{12} y_t = \mu_t + \rho y_{t-12} + \sum_{i=1}^{\rho} \delta_i \Delta_{12} y_{t-i} + \varepsilon_t \quad (3.2)$$

Dickey, et al.(1984) have suggested the ordinary least-squares method in order to test the null hypothesis of $H_0: \rho = 0$ and they use t- type statistics as in standard unit root test. The table of critical values of these test statistics is given in Dickey, Hasza and Fuller (1984).

The HEGY test investigates the presence of seasonal unit root in quarterly data. With the HEGY test, it is investigated whether the series include unit roots and whether the seasonal unit root is deterministic or stochastic (Hylleberg, 1990). As seasonal unit root time series may include a unit root at seasonal frequencies, seasonal differencing methods are used in cases where they include a seasonal unit root. While $(1 - L^4)$the filter is used for differencing in quarterly data, the $(1 - L^{12})$filter is used for the monthly data (Leong, 1997).

$$(1-L^4)=(1-L^2)(1+L^2)$$

$$(1-L)(1+L)(1-iL)(1+iL) \qquad (3.3)$$

L in the polynomial in the equation (3.3) is the lag operator. Here, there are four unit roots which are, 1,-1, i and –*i*.

- +1; unit root at frequency zero (nonseasonal unit root)
- -1; semi-annual frequencies (½ frequency) seasonal unit root
- -*i*; unit root equal to quarter cycle or frequency ¼ ,¾.

The following regression is estimated for these roots tested with the HEGY (1990);

$$\Delta_4 y_{st} = \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \varepsilon_t \qquad (3.4)$$

Variables in equation (3.4) have been developed by Hylleberg (1990) and their expansions are shown below:

$$\Delta_4 = 1-L^4 = (1-L)(1+L)(1+L^2)$$
$$y_{1,t} = (1+L+L^2+L^3)y_t$$
$$y_{2,t} = -(1-L+L^2-L^3)y_t$$
$$y_{3,t} = -(1-L^2)y_t \qquad (3.5)$$

The model can be estimated using ordinary least-square estimators. In frequency zero, $H_0 : \pi_1 = 0$, the null hypothesis, is used to determine the presence of a unit root (non-seasonal unit root). That the null hypothesis cannot be rejected indicates that the series has a non-seasonal unit root in zero frequency. In other words, the time series has a non-seasonal stochastic trend. In such a case, (1 - *L*)the filter is used to make the series stationary. The $H_0 : \pi_2 = 0$ hypothesis is tested in order to investigate the presence of a seasonal unit root at semi-annual frequency. If this hypothesis cannot be rejected it indicates that the presence of a seasonal unit root in the series at semi-annual frequency and in this case the series will be made stationary by using a (1 + *L*) filter. Both hypotheses are tested using the one-tail t- test ($\pi_i < 0$). The $H_0 : \pi_3 = \pi_4 = 0$ hypothesis is tested in order to seek the presence of seasonal roots with annual frequency (i and –i). That the H_0 hypothesis cannot be rejected indicates the presence of a seasonal unit root with annual frequency (Hylleberg; 1990). The HEGY test hypotheses are given below:

$$H_0 : \pi_1 = 0 \qquad H_0 : \pi_2 = 0 \qquad H_0 : \pi_3 = \pi_4 = 0$$
$$H_1 : \pi_1 < 0 \qquad H_1 : \pi_2 < 0 \qquad H_1 : \pi_3 \neq 0 and / or \pi_4 \neq 0$$

Regression in equation (3.4) does not include deterministic variables such as constant, trend and seasonal dummy variables. The model can be extended by adding constant terms, trend and seasonal dummy to the regression as follows:

$$y_{4t} = \alpha_0 + \pi_i y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \sum_{i=1}^{k} \beta_i y_{4,t-i} + \varepsilon_t \quad (3.6)$$

Equation in (3.6) is the equation with a constant term, the model with both constant terms and seasonal dummy variable is:

$$y_{4t} = \alpha_0 + \pi_i y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \sum_{i=1}^{k} \beta_i y_{4,t-i} + \varepsilon_t \quad (3.7)$$

Meanwhile, the model with a constant term, seasonal dummy variables and trend is:

$$y_{4t} = \alpha_0 + \pi_i y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \gamma_t + \sum_{i=1}^{k} \beta_i y_{4,t-i} + \varepsilon_t \quad (3.8)$$

The equation is arranged by determining the optimal lags for each model. The calculated π values are compared to the table of critical values which were provided in Hylleberg's (1990) study. The basic hypothesis is that the series has unit root does not have the standard distributions for estimated parameters, and must be compared to the critical values in HEGY's (1990) study.

The HEGY test method also applies to quarterly data. The seasonal unit root test for monthly data was developed by Franses (1990).

$$\begin{aligned} \Delta_{12} y_t &= \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-1} + \pi_4 y_{3t-2} + \pi_5 y_{4,t-2} + \\ &\pi_6 y_{4,t-2} + \pi_7 y_{5,t-1} + \pi_8 y_{5,t-2} + \pi_9 y_{6,t-1} + \pi_{10} y_{6,t-2} + \pi_{11} y_{7,t-2} \\ &+ \pi_{12} y_{7,t-2} + \sum_{j=1}^{p} \alpha_j \Delta_{12} y_{t-j} + \varepsilon_t \end{aligned} \quad (3.9)$$

Here;

$$\begin{aligned} y_{1,t} &= (1+L)(1+L^2)(1+L^4+L^8)y_t \\ y_{2,t} &= -(1-L)(1+L^2)(1+L^4+L^8)y_t \\ y_{3,t} &= -(1-L^2)(1+L^4+L^8)y_t \\ y_{4,t} &= -(1-L^4)(1-\sqrt{3}L+L^2)(1+L^4+L^8)y_t \\ y_{5,t} &= -(1-L^4)(1+\sqrt{3}L+L^2)(1+L^4+L^8)y_t \\ y_{6,t} &= -(1-L^4)(1-L^2+L^4)(1-L+L^2)y_t \\ y_{7,t} &= -(1-L^4)(1-L^2+L^4)(1+L+L^2)y_t \end{aligned} \quad (3.10)$$

If π_1 statistically equals to 0 in model (3.9), yt has a non-seasonal unit root. The same procedures should be applied to other π as well. F statistics is applied for complex roots and t statistics is applied for other roots. The critical values were given in Franses and Hobijin (1997). Deterministic parts can also be added to the model set up for monthly series as in the HEGY test.

In this study, the seasonal behaviour of the seasonally unadjusted quarterly Turkish Industrial Production Index and sub-sectors is analysed. Data covers the period between 1977Q1–2008Q4 for the manufacturing industry, mining and quarrying, and electricity, gas and water production. The data were maintained from the Turkish Statistical Institute (TURKSTAT). Three different data sets for the manufacturing industry calculated based on different years were consolidated and turned into data using the 1997=100 based year. In this study, the presence of the seasonal unit root was investigated with the HEGY test through the Jmulti programme.

3. Data and Empirical Results

The data series used in this study are the quarterly total industrial production index and those for the sub-sectors, namely the manufacturing industry, mining and quarrying, and electricity, gas and water. In the study the different based year series are linked together. The combined series construct aggregate series and are obtained from the TURKSTAT. These series are obtained from the Turkish Statistical Institute[1]. The data cover the period from the first quarter of 1977 through to the fourth quarter of 2008 and the base year of the index is 1997=100.

I_t, denotes for Total Industrial Production Index, MQ_t, Mining and Quarrying, M_t Manufacturing Industry and EGW_t, Electricity, gas and water. The data are seasonally unadjusted values. The series are all in natural logarithmic scale. Figure 1 displays the run sequence plots of the series in logarithmic scales.

All of the series have an increasing trend and seems to be nonstationary. In the Mining and Quarrying series, this upward trending is less apparent. In contrast to the level series, the graphs of the first differenced series are all fluctuate around zero. The seasonal fluctuations can also be seen from the graphs and they become more clearer after the differencing procedure. Taking the fourth differences of the series will eliminate the seasonal determinants of the series. Figure 2 displays the series which were seasonally differenced.

[1] *The additional manipulations used for extending the series was conducted by TURKSTAT.*

Figure 1. Quarterly Series in Levels and First Differences

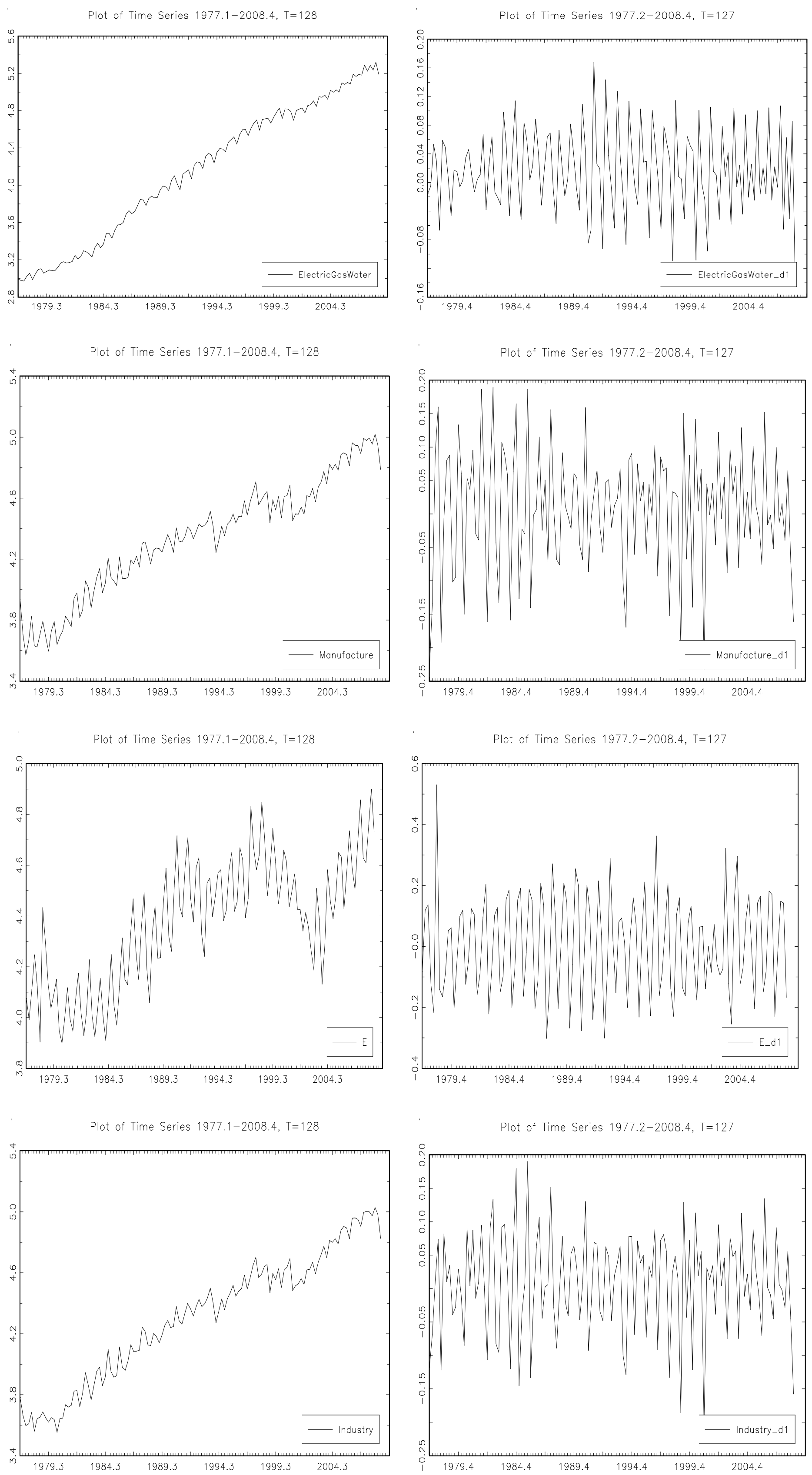
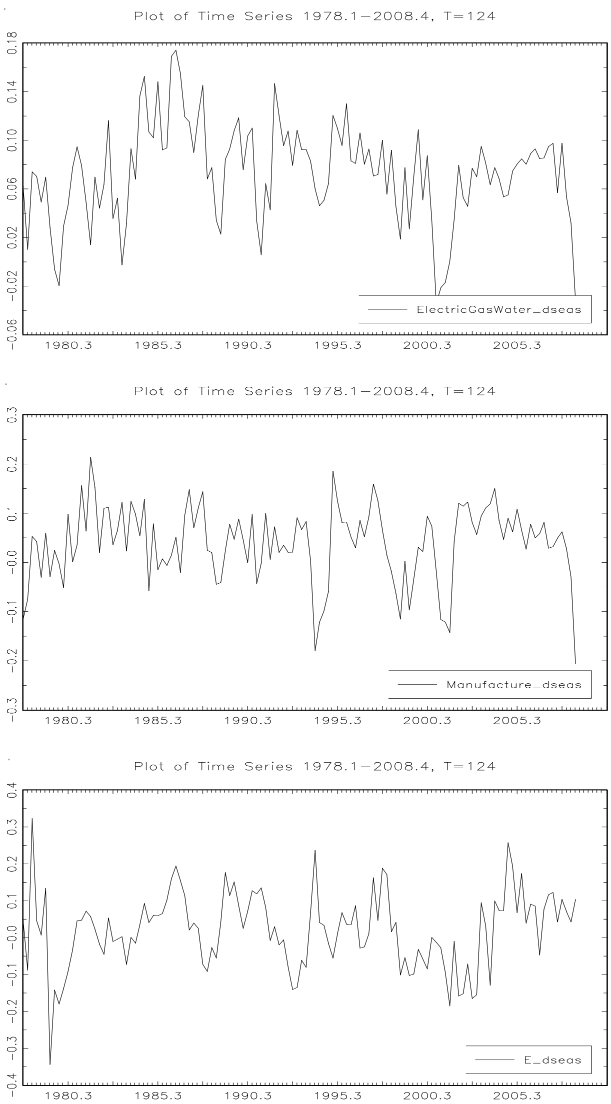


Figure 2. Seasonal differences for the I_t, MQ_t, M_t, EGW_t series



Beside the graphical analysis, the HEGY test was examined for the long-run and seasonal unit roots in all the Turkish Industrial Production series The HEGY test is designed for testing the null hypothesis of a unit root against the stationary alternatives. For testing the seasonality of the series, we apply five different models:

Model 1: The model without deterministic components.

Model 2: The intercept term is included in the model.

Model 3: The intercept term and the three seasonal dummy variables are included in the model.

Model 4: The intercept term and the trend are included in the model.

Model 5: The intercept term, the trend and the three seasonal dummy variables are included in the model.

The lags are determined using the AIC. For all the series the ARCH LM test indicates that there is no conditional autoregressive heteroscedeasticity in the residuals. Jargue- Bera test indicates normal residuals. The OLS estimates of Total Industrial Production Index for above models are reported in Table 1.

Table 1. The HEGY Test Results for the quarterly Turkish Industrial Production Index

Model	Lags	π_1	π_2	F3&4
Model 1(-)	5	2.5292	-1.5708	2.1442
Model 2(I)	5	-1.2701	-1.5403	2.1380
Model 3(I,S)	5	-1.2505	-2.2929	1.7636
Model 4 (I,T)	5	-2.1791	-1.5177	2.2375
Model 5 (I,S,T)	5	-2.1493	-2.2691	1.8361

*denotes 1% level of significance, **denotes 5% level of significance

As is clear from the Table 1, *t*- statistics of π_1 for all models are not significant at the 5% level, so we fail to reject the null hypothesis that $\pi_1 = 0$. Therefore, unit roots are found in the Industrial Production series at the zero frequency. This, in turn, shows the presence of a nonseasonal unit root in the series. Furthermore, π_2 and π_3, π_4 are also not significant. The series has seasonal unit roots at semi-annual and annual frequencies. This means that the series indicate seasonal patterns at all frequencies.

The OLS results for the Mining and Quarying sector is reported in Table 2. MQ_t, has also non-seasonal unit roots for all models, so the series contain a nonseasonal stochastic trend. The $\pi_2 = 0$ hypothesis is rejected for all the models and, therefore, the MQ_t does not have semi-annual seasonal unit roots. According to models 3 and 5; seasonal patterns are not present in the series, it has got only nonseasonal unit roots. Adding the seasonal dummy variables to the series makes MQ_t stationary.

Table 2. The HEGY Test Results for quarterly MQ_t Series

Model	Lags	π_1	π_2	F3&4
Model 1(-)	6	0.9476	-4.3456*	1.5396
Model 2(I)	6	-0.8998	-4.3627*	1.5353
Model 3(I,S)	1	-0.7545	-3.7335*	11.2101*
Model 4 (I,T)	6	-2.4970	-4.3600*	1.5574
Model 5 (I,S,T)	1	-2.0240	-3.6510*	11.5340*

*denotes 1% level of significance, **denotes 5% level of significance

The HEGY test results for M_t series shown in Table 3, indicate that nonseasonal unit roots are found in all models. The series do not follow a stationary process. Yet, for semi-annual and annual frequencies for all the models, the results are not clear as in L_t. Model 1 has a unit root in semi-annual frequency but not in annual frequency as Model 4. The model with the intercept term has only nonseasonal unit root and the seasonal unit root hypothesis rejected at the 5% significance level. Including the seasonal dummies to the model will result in non-seasonal and seasonal unit roots and the null hypotheses for π_1 and π_2 could not be rejected. The model with the intercept and the trend has non-seasonal and annual seasonal unit roots.

Table 3. The HEGY Test Results for the Turkish Manufacturing Series

Model	Lags	π_1	π_2	F3&4
Model 1(-)	5	2.3532	-1.4867	4.3178**
Model 2(I)	4	-1.1136	-2.0447**	4.3337**
Model 3(I,S)	5	-1.5120	-2.3366	3.5252
Model 4 (I,T)	6	-2.8486	-1.5740	4.1942**
Model 5 (I,S,T)	4	-1.8208	-3.0297**	3.7344

*denotes 1% level of significance, **denotes 5% level of significance

In EGW_t, *t*- and *F* statistics for π_1, π_2 and π_3, π_4 for all the models are not significant at the 5% level and the null hypothesis could not be rejected. Unit roots are found at the zero, semi-annual and annual frequencies.

Table 4. The HEGY Test Results for quarterly Turkish Electricity, Gas and Water Series

Model	Lags	π_1	π_2	F3&4
Model 1(-)	5	1.8142	0.3666	1.7094
Model 2(I)	5	-1.0699	0.3481	1.6213
Model 3(I,S)	5	-1.0862	-0.6944	1.8261
Model 4 (I,T)	5	-1.2111	0.3744	1.6563
Model 5 (I,S,T)	5	-1.1641	-0.6550	1.8275

*denotes 1% level of significance, **denotes 5% level of significance.

5. Summary and Conclusions

In this study, the seasonal behaviour of the seasonally unadjusted quarterly Turkish Industrial series is analysed for the1977:1-2008:4 periods. The main motivation is to specify the seasonality correctly in econometric models. The analysis is conducted using the HEGY approach developed by Hylleberg, Engle, Granger and Yoo (1990). According to analysis the main findings are that all of the four series have unit roots at zero frequency, which means that all series have got non-seasonal unit roots and non-seasonal stochastic trends. This implies that series may be cointegrated at zero frequency. The electricity and total industry production series are non-stationary at all seasonal frequencies.

Generally previous studies about seasonality are investigated same series such as GDP, consumption. According to Ayvaz-Kızılgöl’s study (2011) there are seasonal unit roots in GDP and consumption series at all frequencies. Similarly Türe and Akdi (2005) and Çağlayan (2003) have found unit root in GDP and consumption series at zero-frequency. In a study conducted by Çavdarlı (2007), the unit root test was applied to payment per employment in public and private sector, investment, input, output, added value, export and import series in the Turkish manufacturing industry, and the long-term relationship between the relevant series was investigated using cointegration analysis.

The seasonal fluctuations are important for applied econometric researchers. The researchers need to take into account these fluctuations when analyzing the series. The series which have seasonal fluctuations are non-stationary and should be differentiated. Differencing the series several times causes information losses. For this reason seasonal unit root applications should be applied. If the seasonality is not take into account this should causes biases in the series or loss of valuable information. The seasonal variation in some economic variables are important because economic agents take into account such fluctuations when planning their future behaviour.

To sum up, this study is supportive, complementary and contributes related literature with a different perspective and provide information on seasonality in Turkish industrial production. Industrial production and its analysis are so important for sustainable growth, economic and technological development.

References

Alper, C. E. & Arıoba, B. (2001). Makroekonomik verilerin mevsimsellikten arındırılması: Türkiye'deki uygulamalı araştırmacılara bir dikkat notu. ISE Review, 5(18), 31-50.

Ayvaz Kızılgöl, Ö. (2011). Mevsimsel eşbütünleşme testi: Türkiye'nin makroekonomik verileriyle bir uygulama, Atatürk University Journal of Economics and Administrative Sciences, 25(2):13-25.

Ayvaz Ö. (2006). Mevsimsel birim kök testi, Atatürk University Journal of Economics and Administrative Sciences, 20(1), 71-87.

Beaulieu J.J. & Miron, J.A. (1992). Seasonal Unit Roots in Aggregate U.S. Data. NBER Technical Papers No:126.

Çağlayan, E. (2003). Yaşam boyu sürekli gelir hipoztezinde mevsimsellik, Marmara University, Journal of the Faculty of Economic and Administrative Sciences. 18(1), 409-422.

Çavdarlı, A. İ. (2007). Türkiye imalât sanayi için bir kointegrasyon analizi, Unpublished Phd Thesis, Ankara University

Dickey, D.A. & Fuller, W.A. (1979). Distribution of estimators for autoregressive time series with a unit root, Journal of the American Statistical Association, 74,427-431.

Dickey, D.A., Hasza, D.P. & Fuller, W.A. (1984). Testing for unit roots in seasonal time series. Journal of the American Statistical Association, 79(386), 355-367.

Doğruel, A. Suut & Doğruel, F. (2008). Türk sanayiine sektörel bakış. İstanbul: TÜSİAD Publications (Publication Number: TÜSİAD-T/2008 - 05/466)

Franses, P. H. (1990). Testing for seasonal unit roots in monthly data. Econometric Institue Rapor Nm: 9032/A, Erasmus University, Rotterdam

Franses, P.H. & Hobjin, B. (1997). Critical values for unit root tests in seasonal time series. Journal of Applied Statistics, 24(1), 25-47.

Franses, P.H. (1996). Periodicity and stochstic trends in economic time series. Oxford Universty Press, Oxford.

Hylleberg, S., Engle, R.F., Granger, C.W.J. & Yoo, S. (1990). Seasonal integration and cointegration. Journal of Econometrics, 44, 215–238.

Leong, K. (1997). Seasonal integration in economic time series. Mathematics and Computers in Simulation, 43(3-6), 413-419.

Martin-Álvarez, F.; Cano-Fernández, V.J. & Cáceres-Hernández, J. (1999). The introduction of seasonal unit roots and cointegration to test index aggregation optimality: An application to a Spanish farm price index, Journal of Empirical Economics, 24(3):403-414.

McDougall, R. S. (1995). The seasonal unit root structure in New Zealand macroeconomic variables, Applied Economics, 27(9):817-827.

Osborn, D.R. ; Heravi, S. & Birchenhall, C.R. (1999). Seasonal unit roots and forecasts of two-digit European industrial production, International Journal of Forecasting, 15(1):27-47.

Polat, Ö. & Uslu, E.E. (2010). Türkiye'nin Dış Ticaret Verilerinde Mevsimsellik. Gaziantep University, Journal of Social Sciences 9(2), 407-423.

Rodrigues, P.M. & Denise, R. O. (1999). Performance of seasonal unit root tests for monthly data. Journal of Applied Statistics, 26(8), 985-1004.

Sivri, U. (2009). Mevsimsel rasyonel beklentiler yaşam boyu sürekli gelir hipotezinin testi. Ankara University Journal of the Faculty of Political Sciences, 64(4),175-193.

Ünsal, A. (1997). Zaman serilerinde regresyon ve varyans analizi yöntemleri ile mevsimsel dalgalanmaların araştırılması ve bir uygulama, Ekonomik Yaklaşım, 8(26), 119-132.

Yamak, R. & Sivri, U. (1998). Türk sanayii üretiminde mevsimsellik. İktisat, İşletme ve Finans, 13(147), 33-41.

Yamak, R. & Yamak, N. (1999). Türkiye ekonomisinde mevsimselliğin türü ve boyutu. 4. Ulusal Ekonometri ve İstatistik Sempozyumu, Sempozyum Kitabı, ss.609-619.