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The Seasonal Adjustment of the Consumer and Wholesale Prices: a Comparison of Census X-11, X-12 ARIMA and TRAMO/SEATS

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The Seasonal Adjustment of the Consumer and Wholesale Prices: a Comparison of Census X-11, X-12 ARIMA and TRAMO/SEATS*

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Abstract

The paper aims at analyzing the seasonal movements of consumer prices and wholesale prices with respect to different seasonal adjustment techniques. Suitability of different seasonal adjustment techniques will be tested for CPI, WPI, CPI excluding food prices, and WPI excluding agricultural prices. The literature on the analysis of seasonality is composed of different groups. One group treats the seasonality as a noise that contaminates the economic data. Another group treats seasonality as a more integrated part of the modeling strategy. However, the most well-known method among the seasonal adjustment procedure is the treatment to the problem of seasonality as a noise, and this is the method that has been widely applied by the statistical offices of different countries to create official seasonally adjusted data. In this respect, the most commonly applied official seasonal adjustment procedure has for many years been the X-11 method developed at the US Bureau of the Census. The X-11 procedure has been replaced by X-12. Among the two methodology, in some countries and in the EU statistical office EUROSTAT, a program TRAMO/SEATS is applied as well in recent years. After comparing these different procedures, the paper concludes with the analysis of which seasonal adjustment procedure may better fit for the Turkish CPI and WPI indices.

Keywords: seasonality, Census X-11, X-12 ARIMA, TRAMO/SEATS
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1. Introduction

The most important motivation behind the study of seasonal adjustment is the lack of an institutionally determined seasonally adjusted time series for Turkey, especially prior to the inflation targeting framework, during which the seasonally adjusted price series and the seasonal components of the series in question will be significant for the monetary policy. In this framework, this paper aims at forming a small study for Turkish price series with respect to the information about the different seasonal adjustment procedures that has been implemented in different statistics offices of different countries and to examine the characteristics of Turkey's consumer and wholesale price series using these different adjustment procedures.

The issue of seasonal adjustment is very complicated as it is a technical issue that has a considerable policy-wise conclusions. To give an example about how the seasonal adjustment issue is important both on the technical and policy formation side, one can refer to Maravall 1996:

> "*For example, what are the standard errors associated with the estimated seasonal factors? This point has important policy implications. In short-term monetary control, if the monthly target for the rate of growth of M1 (seasonally adjusted) is 10% and actual growth for that month turns out to be 13%, can we conclude that growth has been excessive and raise, as a consequence, short-term interest rates? Can the 3 percent points difference be attributed to the error implied by the estimation of the seasonally adjusted series? Similarly when assessing the evolution of unemployment, if the series of total employment grows by 90.000 persons in quarter, and the seasonal effect for that quarter is estimated as an increase of 50.000 persons, can we assume that the increase has been more than a pure seasonal effect? (...)*"

In line with what Maravall considered in his study, the same issue can be implemented to the Turkish price data, especially within the first half of 2002 in which the realizations for the agricultural and food prices are beyond the pure seasonal effect. When considering the seasonally adjustment issue, especially for a country that has a highly volatile price data that has a high percentage of outliers, one may be bounded with many questions related with the most suitable adjustment procedure that fits the time-series data, which has unstable characteristics. In this respect, the paper will try to raise some important questions which may be a subject for other studies in the area of seasonal adjustment for Turkey's price indices and try to seek for possible solutions to the questions that are raised related with the seasonal adjustment issue.

One of the questions that will be raised within the context of this paper is choosing a starting year of seasonal adjustment that will be discussed in the third part of the paper. In the fourth part, different adjustment methods within the framework of their historical evolution and their properties will be scrutinized in the fourth part of the paper. Finally, the price series analyzed within the paper will be considered with respect to suitability to seasonal adjustment, and how these series can be used for short-term monitoring and forecasting of inflation. The paper concludes with the importance of seasonal adjustment with respect to central bank policy. As a matter of fact, besides price indices, seasonal adjustment of many other indices are important in terms of the central bank policy, like capacity utilization rate, gross domestic product and unemployment rate because the current business condition of the economy does have an effect on the future inflation rate. Nevertheless, in this study, the focus will be on the deseasonalization of different price indices, the CPI and WPI, and their sub-items.

2. Seasonal Adjustment and Characteristics of the Turkey's Price Indices

For the purposes of economic analysis and to set short-term macroeconomic policy, governments frequently use seasonally adjusted series, on occasion, trends. Statistical offices generally publish information on the national economies using seasonally adjusted series. Seasonal adjustment has a special importance, especially with respect to inflation as the turning points of inflation is crucial for the conduct of monetary policy.

The aim of the seasonal analysis is to isolate the seasonal fluctuations, generally with the method of decomposing time-series into its different components. These components are usually selected as a trend component, a cyclical component, a seasonal component, an irregular or random component and lastly a trend break.

The trend component of a time-series shows the general tendency of the non-recurring movement of the series over a long period of time. The cyclical component includes fluctuations over 3 to 11 years that are related with the short waves.[1]

[1] Early investigators found that it was not possible to uniquely decompose the trend and cycle components. Thus, these were grouped together; the resulting component is usually referred to as the "trend cycle component". This component gathers two parts: a long-term trend from general phenomena of growth or decrease usually linked to

The seasonal component covers fluctuations within a year that usually arises out of calendar effects, institutional influences, weather influences and expectations. The irregular or random component refers to non-recurring movements, which have no specific cause. Occasionally, outliers indicate structural or other changes, which occur usually ones for a time-series.

Table 1: Decomposition of CPI into its components[2]

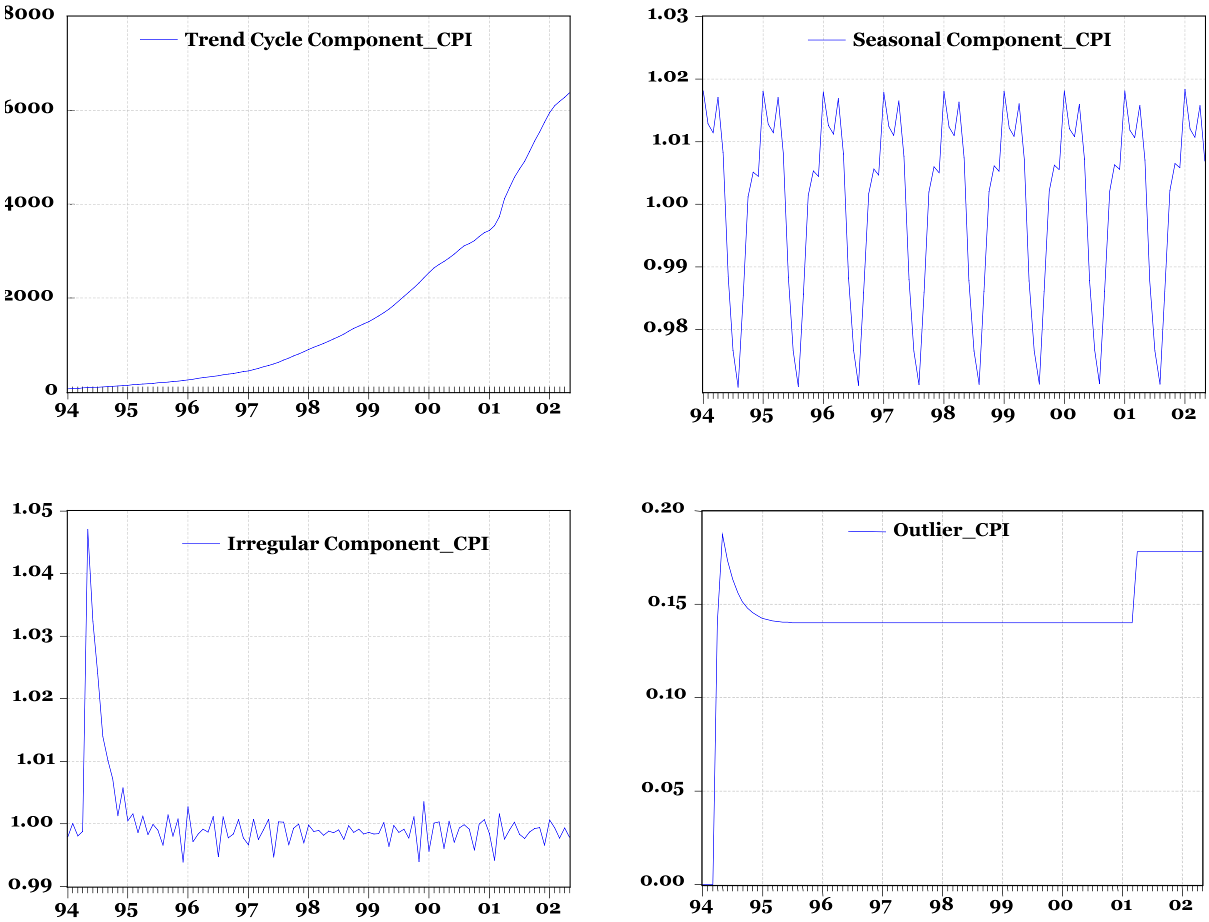

Table 1 illustrates the different components of consumer price index. Components of the other series that will be scrutinized within the context of this paper will take place in Annex 1. Decomposition of

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economic activity and to a rhythmic cycle from an economic variation suitable for economic fluctuations which, traditionally, go from expansion to recession, this cycle's length being unknown but longer than one year (Institut de la statistique du Québec).

[2] Raw CPI series starting with the year 1994 has been adapted. Demetra has been utilized for seasonal adjustment. Other series that will be utilized within the context of the paper takes place in Annex 1.

time series into the components that has been considered above is the main purpose of seasonal analysis of economic or other series. Considering the usual length of the series to be analyzed, the trend and the cycle are usually taken together.

In the seasonal adjustment process, there are several decisions to be taken to carry out the process, which will be effective in the final solution to the seasonality problem. One of them is whether to use additive or multiplicative seasonal components, whether to use the direct or indirect method in the seasonal adjustment of the time-series, how to deal with the outliers, and maybe most important of all which program package to utilize for the seasonal adjustment. In the remaining part of the paper, some of these issue will be discussed within the framework of Turkey's price data. Some of the above-mentioned problems are solved by the program packages themselves, and the problems and their solutions stages are given more thoroughly, throughout the paper.

Information provided by the direct analysis of price indices is affected by several sources of noise (erratic fluctuations, measurement errors, seasonal movements, and so on); this analysis can be framed in terms of extraction of a "signal" from the observed phenomena, removing what can be regarded as pure "noise". Several techniques can be used for this purpose. In this paper, first the characterization of seasonality in Turkey's price indices will be carried out and after that the most suitable adjustment method will be discussed within the framework of three different seasonal adjustment procedures, namely the Census X-11, X-12 ARIMA and TRAMO SEATS.

2.1. Basic Seasonal Adjustment Procedure

Broadly speaking, all methods of seasonal adjustment are based on the following additive model:

$$y_{ij} = T_{ij} + S_{ij} + I_{ij}$$

or alternatively on the multiplicative model

$$y_{ij} = T_{ij} * s_{ij} * i_{ij}$$

where y_{ij} is the original series in month or quarter i and year j

T_{ij} the trend-cycle component in period (or moment) i, j

S_{ij} the seasonal component in period (or moment) i, j

I_{ij} the irregular component in period (or moment) i, j

s_{ij} the seasonal index in period (or moment) i, j, and

i_{ij} the index of the irregular component in period (or moment) i, j.

Obviously the multiplicative method reduces to the additive model by a logarithmic transformation. The formulas above show that the observed series y_{ij} is decomposed into three non-observable components. The first step in seasonal adjustment is to determine whether the nature of the season is additive, multiplicative or a mixture of the two.

The increasing amplitude of seasonal variations observed in all the price index series that will be scrutinized is suggestive of a multiplicative seasonal pattern. Multiplicative seasonal pattern is the seasonal effect expressed in percentage terms. When the multiplicative seasonal pattern is concerned, the absolute magnitude of the seasonal variations increases as the series grows over time. Such a pattern can be removed by multiplicative seasonal adjustment.

As an alternative to multiplicative seasonal adjustment, it is also possible to perform additive seasonal adjustment. A time series whose seasonal variations are roughly constant in magnitude, independent of the current average level of the series, would be suitable for additive adjustment.

Additive seasonal patterns are somewhat rare in nature, but a series that has a natural multiplicative seasonal pattern is converted to one with an additive seasonal pattern by applying a **logarithm transformation** to the original data.

Methods of seasonal adjustment almost invariably choose between an additive and a multiplicative variant. The choice among the two types of adjustment can be made on an ad hoc basis by using a simple regression between the preliminary trend and the absolute value of the preliminary seasonal component of a series. This regression is of the form:

$$|y - y_T| = \alpha + \beta y_T \qquad 2.1$$

where y is the value of the original series, and y_T the centered moving average of y over the period of one year. If the components are not correlated, that is, if coefficient β does not differ significantly from zero, additive adjustment will probably be appropriate. In other situations, that is, if β is significant, a multiplicative or mixed method may be the best. **Since the multiplicative method is usually based on the logarithms of the series to be adjusted, obviously series with negative values should always be adjusted additively.**

When the regression 2.1 is used for CPI, WPI, CPI excluding food and WPI excluding agriculture, the results can be given as

$|y - y_T| = \underset{(13.29)}{-32.9} + \underset{(8.76)}{0.05}\, y_T$ for consumer price index,

$$|y - y_T| = -\underset{(12.01)}{32.9} + \underset{(9.70)}{0.06}\, y_T$$ for wholesale price index,

$$|y - y_T| = -\underset{(10.97)}{25.3} + \underset{(8.84)}{0.04}\, y_T$$ for consumer price index excluding food, beverages and tobacco prices and

$$|y - y_T| = -\underset{(10.84)}{29.1} + \underset{(10.20)}{0.05}\, y_T$$ for wholesale price index excluding agricultural prices.

The values in parentheses are the t-values, and it is observed that the coefficient β differs significantly from zero, multiplicative adjustment will probably be appropriate for all the indexes that will be exploited within the framework of this study.

2.2. Characteristics of the Turkey's Price Series

Considering the price series, seasonal price movements may be defined as intra-year changes occurring to a similar extent in successive years. If the reasons of the seasonality in Turkey's price indexes is outlined for CPI:

(i) food prices varying during the year,

(ii) sales prices affecting in particular the clothing and shoes prices,

(iii) price increases at fixed intervals, as in the case of public goods,

are the most common reasons for seasonality. For WPI, the seasonality is mostly caused by the agricultural prices, and it is observed that when the agricultural prices are excluded from the WPI series, the remaining series clearly show no seasonal pattern.[3]

There are quite different views on the nature of seasonality in economic data. One view is that seasonal variation is a fundamental part of many economic time series and, when it is present, it should be explained. Thus, ideally, an econometric model for a dependent variable y_t should explain any seasonal variation in the independent variables by including seasonal variables among the latter. In this respect a very rough way to assess the importance of seasonality in the price series is to regress their first differences on seasonal dummies (Davidson and MacKinnon, 1992, p. 687). This approach to seasonal adjustment, which is quite popular among econometricians but is almost never used by statistical agencies was advocated by Lovell (1963).

[3] In Annex 1, the issue can be observed from the decomposition of WPI excluding agricultural price series into its components.

Table 2: The short-term Variability of the Price Indices Explained by Seasonal Dummies[4]

Indices	Adjusted R^2	Adjusted R^2 with linear trend
Overall CPI	0.22	0.35
Overall WPI	0.19	0.26
CPI excluding food, beverages and tobacco	0.19	0.35
WPI excluding agriculture	0.04	0.08
Food, beverages and tobacco	0.39	0.44
Agriculture	0.65	0.70

Table 2 shows the results of the regression of the first difference of the logarithm of price indices on seasonal dummies. Results reported in Table 2 reveal that, for overall CPI, around 35 percent of the variability is explained by the dummies. Among sub indices, it is verified that agricultural prices are mostly explained by seasonal dummies, and when agricultural prices are excluded from the WPI, the remaining part move largely independent of seasonal factors. In this respect, the result of the analysis exemplifies that, a sizeable part of the short-term variability of the overall WPI and CPI series is explained by seasonal movements.

As considered above, for seasonal adjustment of the price series, there are practical issues related with the model choice for seasonal adjustment, period of series that will be the subject of seasonal adjustment and the use of backdata, stability of the seasonally adjusted data, and the choice between the suitable adjustment methods. The related questions are addressed in the following subsections of the study.

3. Practical Challenges Facing Seasonal Adjustment

Considering the seasonal adjustment of time-series data, a prerequisite for the monitoring of the short-term development of economic statistics is the availability of seasonally adjusted data. The formation of seasonally adjusted data for Turkey's price series faces a number of challenges that has to be solved at firsthand. The first is choosing a starting period for the seasonal adjustment. Base year for Turkey's price indices start form 1994 in which Turkey experienced a

[4] The first column values are the result of a regression of the first difference of the logarithm of each index on a constant and 11 seasonal dummies, the second column is obtained by adding the interaction of seasonal dummies with a linear trend to the regressors (for details, see Davidson and MacKinnon, 1992).

crisis and a high inflation period. In this respect, before starting the seasonal adjustment process, one has to decide whether to start form the year 1994 that has a high percentage of outliers or start from the beginning of the year 1995 that eliminates some of the months in which monthly inflation rates increased as much as around 20 percent or more.

Another challenge faced with respect to seasonal adjustment procedure is the problem of direct versus indirect seasonal adjustment. Direct adjustment consists of removing seasonality from the aggregated series. An alternative that analysts typically consider is indirect adjustment, where the sub-series are seasonally adjusted first and then aggregated.[5]Planas and Campolongo (2001) argued that, in general when the sub-series do not have similar spectral densities, the indirect approach is better both in terms of final estimation error and of revision error. On the opposite, the direct approach can be more accurate when the sub-series are characterized by similar spectral distributions. The issue will be analyzed in a detailed manner in the following subsections of the study.

Other important problem faced by institutions carrying out seasonal adjustment procedures is the problem of revising preliminary figures. Optimal updating of preliminary seasonally adjusted data implies re-estimation whenever a new observation becomes available. This "concurrent" adjustment implies a very large amount of work; in particular, it requires agencies producing data to change every month many series for many years. In this framework, the revision of the seasonal estimation can be carried out either was soon as a new observation becomes available ("concurrent adjustment") or at predetermined, longer intervals.

The last point is whether to use a model-based approach when carrying out seasonal adjustment or to utilize an empirical method like X11-ARIMA or X12. All of these challenges will be discussed in detail within the framework of Turkey's consumer price and wholesale price series.

3.1. Choosing the Starting Period for Seasonal Adjustment

The use of backdata for seasonal adjustment is of crucial importance. For longer series, the use of asymmetric filters is reduced and also estimation accuracy is increased. The use of backdata, when they are available, is therefore recommended to improve the quality of

[5] The issue of aggregation takes place in the study of Planas and Campolongo (2001) within the framework of detailed analysis.

estimates. In other words, the longer time period chosen for the seasonal adjustment improves the quality of the seasonal adjustment procedure. However there may be exceptions related with the inclusion of a certain period as the included year may change the seasonal pattern of the series in question.

The base year for the index of consumer prices (CPI) is the year 1994, which is well-known with a great devaluation in April and a following stagflation. Therefore, while doing the seasonal adjustment, whether the crisis year should be included or not can be regarded as a legitimate question. Before this discussion, one can try to answer whether the inclusion of the year 1994 makes any difference for the seasonal patterns. Detailed analysis on the choosing the starting year for the seasonal adjustment showed that inclusion of the year 1994 makes a difference with respect to seasonality of price series. However, the difference related with the seasonal pattern varies among different indices and different techniques of seasonal adjustment (Annex 2). When comparing 3 different seasonal adjustment methods, TRAMO/SEATS, X-12 ARIMA and Census X-11, different criteria has been adopted for choosing the suitable starting period.

The first criteria that has been considered is the average difference between the seasonally adjusted figures. It is simply the average of the absolute differences between the seasonally adjusted inflation figures from two different samples; namely the one that includes the year 1994 and the other does not. More formally average difference is:

$$\text{AD} = \sum_{t=2}^{n} \left| S_t^{94} - S_t^{95} \right| / (n-1)$$

where St94 and St95 are the seasonally adjusted monthly inflation figures at time t obtained from the samples with and without 1994 respectively. The comparison is made for the common period (Jan 95 – Feb 02) and n is the size of this sample.[6]

The second criteria is the number of inconsistent points in time: If seasonally adjusted inflation figures indicates an increase compared to the previous period for one sample and a decrease for the other one in time t, then time t is considered as an inconsistent point in time. In other words:

If $(S_t^{94} - S_{t-1}^{94}) / (S_t^{95} - S_{t-1}^{95}) > 0$ then time t is consistent

$(S_t^{94} - S_{t-1}^{94}) / (S_t^{95} - S_{t-1}^{95}) < 0$ then time t is inconsistent

[6] As the seasonally adjusted monthly inflation is only available from February 1995 for the both samples, t=2 stands for Feb 95 and t=n stands for February 2002

This kind of consistency is important for the reason that by comparing seasonally adjusted monthly figures the analysts usually drive conclusions about whether the inflation is on a increasing or a decreasing trend.

The results revealed that, it significantly matters to pick 1994 or 1995 as the starting year. The average differences (criteria 1) are given for three different methods and four different price indices in Table 3 below. It can be observed that seasonal adjustment of non-agricultural WPI by using TRAMO/SEATS revealed the outcome of no seasonality. Although X-12 ARIMA gives the most different results for alternative starting years, the differences are significant for all methods.

Table 3 Average differences arising from choosing alternative starting years (Criteria 1)

	WPI	CPI	Non-agriculture WPI	Non-food CPI
Tramo/Seats	0.11	0.18	__	0.15
X-12 Arima	0.35	0.20	0.34	0.19
Census X-11	0.25	0.11	0.20	0.09

The difference between the seasonally adjusted figures reached over 1 percentage point for some observations. The consistency of two samples (criteria 2) is evaluated in Table 4

Table 4 Number of inconsistent points in time out of a total 85 observations (Criteria 2)

	WPI	CPI	Non-agriculture WPI	Non-food CPI
Tramo/Seats	5	3	__	4
X-12 Arima	11	12	14	8
Census X-11	6	5	11	3

The second criteria also shows that starting year matters most significantly for X-12 ARIMA method. The distribution in 1994 is significantly different from the averages of 1995-2000 period particularly for the CPI. At this point, one can argue that, as a crisis year with sufficiently high inflation rates, year 2001 should also be treated as 1994 and left out of the sample. However, in 2001, the general seasonal pattern had not changed significantly. In 2001, the inflation figures in March and April was quite higher than the seasonal averages, but usual seasonal path was followed thereafter. On the other hand, the year 1994 was characterized by a one time jump in prices (which was associated with highest monthly inflation in the economic history of Turkey) and the seasonal pattern is completely different especially for the CPI. Such sharp changes in prices probably resulted in overestimation of seasonal effects observed in April's.

In addition to the two criteria that has been considered above, the pattern and the volatility of the seasonal factors has been examined for the series starting with the period 1994 and for the series starting with the period 1995. The results are illustrated in Annex 2. When the tables has been examined in detail, it has been observed that the series starting with the period of 1995 is more volatile, when TRAMO/SEATS has been utilized as a seasonal adjustment method, but the seasonal pattern of the series do not differ from each other when the starting period is changed. Utilizing X-12 ARIMA gives different results in this respect. Although the volatility of the two series are not divergent from each other, seasonal patterns change significantly depending on the starting period of the data. Changing seasonal patterns are much more prominent, when the WPI and WPI excluding agriculture is concerned.

Finally, when the same analysis is carried out by using Census X-11 method, it is observed that the period starting with 1994 gives more volatile seasonal pattern. Besides the seasonal factors differ significantly from each other, especially for the first three years of the seasonal adjusted period.

To sum up, in the light of the all tests and evaluations above it is observed that exclusion of year 1994 does not make very significant changes related to the seasonal pattern of all the series in question. On the other hand , exclusion of year 1994 will cause seasonal adjustment to be carried out without 12 months, which may decrease the quality of seasonal adjustment. Therefore, all the seasonal adjustment issue is carried out with the price indices starting form the period 1994.

3.2. Direct versus Indirect Seasonal Adjustment

In its paper related with the seasonal adjustment European Central Bank discussed the issue of direct and indirect adjustment, and illustrated some criteria to discriminate between the direct and indirect approaches.[7] The most important criteria that has been put forward is the smoothness of seasonally adjusted series. For the Turkish price indices, it is generally a well-known fact that some of the sub-items, especially that may be classified as administered prices, illustrate a very volatile behaviour. As a result, when smoothness of

[7] For a detailed analysis to decide between direct or indirect method of seasonal adjustment refer to ECB, 2000.

the seasonally adjusted series criteria is considered, direct approach seems a better choice for the Turkish price indices.

The volatility of the sub-items of overall price indices may be solved excluding these items from the overall indices as these volatile prices cannot be controlled by the Central Bank. In fact, it is still a continuing discourse in many countries (especially countries adopting inflation targeting) that the targeted inflation should not be the CPI as a whole but a core index that excludes the most volatile items of the price indices. In fact, the course of administered prices can be an important problem for high volatility of price indices because adjustments in administered prices are made less frequently, but at much higher rates when compared with the price adjustments of the private sector. In general, high price adjustments for the administered prices are done usually related with the fiscal problems, and these adjustments are not related with the cost fluctuations of the specific good. Due to that reason, the control over the overall price index becomes a much more problematic issue. To solve the problem of volatility with respect to the sub-items of the overall index, some part of the administered prices should be excluded from the CPI.

Other problem related with the indirect approach is that, in very detailed series the irregular component is often high and it may be difficult to detect seasonal signals. This fact can again be observed from the tables of Annex 2. When the irregular component of food price series is compared with the overall CPI, it is seen that the food prices has significantly higher irregular component. The same conclusion can be reached with respect to agricultural prices and overall WPI. To sum up, it can be concluded that seasonal adjustment for the overall indices at that point for the Turkish consumer and produces prices seems better for seasonal adjustment. However, for a better analysis of seasonal adjustment core indices should be formed excluding the most volatile components that distort the seasonal pattern of the overall indices.

3.3. "Concurrent Adjustment" versus Projected Seasonal Factors

The concept of "concurrent adjustment" is related with the revision of the data. The revision of the seasonal estimation can be carried out either as soon as a new observation becomes available that is names as "concurrent adjustment" or at predetermined, longer intervals. This practice requires the use of forecasting factors.

According to a study by ECB[8], it is argued that according to a pure theoretical point of view and excluding the existence of outliers, the use of concurrent adjustment is preferable. New data always contributes new information and therefore should be used. The counter argument to the concurrent adjustment process is that the recent data may not be as reliable as the old historical data as they undergo a specific revision process. This counter argument is not considerable especially for the Turkey's price series, as the price data is not revised when a new monthly data is announced. This arguments fits for the industrial production data or more generally to the data related with the foreign trade.[9]

Another argument against the concurrent adjustment is that, the identification of the components at the series end is less reliable than for historical periods and due to that reason the benefits of concurrent adjustment may be diminished. Also, the monthly revision of seasonally adjusted numbers may confuse the user.

In a survey by OECD which covers 15 OECD non-European Union countries and 15 EU countries plus Norway[10], it is observed that seasonal adjustment options are updated on a fixed periodicity by about 70% of the investigated institutions. Most of them perform updating once a year. About 35% of the institutions update options after revisions in raw data, but in many cases this is done only in case of significant revisions. According to the survey, also, seasonal adjustment options in OECD non-EU countries are updated on a fixed periodicity by over 80% of investigated institutions. 60% of them perform updating once a year (OECD, 2002).

To sum up, the choice between concurrent and longer-period adjustment depends on first, the stability of the seasonal component, the size of the irregular component (a high irregular component may make use of concurrent adjustment difficult), the main use of data and the revision pattern of raw data.

To decide between whether to adjust Turkey's seasonally adjusted on a monthly basis or a longer period requires a detailed statistical examination of the seasonal components and irregular components on a detailed way. However, a simple analysis may give an overall intuition about the issue of whether to make a concurrent adjustment for the Turkey's price series. For this reason, the outlier composition of the series that are being analyzed within the framework of this paper will be analyzed at first.

[8] In the paper prepared by ECB, namely "Seasonal Adjustment of Monetary Aggregates and HICP for the Euro Area", the technical and practical issues related with the seasonal adjustment of both the monetary aggregates and price indices are analyzed in detail.

[9] For example Turkey's foreign trade data is revised covering a period around a year.

[10] The survey carried out by OECD and published in June 2002 illustrated detailed answers to many technical and practical issues related by the seasonal adjustment issue.

Table 5 Type and Number of Outliers for the Selected Price Indices of Turkey (1994-2002)/ TRAMO SEATS

	OUTLIERS			
	LS	AO	TC	Total Number
WPI	Apr-94; Apr-01; Mar-01			3
WPI-EX-AGR	Apr-94; Jan-95; Jan-96; Dec-99; Mar-01; Apr-01	Jun-97	May-94; Oct-01	9
AGR	Dec-01			1
CPI	Apr-94; Apr-01		May-94	3
CPI-EX-FOOD	Apr-94; Jul-97; Dec-99; Apr-01; Mar-01	Dec-95	May-94	7
FOOD	Apr-94			1

Table 5 and Table 6 illustrate the type of outliers that are present in price indices by using DEMETRA as a seasonal adjustment program. Here, LS refers to level shifts, which are outliers permanently affecting the level of series after a point in time. TC refers to transient changes, which are outliers that have a temporary effect on the values of the series. Lastly, AO (additive outliers), corresponds to sudden jumps occurring at certain points in time.

Table 6 Type and Number of Outliers for the Selected Price Indices of Turkey (1994-2002)/X-12 ARIMA

	OUTLIERS			
	LS	AO	TC	Total Number
WPI	Apr-94			1
WPI-EX-AGR	Apr-94; Apr-01	Mar-01		3
AGR				0
CPI	Apr-94; Apr-01		May-94	3
CPI-EX-FOOD	Apr-94; Dec-99; Apr-01	Dec-95; Jun-97; Mar-01	May-94	6
FOOD	Apr-94			1

It is clearly observed that, the number of outliers are higher among the series excluding the sub-items that has distinct seasonal pattern, namely the WPI excluding agricultural prices and the CPI excluding food prices. The reason behind this fact is that, the remaining sub-items included in the WPI excluding agricultural prices and the CPI excluding food prices do not have a distinct seasonal pattern. The type of the outlier is generally a level shift that is most prominent in certain months of 1994 and 2001. All these outliers that are considered in Table 5 and 6 makes the series that will be subject to several seasonal adjustment procedures, have negative effects on the stability of the series in question. In addition to high percentage of outliers in the seasonally adjusted series, graphics in Annex 1 points to the fact that the price series have a high irregular component, especially the food and the agricultural price series.

In addition to the percentage of outliers and the analysis of irregular components, Cristadoro and Sabbatini (2000) in their study argued that a percentage lower than 30 percent of, average percentage reduction in RMSE from concurrent adjustment indicates that there is no point in having concurrent estimation.[11] When the price indices of Turkey that are subject to the analysis carried out in this study are examined with respect to their average percentage reduction in RMSE from concurrent adjustment, it has been observed that the percentage varies between 1 percent and 9 percent on average. These small numbers again underline to the fact that concurrent adjustment is not very suitable to Turkey's price indices.

To sum up, it can be concluded that like Turkey, in the countries with high and volatile inflation figures, the question of concurrent adjustment versus long-term adjustment can be addressed by estimating a new model for each year (if the economy's inflation process is very dynamic this period may decline to 6-months period) and utilizing the coefficients of the model throughout the year. With this methodology, the data are not revised backwardly throughout the year in the case of introduction of a new variable. In Turkey, owing to the fact that the price indices fluctuate frequently, the method of using a new model for each year is preferred (CBRT, 2002).

3.4. Comparison of Different Methods and Their Limitations

A short history of the seasonal adjustment methods developed over the years makes it possible to better understand those currently used by the statistical agencies of the industrialized and developing countries. The coming of computers and different programs made it possible to seasonally adjust in a mathematical way a great number of time series.

One of the first mathematical methods developed for seasonal factor estimates has been the observational arithmetic mean method of known observations for periods around those needed for seasonal estimates (moving averages). This method however has certain weaknesses. Therefore, it pretends that the long-term trend is non-existing or that it changes very little. In addition, variations due to the

[11] For a detailed analysis please refer to Cristadoro and Sabbatini (2000).

cyclical fluctuation could be allotted, by error, with the seasonal fluctuation.

Taking into account these weaknesses of simple arithmetic compilation, other methods using the weighted averages were developed to calculate more precise seasonal coefficients. Thus, in 1954, the United States Bureau of the Census introduced Method I for seasonal adjustment by computer on a larger scale. Method II, developed thereafter by the Bureau of the Census, differs from the first methods, while having as base the method of averages because it estimates the trend-cycle and the seasonal and irregular components by carrying out several iterations to smooth the series. Moreover, the recombining of the original series can be obtained by multiplying or adding. It was at the beginning of the Sixties that Method II became stable. The various alternatives of the above were named X for experimental and were called then X-0, X-1, X-2... X-9, until the X-11 model used everyday since 1965 in the United States and Canada. Year 1967 marks a crucial event in the area of seasonal adjustment. That event was the appearance of the program X-11. Except for some outlier treatment, X11 can be seen as a sequence of linear filters, and hence as a linear filter itself. Over the next decade, X-11 spread at an amazing speed, and many thousands of series came to be adjusted with X-11. It was an efficient and easy-to-use procedure that seemed to provide good results for many series. Yet, towards the end of the seventies some awareness of X-11 limitations started to develop. Those limitations were mostly associated with the rigidity of the X-11 filter. To the properties of Census X-11 we turn next.

3.4.1. Census X-11 Method

The Census X-11 method was developed at the US Bureau of the Census, and became operational in 1965. This method is based on different kinds of moving averages without an underlying explicit model and it was developed mostly on an empirical basis. When utilizing the method, first, a choice must be made between the additive and the multiplicative variant. Moreover, the procedure contains several other options, which sometimes may be required in practice (for instance, trading-day adjustment, treatment of outliers). However, in practice calculations are usually based on standardized procedures.[12]

Although the Census X-11 method is widely used in practice, it has not remained free from criticism, without however losing its dominating role. The criticisms were leveled at various aspects.

[12] The steps considering the calculation of seasonally adjusted data with X-11 is explained in detail in Fischer, 1995, p.13.

Firstly, objections of a statistical or methodological nature have been raised. The absence of an underlying statistical model for Census X-11 is believed to be a serious deficiency because it hampers a clear interpretation of the result in a statistical sense.

Another problem related with the Census X-11 method is that, in general, the Census X-11 method estimates a moving seasonal pattern which finally results from a 145-term moving average. This implies that observations are lost during the computations; consequently, Census X-11 tends systematically to underestimate the changes in the seasonal pattern at the beginning and at the end of the series.

Some limitations related with the Census X-11 method has been illustrated in Maravall 1996.[13] Maravall stated that X-11 did not contain a basis for proper inference. For example, for a seasonal adjustment of a time-series, one cannot observe the standard errors associated with the estimated seasonal factors. In the same way, X-11 does not allow us to compute optimal forecasts of the components. Another limitation of the method is that, although X-11 computes separate estimates of the trend, seasonal and irregular components, their statistical properties are not known. Therefore, it is not possible to answer questions such as, whether the trend or seasonally adjusted series provide a more adequate signal of the relevant underlying evolution of the series (Maravall, 1996).

To sum up the advantages and disadvantages of utilizing Census X-11, the advantages of X-11 can be demonstrated as:

- The robustness,
- The practical experience put into method,
- Its widespread use and therefore the current updates (Fischer,1995).

The disadvantages are:

- The use of asymmetric filter at both ends of the time series,
- The lack of an explicit model (Fischer,1995).

To overcome some of these limitations, throughout the years X-11 has been subject to modifications. In particular, the program X-11 ARIMA has been developed by the Statistics Canada that improved upon X-11 in several ways. The next section will consider X-11 ARIMA program.

[13] The technical discussion in Maravall 1996 related with the issue has not been considered in detail.

3.4.2. X-11 ARIMA Method

This method has been developed at Statistics Canada that attempted to meet a major disadvantage of Census X-11, namely, that addition of fresh data often leads to a substantial revision of the most recent data. The revisions required in Census X-11 are in part due to the use of asymmetrical weights in the moving averages at the end of the observation period. The X-11 ARIMA method offers a solution to the problem by employing symmetrical weights to the observations at the end (and the beginning) of the series. For this purpose the series is extrapolated with ARIMA forecasts (and backcasts).[14]

3.4.3. X-12 ARIMA Method

X-12 ARIMA basically uses X-11 ARIMA procedure but with some important changes. Besides the implementation of several new useful tools like the spectrum of the different type of components and the sliding span diagnostics, the main change is an additional pre treatment for the data. The most prominent characteristics of the method can be described as follows:

- Detect and correct for different types of outliers
- Estimate a calendar component or any type of regression parameters and check for the evidence of this component
- Automatically estimate ARIMA models.

One criticism of X-11 ARIMA was that it does not use exact Maximum Likelihood estimation, this problem is solved in X-12 ARIMA. Besides, one of the disadvantages of Census X-11 is that it is not model based, i.e., the filters used do not depend on the data. X-12 ARIMA is not model based also, but it contains features, which improve the seasonal adjustment procedure considerably. It contains a pre-adjustment program, REGARIMA, where effects of variation in calendar composition and other causal factors are estimated and removed.

[14] See Butter and Fase, 1991, for a detailed explanation of Census X-11 ARIMA.

3.4.4. Model Based Method, TRAMO/SEATS

The major advantage of a model based method is that it provides a convenient framework for a straightforward statistical analysis. One of the other most important advantages of a model based approach is that, the danger of spurious adjustment is certainly diminished, i.e, if a series is white-noise, it would be detected at the identification stage and no seasonal adjustment would be performed. Another important point related with the model based approach is the detailed statistical results related with the adjustment procedure. Table 7 and Table 8 illustrates how the model-based approach can provide elements of diagnostics . Thus the model-based approach offers a natural setup for carrying out diagnostics, and permits to improve upon the results by applying the standard iterations (identification/estimation/diagnosis and back to identification) (Maravall, 1996).

TRAMO, "Time Series Regression with ARIMA Noise, Missing Observations and Outliers", is a program for estimation and forecasting of regression models with possibly nonstationary ARIMA errors and any sequence of missing values. The program interpolates these values, identifies and corrects for several types of outliers, and estimates special effects such as Trading Day and Easter and, in general, intervention variable type effects. SEATS, "Signal Extraction in ARIMA Time Series", is a program for estimation of unobserved components in time series. The trend-cycle, seasonal, irregular and perhaps transitory components are estimated and forecasted with signal extraction techniques applied to ARIMA models. The two programs are structures so as to be used together both for in-depth analysis of a few series or for automatic routine applications to a large number of series. When used for seasonal adjustment, TRAMO preadjusts the series to be adjusted by SEATS. The two programs are officially used (and recommended) by Eurostat and, together with X-12 ARIMA, by the European Central Bank (Maravall and Sanchez, 2000).[15]

When the TRAMO/SEATS and X-12 ARIMA are compared to each other, it is observed that both TRAMO and X-12 ARIMA are designed to preadjust series before the seasonal adjustment by removing some deterministic effects such as trading day, moving holidays and outliers. TRAMO and X-12 ARIMA also contain similar model diagnostics.

SEATS and X-12 ARIMA are similar in that both programs use the preadjusted series to decompose the series into seasonal, trend-cycle, and irregular component. SEATS uses the model for the decomposition of the series. X-12 ARIMA uses the model to provide

[15] For a detailed information on TRAMO/SEATS please refer to Gomez and Maravall, 1996.

statistically efficient estimates of the regression coefficients, and usually, also to forecast the series.

3.4.5. Comparison of TRAMO/SEATS and X-12 ARIMA with respect to Turkey's Price Data

The main idea behind this part is to see how the different methods utilized for seasonal adjustment handle the time series, which are CPI, WPI, CPI excluding food prices and WPI excluding agricultural prices. The most important point here, which should be taken into consideration is that, the comparison of the two techniques is mostly a statistical issue that has been carried out by the Statistical Agencies of most of the countries. In this respect, this part only considers the diagnostic check of the program DEMETRA and will not cover a detailed analysis that is beyond the aim of this study.

The time series that will be analyzed in detail covers the period of 1994-2002. By different methods that will be considered for comparison, only X-12 ARIMA and TRAMO/SEATS has been considered. Census X-11 is left out of the comparison as the major disadvantage of Census X-11 is that it does not correct for causal factors. This causes problems when effects interfere with the seasonal movement. Census X-11 estimates an average pattern of a time series. Large deviations from average scores are included in the seasonal component. This distorts the seasonal pattern. For the Turkey's CPI data that contain significant irregularities, usage of Census X-11 will create misleading seasonal patterns, as the irregularities will be included in the seasonal factors.

All the programs were run with the automatic model option of the DEMETRA 2.0[16]. The diagnostic results are illustrated in a detailed manner in Table 7 and Table 8. When table 7 is examined it is observed that the seasonal adjustment of overall CPI and the CPI excluding food prices has poor performance, and fails most of the diagnostic check. On the other hand, same series are quite successful, when X-12 ARIMA is utilized as procedure for seasonal adjustment.

[16] Demetra is a program developed by Eurostat that is utilized for seasonal adjustment procedure.

Table 7: The Main Diagnostics of TRAMO-SEATS for Turkey's Price Indices

	Starting Year	Log Trans.	ARIMA model	Normality(1)	Kurtosis(2)	Skewness	A/c residuals(3)	Percentage Outliers(4)	Overall quality of s.a.(5)
Overall CPI	1994	Yes	(1 1 0)(0 1 1)	**9.10**	**4.05**	**0.61**	11.9	2.97 (3)	Low
Overall WPI	1994	Yes	(1 1 0)(0 1 1)	2.40	3.24	0.39	20.07	2.97 (3)	High
CPI Excluding Food	1994	Yes	(0 2 2)(0 1 1)	3.18	2.81	0.48	**8.72**	**6.93(7)**	Low
WPI Excluding Agriculture	1994	Yes	(1 1 0)(0 0 0)	1.30	3.07	0.29	32.04	**8.91(9)**	High
Food Prices	1994	Yes	(0 1 1)(0 1 1)	4.36	**1.95**	0.17	15.95	0.99(1)	High
Agricultural Prices	1994	Yes	(1 1 0)(0 1 1)	0.31	2.80	-0.11	14.35	0.99(1)	High

Bold characters indicate that the model failed the diagnostic tests at the 5% confidence level.

(1) Bera-Jarque test for normality of residuals; the null hypothesis is that residuals are normal (critical value at the 5% confidence level is equal to 5.99; at the 10% confidence level it is equal to 4.61).
(2) In the case of normal distribution the value is 3.
(3) Lijung-Box test for serial correlation; the null hypothesis is the absence of serial correlation.
(4) Percentage of outliers on the number of observations (the number of outliers is in the brackets).
(5) Judgmental (based on diagnostics included in the table).

Table 8: The Main Diagnostics of X-12 ARIMA for Turkey's Price Indices

	Starting Year	Log Trans.	ARIMA model	Kurtosis(1)	A/c residuals(2)	Percentage Outliers(3)	Forecast Error(4)	Overall quality of s.a.(5)
Overall CPI	1994	Yes	(2 1 2)(0 1 1)	4.08	9.80	2.97% (3)	1.11%	High
Overall WPI	1994	Yes	(2 1 2)(0 1 1)	**5.28**	16.16	0.99% (1)	10.29%	Low
CPI Excluding Food	1994	Yes	(2 1 2)(0 1 1)	2.67	28.97	**6.93% (7)**	0.94%	High
WPI Excluding Agriculture	1994	Yes	(2 1 0)(0 1 1)	3.45	22.10	2.97% (3)	2.67%	NA
Food Prices	1994	Yes	(2 1 2)(0 1 1)	2.73	13.80	0.99% (1)	10.18%	High
Agricultural Prices	1994	Yes	(0 1 2)(0 1 1)	4.11	11.90	0.00%	0.89%	High

Bold characters indicate that the model failed the diagnostic tests at the 5% confidence level.

(1) In the case of normal distribution the value is 3.
(2) Lijung-Box test for serial correlation; the null hypothesis is the absence of serial correlation.
(3) Percentage of outliers on the number of observations (the number of outliers is in the brackets).
(4) Forecast Error over last year.
(5) Judgmental (based on diagnostics included in the table).

When comparing TRAMO/SEATS and X-12 ARIMA for the other countries, the survey carried out by OECD gives a clear result. Accordingly, the study concluded that:

> *"X-12 ARIMA will be the predominant seasonal adjustment method in the future among OECD countries with TRAMO-SEATS taking the major share of the remaining market. However, It should be noted that many institutions will continue to use several methods, in particular X-12 ARIMA and TRAMO-SEATS in combination. In OECD EU countries, the joint use of TRAMO-SEATS and X-12 ARIMA will take the major share of the market in the future. On the other hand, in OECD non-EU countries X-12 ARIMA will still dominate the market over the years to come. "* (OECD, 2002).

To sum up, it seems that many countries are heading towards using more model-based procedures for the seasonal adjustment issues, and many countries combine various approaches related with the characteristics of their time-series data. It seems that model based approach is more suitable for Turkey's price data also, but TRAMO/SEATS is a new and developing program, therefore one has to be careful while using this method for a seasonal adjustment procedure.

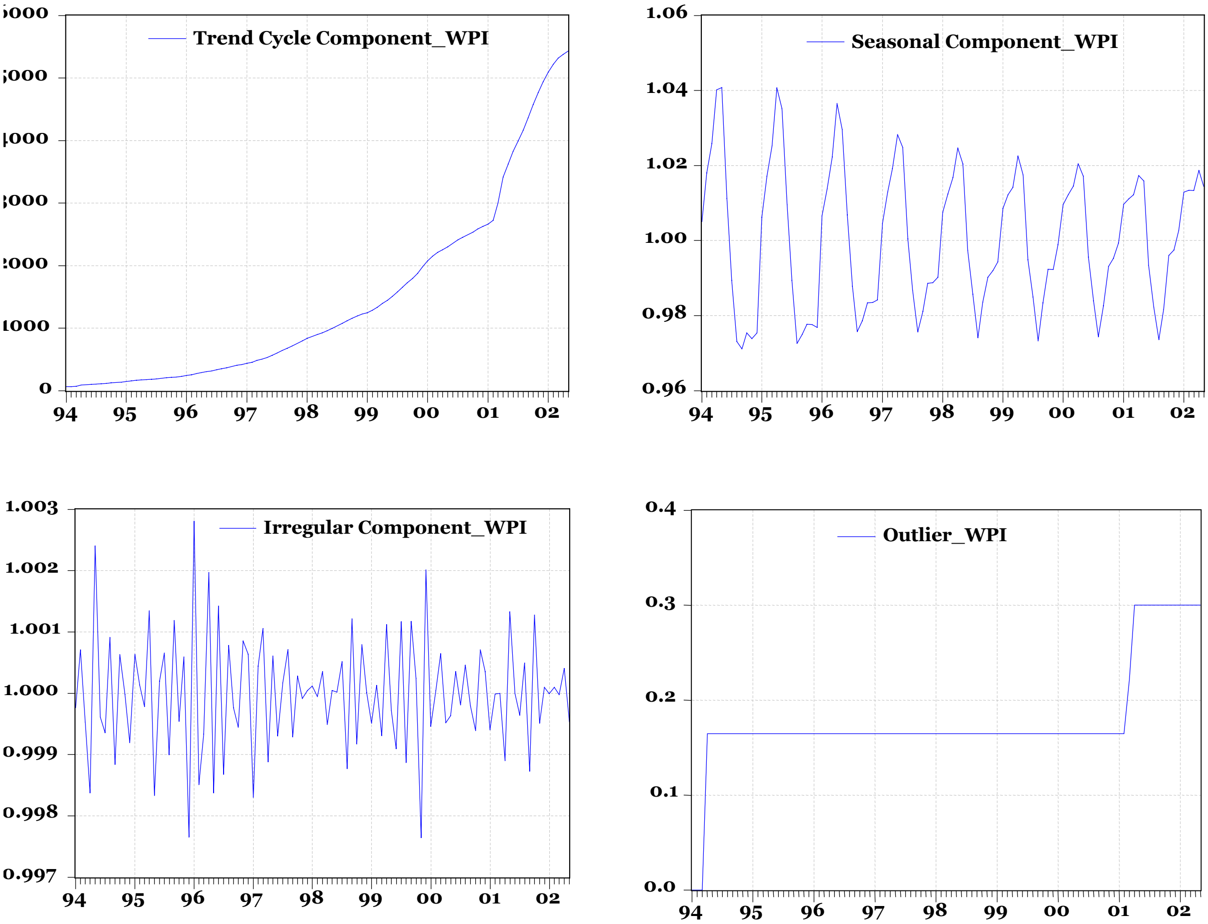
4. Conclusion

Seasonally adjusted price indices are functional for short-term monitoring and near-term forecasting of inflation. Fluctuations in monthly inflation rates are in part familiar to the analysts because a rough analysis of seasonal patterns illustrates these fluctuations, but this knowledge is not complete for the perfect analysis of monthly inflation series. It is also important to differentiate if higher than or lower than average monthly inflation rates are derived from seasonal effects or the trend component. This paper focuses on some practical issues related with the seasonal analysis of time-series in general and Turkey's price data specifically. A preliminary analysis of the seasonal behaviour of the overall CPI, WPI, CPI excluding food prices and WPI excluding agricultural prices suggests that:

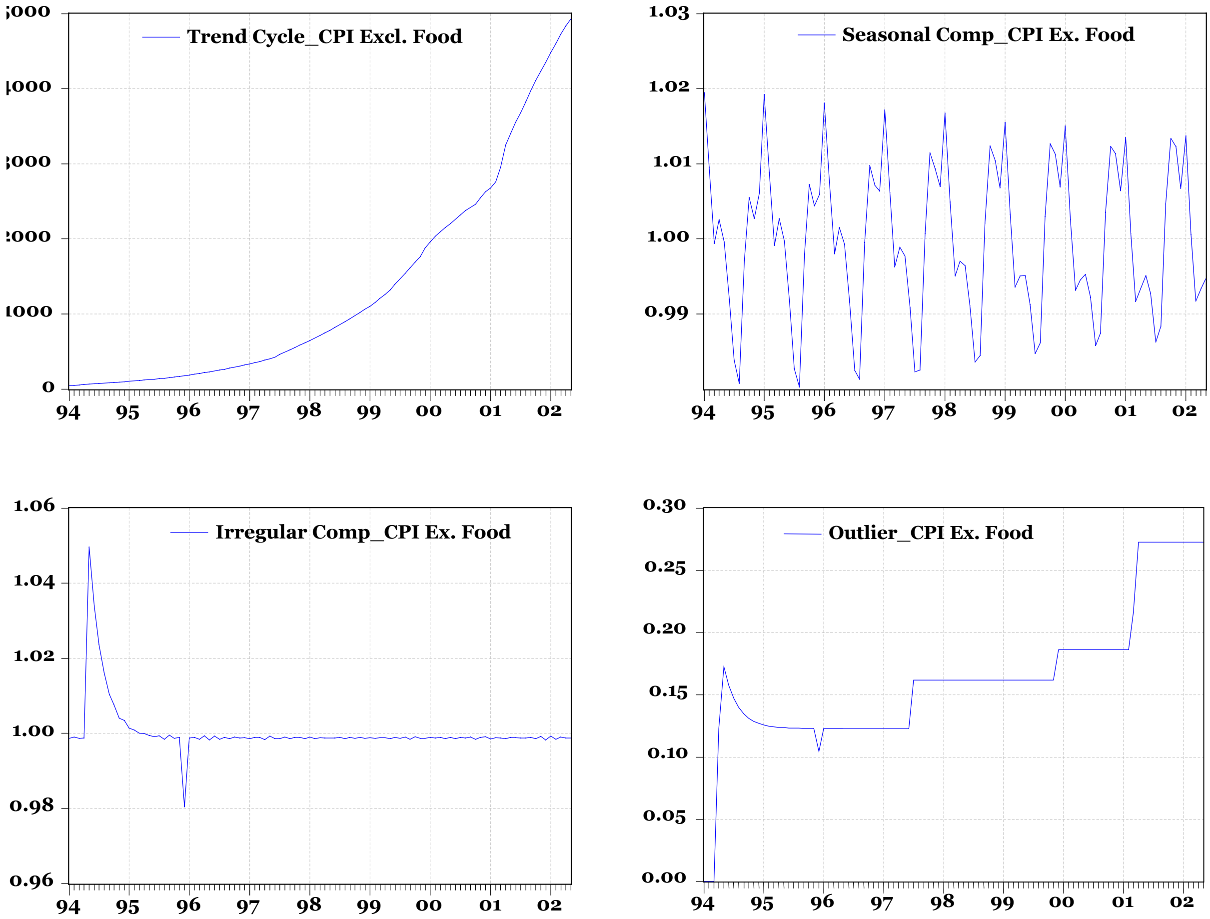
A considerable amount of the short-term variability of the price indices depends on seasonal movements. This movement is stronger in food prices that is the most important sub-item of overall CPI, and agricultural prices, which is the sub-item of overall WPI. When the agricultural prices and the food prices are excluded from the overall indices in question, it is observed that the remaining series are left with a high level of irregular component, and it is also observed that these series had not have and distinct seasonal pattern. In this respect, it is very difficult to seasonally adjust these series. All these points direct towards the point that, a core index of prices is needed for healthy analysis of prices that is essential in monitoring inflation for monitory policy purposes.

Annex 1

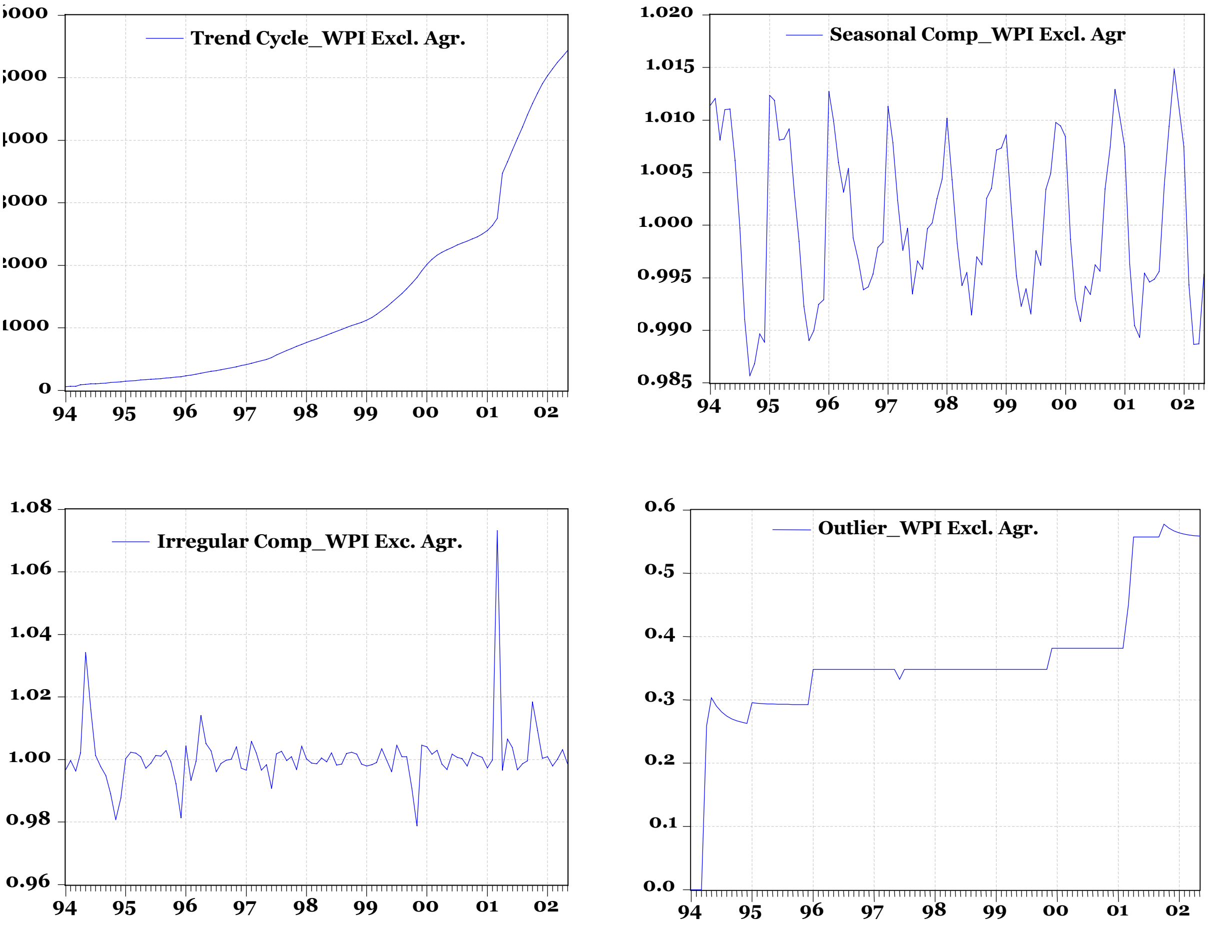
Decomposition of WPI into its components



Decomposition of CPI excluding food prices into its components

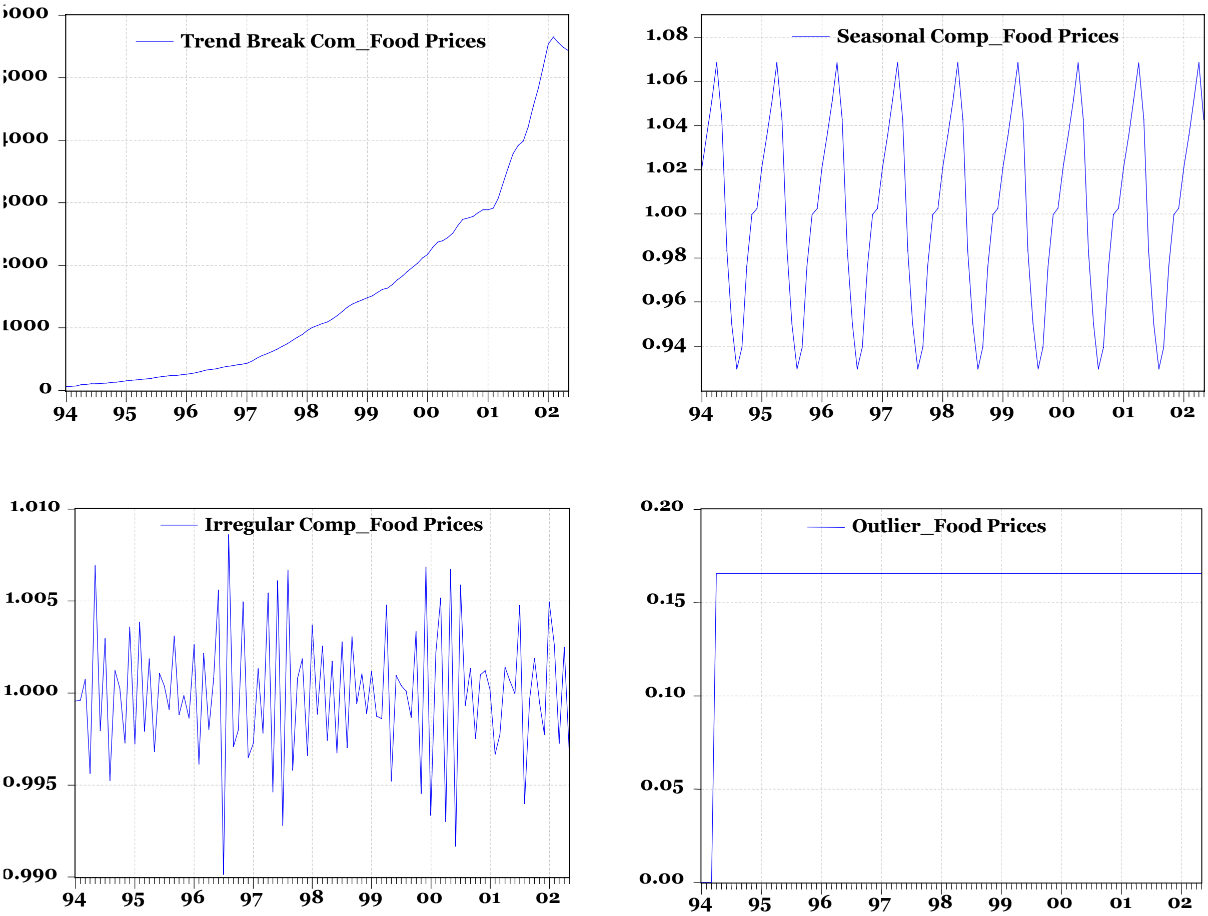


Decomposition of WPI excluding agricultural prices into its Components[17]

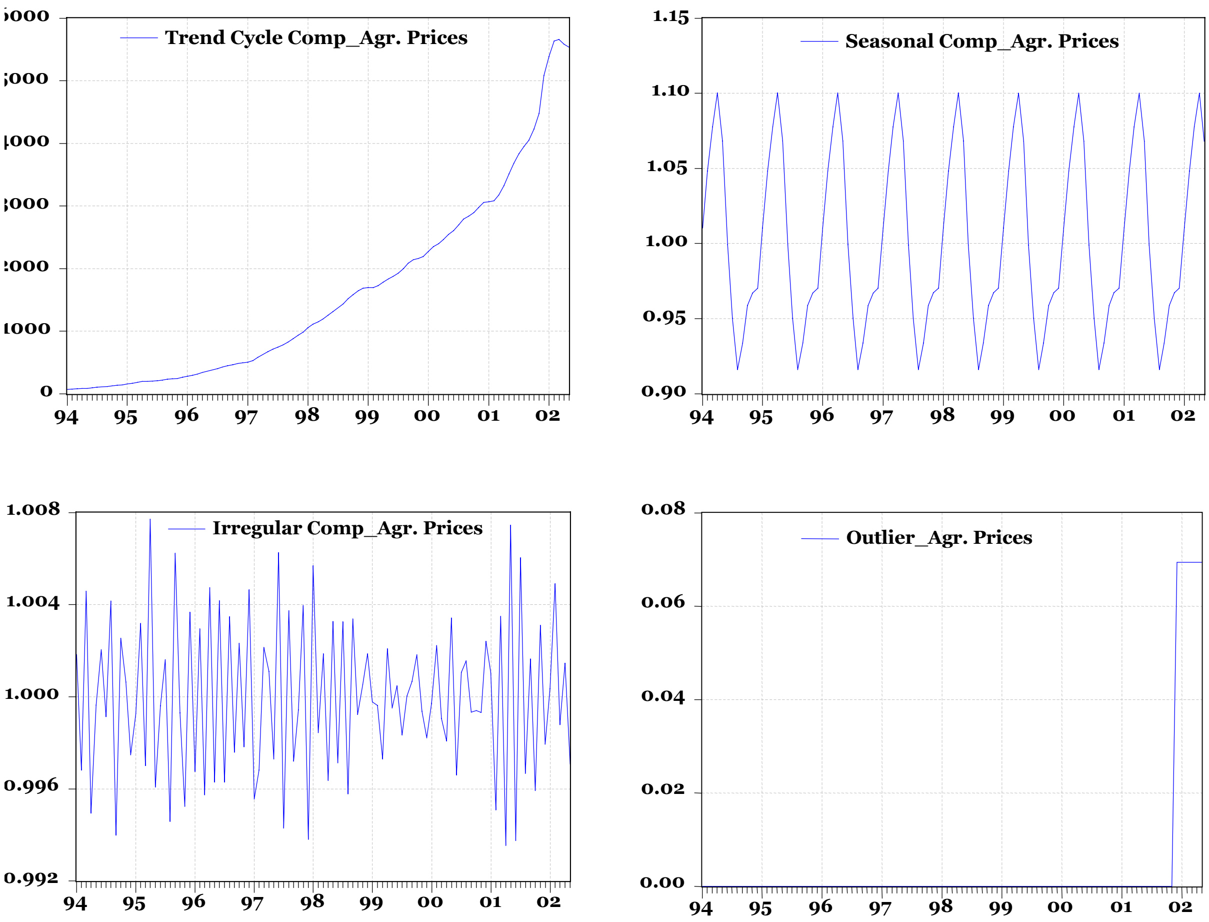


[17] TRAMO/SEATS found no seasonal pattern related with the WPI excluding agricultural prices series, the seasonal component analysis in the table has been realized with the help of X-12 ARIMA modeling.

Decomposition of food prices into its components



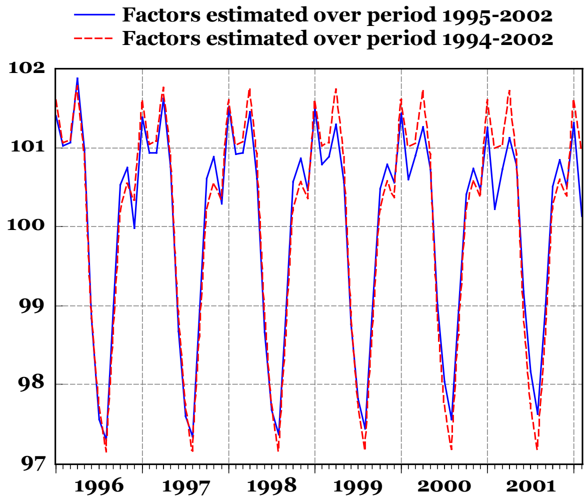
Decomposition of agricultural prices into its components



Annex 2

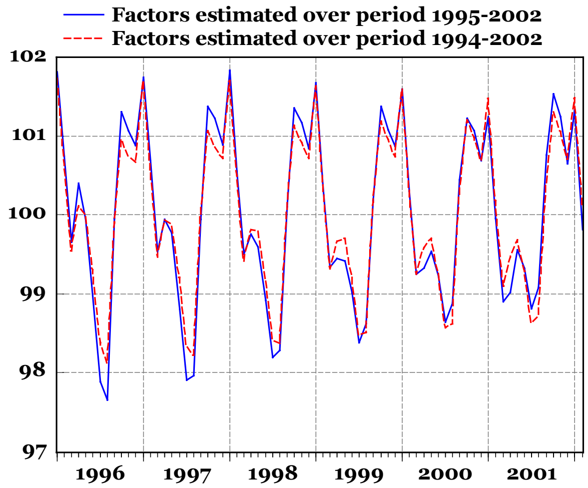
Seasonal Factors by TRAMO SEATS*

CPI



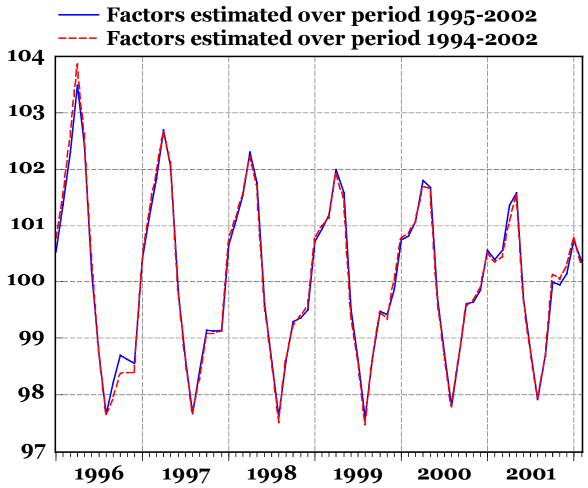
volatility for period 95-02: **0.013**
volatility for period 94-02: **0.015**

CPI Excluding Food



volatility for period 95-02: **0.011**
volatility for period 94-02: **0.010**

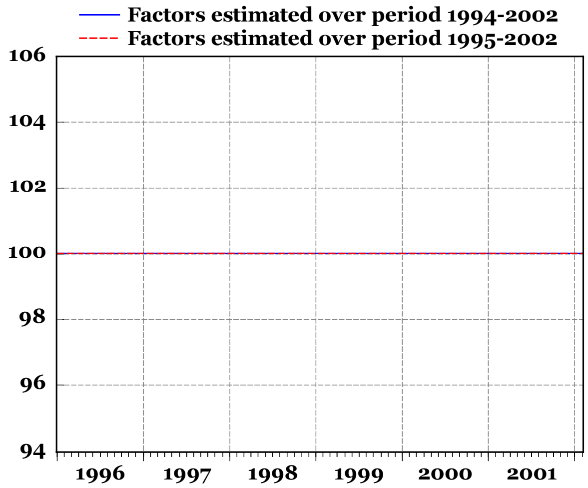
WPI



volatility for period 95-02: **0.014**
volatility for period 94-02: **0.015**

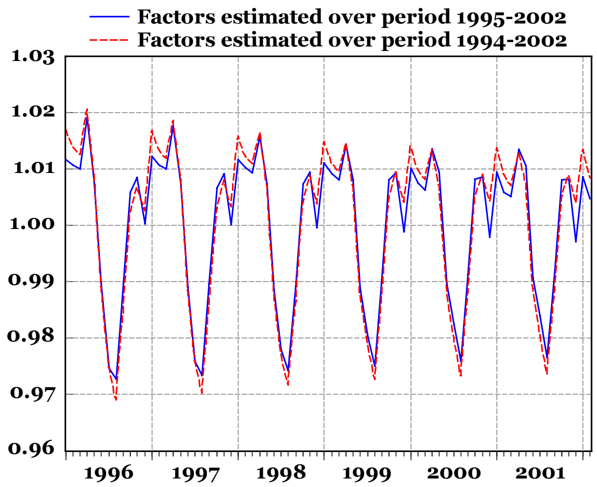
* volatility is defined as standard deviation over mean

WPI Excluding Agriculture



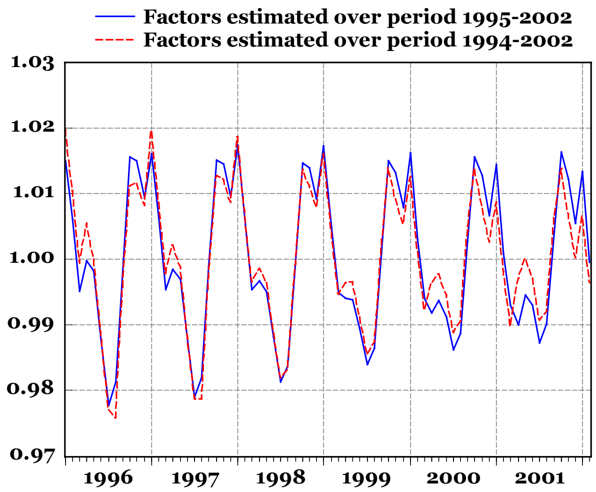
Seasonal Factors by X-12 ARIMA*

CPI



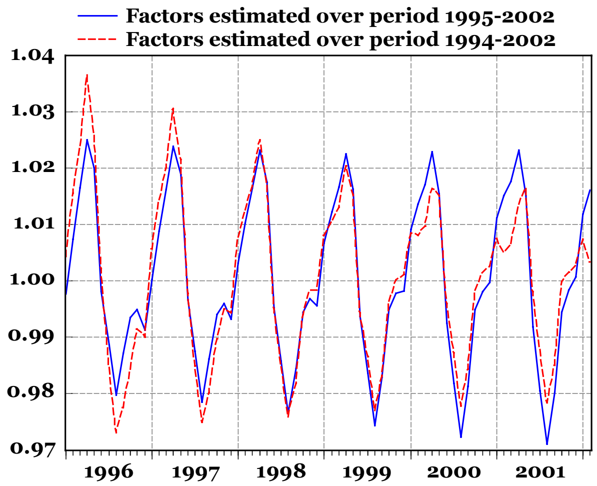
volatility for period 95-02: **0.013**
volatility for period 94-02: **0.015**

CPI Excluding Food



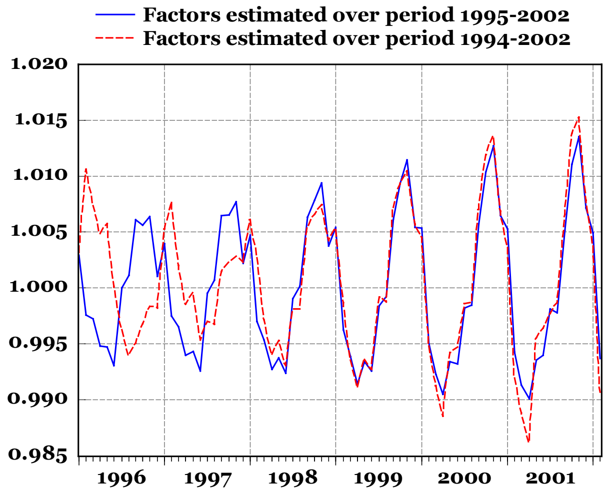
volatility for period 95-02: **0.011**
volatility for period 94-02: **0.011**

WPI



volatility for period 95-02: **0.015**
volatility for period 94-02: **0.015**

WPI Excluding Agriculture

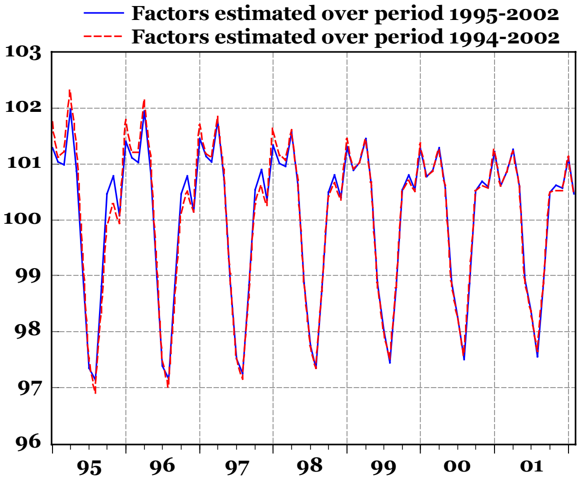


volatility for period 95-02: **0.006**
volatility for period 94-02: **0.007**

* volatility is defined as standard deviation over mean

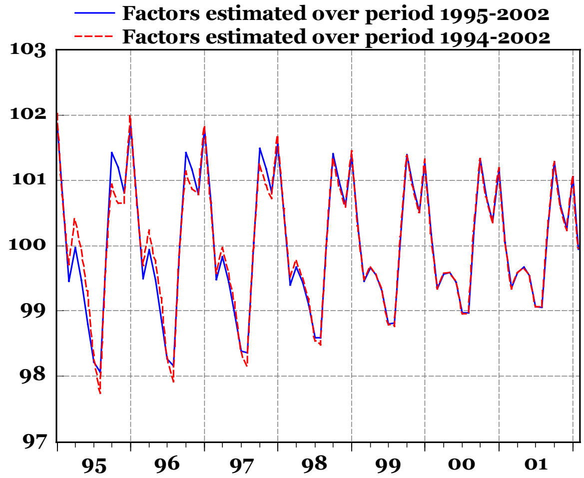
Seasonal Factors by Census X-11

CPI



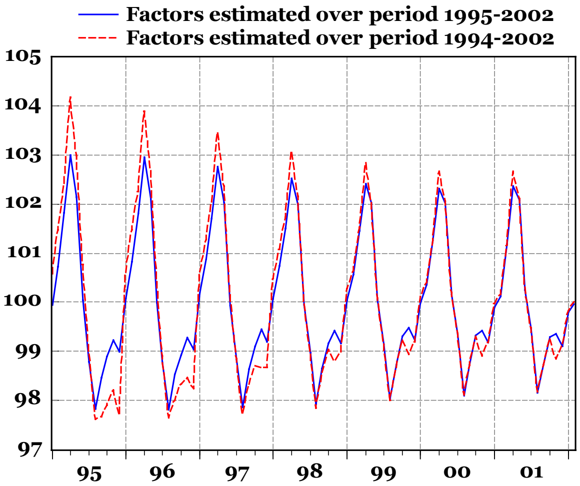
volatility for period 95-02: **0.014**
volatility for period 94-02: **0.014**

CPI Excluding Food



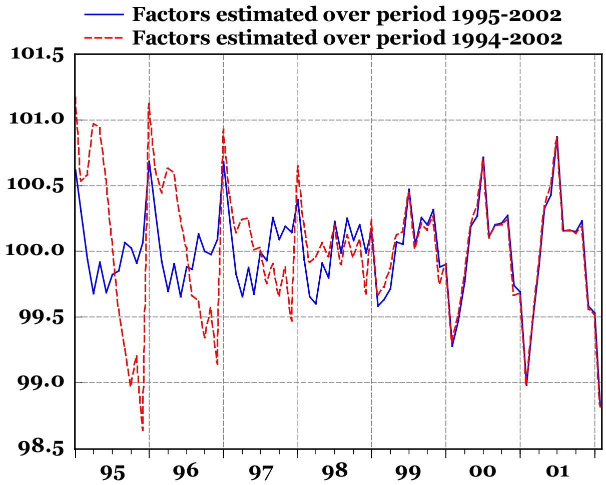
volatility for period 95-02: **0.010**
volatility for period 94-02: **0.010**

WPI



volatility for period 95-02: **0.014**
volatility for period 94-02: **0.017**

WPI Excluding Agriculture



volatility for period 95-02: **0.003**
volatility for period 94-02: **0.005**

* volatility is defined as standard deviation over mean

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