ANALYSIS OF TIME SERIES PROPERTIES OF EXPORT PRICES USING UNOBSERVED COMPONENTS MODEL

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I. INTRODUCTION

The primary commodity exports have been a major source of foreign exchange earnings for a long time in Turkey. Like prices of many other primary commodities, prices of primary commodities that Turkey exports have shown a secular decline vis-à-vis the export prices of industrialized countries' export prices. Although the share of primary commodities in the total exports of Turkey has been declining recently, primary commodities still account for the bulk of exports. The recent trend in primary commodity prices has been unfavorable for the major exporters of primary commodities. During the last few years real primary commodity prices have been continuously declining. Turkey made considerable efforts to increase the share of manufactured goods in total exports. The most convincing evidence of this orientation is the switch to an export oriented economy from an import substituting economy in 1980. This has considerably increased the dependence of the Turkish economy on export earnings and made export prices an important factor in determining movements of key macro economic magnitudes of the domestic economy.

Unfortunately, prices of many other commodities that Turkey exports have also been unfavorable in recent years. Besides this declining commodity terms of trade, the absolute prices of many commodities that Turkey exports have fluctuated widely over the years. Since the early 1980s, the export dependence of the Turkish economy has been continuously increasing. Yet, increased dependence of the Turkish economy on exports has made exports a source of economic destabilization. Consequently, the characteristics of the export prices have become very important in implementing appropriate stabilization policies and develop hedging strategies. Both the secular decline in the relative price of Turkish exports as well as the wide gyration in the absolute prices are considered detrimental to the long-term growth and stabilization policies of Turkey.

The main objective of this paper is to analyze time series properties of prices of commodities that Turkey exports using the unobserved components model. The unobserved components model allows one to decompose a time series into trend and cycle components. One can recover the relative importance of each component from this decomposition. The evaluation of each component over time can also be uncovered from the unobserved components model. This paper obtained significant information about the time series properties of the Turkish export prices series using the trend-cycle decomposition based on the unobserved components model.

The time series behavior of export prices of 32 SITC (Standard International Trade Classification) two digit divisions of the Turkish primary commodity and manufacturing sectors are analyzed in the paper. Among these sectors 15 are in the primary commodities group and 17 are in the manufactured commodities group. The total export price series, which includes all other sectors in addition to the 32 sectors, is also examined here. These 33 monthly export price indexes were examined for 1969:1-1995:12 period. The use of disaggregated data avoids possible aggregation and interpretation problems associated with the use of aggregate data. While previous research emphasized the primary commodity prices, the present study examines manufactured commodities export prices as well as the primary commodities export prices.

This study aims to disentangle how much the recent tendency in commodity prices is associated with reversible cyclical forces. To address this issue the export price series should be decomposed into trend and cyclical components. Two methods of trend-cycle decomposition are available. Both methods are applicable in the presence of unit roots. First method is the trend-cycle decomposition technique of Beveridge and Nelson (1981). Second method is the structural time series approach of Harvey (1985) and Clark (1987). In this study, we prefer the unobserved components decomposition method of Clark (1987). Results from this method are almost identical to results from applying the method of Harvey (1985). We do not use the Beveridge-Nelson method since it requires identification of the correct time series model and the identification of the correct time series model is extremely difficult due to several unobservable components that dominantly determine the behavior of the export prices examined in the paper. The trend-cycle decomposition reveals that the export prices had a considerable slowdown in growth rate after early 1980s and this slowdown is secular not cyclical.

The data used use in this study is sufficiently disaggregated so as to capture important sector specific characteristics. Many studies examining international prices use aggregate data. Aggregate data may hide much of the short-run fluctuations that are present in individual price series. Therefore, aggregate data may overstate the persistence and understate the size of the cyclical component. Among the purposes of this study are the estimation of the size of persistence and the relative importance of the cyclical and permanent components, which is best accomplished by the use of disaggregated data.

The plan of this paper is as follows. Section II describes the data in details. In Section III, we present the unobserved components model used in the paper. The empirical estimates of the unobserved components model are also presented in this section. Section IV discusses our findings.

II. THE DATA

The export price series used in this study were monthly indexes covering the period 1969:1-1995:1. The price indexes were computed from the U.S. dollar denominated unit values. This is unpublished data was collected by the Prime Ministry Undersecretariat of Foreign Trade (UFT). The raw data was obtained directly from the databank of the UFT. Price data related to foreign trade is collected by three different institutions in Turkey. These are the State Statistical Institute (SSI), the Central Bank of Turkey, and the UFT.

We prefer to use the UFT export price series data for the following reasons: (1) the UFT allowed us to obtain data according to SITC classification directly from its database system and (2) we were able to obtain sufficient information about the computational methods used by the UFT, the representativeness of exports, and the choice of the base year. For instance, the UFT uses a correction rule that essentially smooths out the export price series. We were not able to obtain any information as to whether the Central Bank and SSI use such rules.

According to the UFT, the correction rules they use minimizes the errors in statistical records. The rules it uses essentially smooth out the prices. The UFT used the following rule prior to 1989. Let P_0 and P_n be the price in the base year and the price in the current year, respectively. If $P_n > 2P_0$, then the UFT sets $P_n = 2P_0$. However, the UFT changed the rule after 1989. The rule after 1989 sets $P_n = 10P_0$, if $P_n > 10P_0$. Unfortunately, this introduces an inconsistency to the export price series used in this study. The rule before 1989 is particularly damaging for the purpose of this study. This rule may distort the results by artificially reducing the effects of shocks. We were not able to completely correct the effects of these arbitrary rules. However, a partial correction was feasible. The data was corrected applying the same rule used after 1989 to the data before 1989, i.e., data before 1989 was reconstructed using the rule $P_n = 10P_0$, if $P_n > 10P_0$.

Not all sectors under the SITC headings have usable data. Some sectors have many missing values. It was decided to use data on 32 two digit (SITC divisions) sectors. The SITC codes together with a brief description of these sectors are given in Appendix 1. The selection of these sectors was based on whether the sector was continuously subject to international trade and had a significant share in total exports. The share of these 32 sectors in total exports was approximately 89 percent after 1992. The total export price series, which includes all other sectors in addition to 32 sectors listed in Appendix 1, was also examined. The data for all series cover the period 1969:1-1995:12. This was the longest time span for which the data was available. The period covered includes two oil price shocks, the large shocks of political instability in Turkey during late 1970s, and an important structural change following the Economic Stabilization Decisions in 1980.

Since the data used had a monthly frequency one may suspect seasonal effects. Autocorrelation functions of logged first differences indicate some insignificant seasonality in some series. Although, the seasonal effects are insignificant an X-11 filter to all series was applied and the sensitivity of our results to seasonality was examined. The results obtained using X-11 filtered data were almost identical to the results obtained using unfiltered data. Therefore, it was assumed no seasonality and all results presented in the following sections were obtained using the seasonally unadjusted data.

We should also point out that export price series used in this study are not relative price series. The relative price series would serve the purpose of studies examining the terms of trade issues, see for instance Grilli and Yang (1988), von Hagen (1989), and Reinhart and Wickham (1994). The price series we use are non-relative export price indexes. This allows us to make comparisons between primary commodities and manufactures. A comparison between primary commodity prices and prices of manufactures may reveal important similarities. This is because both primary commodities and manufactures may be subject to same aggregate shocks. For instance, a sizable demand shock in a large developed country may affect both primary commodity and manufactures export prices facing Turkish exporters in the same way.

III. UNOBSERVED MODEL ESTIMATES OF EXPORT PRICES

A visual inspection of the export price series, which are shown as the dashed lines in Figure 1, shows that almost all series have slowing growth rates in recent years. In this section, we try to discover how much of this recent weakness in export prices associated with reversible cycles and how much of it is associated with a secular decline resulting from a change in the growth rate of the permanent component. For this propose, we use the unobserved components model of Clark (1987) to decompose the export price series into permanent (trend) and temporary (cycle) components.

Given that the export price series contain unit roots, there are two methods available to disentangle trend from cycle, the Beveridge and Nelson (1981) method and unobserved components model of Clark (1987). The structural time series approach of Harvey (1985) can also be thought as a special unobserved components model. Therefore, results from these models should be similar, if not identical. Given that the power of unit root tests are low and the evidence about the nonstationarity of some export price series is weak, particularly after the effect of structural changes are taken into account, we prefer not to use the Beveridge-Nelson method since it is based on the assumption of nonstationarity. The unobserved components model on the other hand is independent of the nonstationarity assumption. Therefore, we prefer the unobserved components model.

The unobserved components model is based on the idea of decomposing a time series into trend, cycle, and irregular components. This decomposition is usually denoted by

$$(1)\quad y_t = d_t + c_t + e_t, \qquad t = 1, \mathbf{K}, T,$$

where d_t is a trend component, c_t is a stationary cycle component, and e_t is a white noise irregular component with variance s^2. We assume that all three components are independent. We found that the irregular component e_t is insignificant for all export price series, hence, it is omitted. Thus, equation (1) is written as a trend plus cycle model. This trend plus cycle model together with the models of trend and cycle form the complete unobserved components model and can be written as

$$(2)\quad y_t = d_t + c_t,$$
$$(3)\quad d_t = d_{t-1} + d_t + w_t,$$
$$(4)\quad d_t = d_{t-1} + u_t,$$
$$(5)\quad f(L)c_t = v_t,$$

where w_t, u_t, and v_t are independent white noise processes with variances s_w^2, s_u^2, and s_v^2, respectively and $f(L)$ is a finite polynomial in the lag operator L with roots all outside the unit circle.

Equation (2) decomposes log of export prices, y_t, into the additive trend component d_t and the cycle component c_t. Equations (3) and (4) model the nonstationary trend component as a local approximation to a linear trend as in Harvey (1985). Here, w_t are the innovations in the level of d_t, while u_t are the innovations in the first difference or growth rate of d_t. It should be noted that $s_u^2 > 0$ means a variable growth rate. Allowing for a variable growth rate turns out to be very essential for all the export price series. All export price series examined in this study have a slowdown in growth rate

after early 1980s. Allowing a positive s_u^2 should capture this change in the growth rate. If $s_w^2 = s_\mu^2 = 0$, then, d_t reduces to a linear deterministic trend and given that c_t is stationary, the model becomes a trend stationary model. Further, if $s_u^2 = 0$, then, y_t is stationary in first differences and provided that $s_w^2 > 0$, it is a pure difference stationary model with $d_t = d$. Equation (5) models the stationary cyclical component as a finite autoregression. We could allow for more general ARMA models for the cyclical components but this complicates the parameter estimation with little improvement in model fit and forecasting performance. Therefore, we estimated the unobserved components model for all export price series with an AR(2) cyclical component. Results are not sensitive to higher order AR models for the cyclical component.

Parameters of the unobserved components model in (2)-(5) are estimated by maximizing the likelihood of observed sample with respect to the parameters of the model through the Kalman filter in time domain. In implementing this maximum likelihood estimation through the Kalman filter, we assumed that innovations in the trend and cycle components are independent. This assumption does not seem to be unrealistic, since there is no reason to believe that temporary shocks in the export prices should permanently affect the growth rate.

Estimated permanent components form the unobserved components model along with the actual export price series are plotted in Figure 1. From the plots in Figure 1, we observe that all sectors, particularly those in the manufactures group, had a faster growth during 1970s and early 1980s. Most sectors in the primary commodities group had a trough in the permanent component in early 1970s and mid 1980s. The same feature is present for some manufactures. For instance, SITC 65, SITC 66, SITC 81, and SITC 89 had a trough in early 1970s and particularly in mid 1980s. The most prevalent feature of the estimated permanent components common to all sectors is the slowdown of the growth rate after early 1980s. It is clear that bulk of the price weakness is secular and associated with the permanent component. We see no evidence of large cycles in recent years. Therefore, we conclude that recent slowdown in the growth rate of export prices facing the Turkish exporters is permanent and common to both manufactures and primary commodities. Although, both manufactures and primary commodities had a permanent weakness in the growth rate, the slowdown in most primary commodities is larger than manufactures. This feature can also be seen in the total price index. Figure 2 plots the estimated permanent component of the total price series along with the actual series. Like the individual sectors, total price series had a considerable permanent slowdown in the growth rate after early 1980s. Further, we see no important cyclical deviations from the trend in the total price series.

Figure 1. Unobserved Components Decomposition of Export Prices

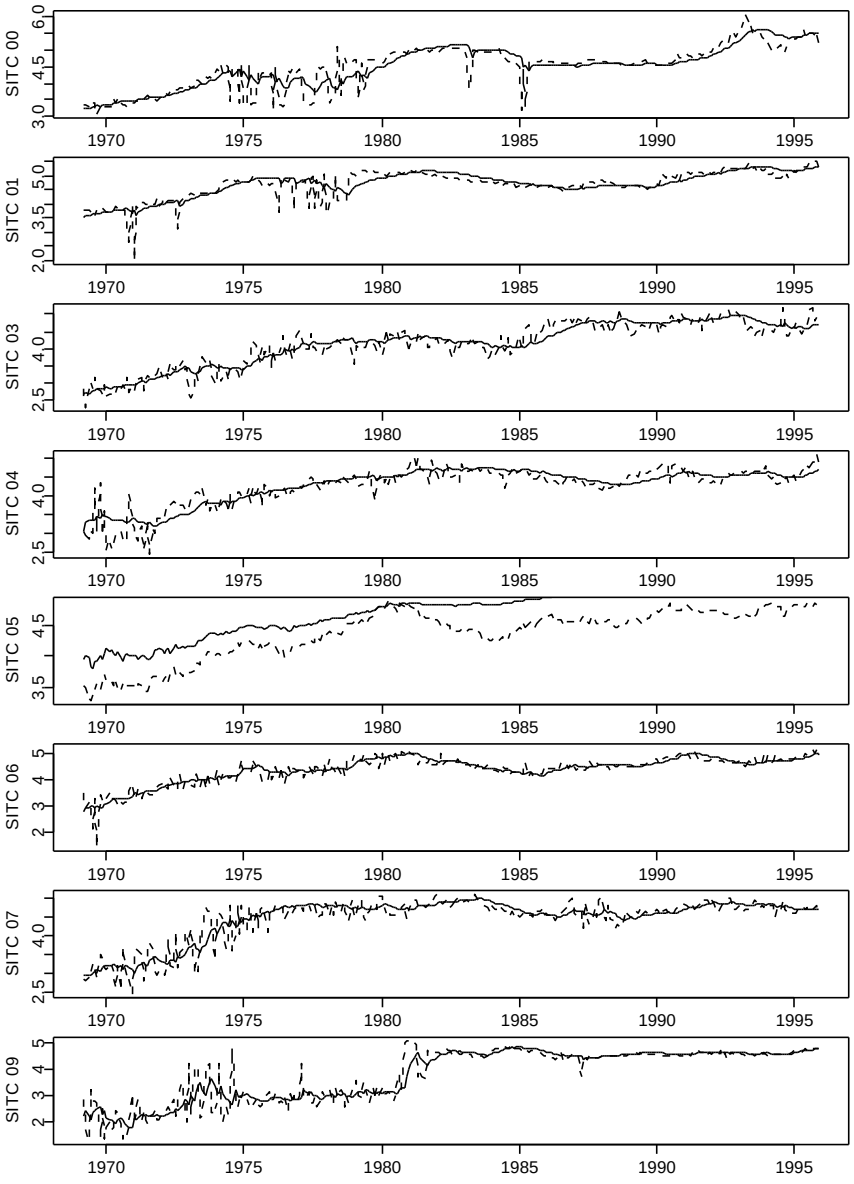


Figure 1. Unobserved Components Decomposition of Export Prices (continued)

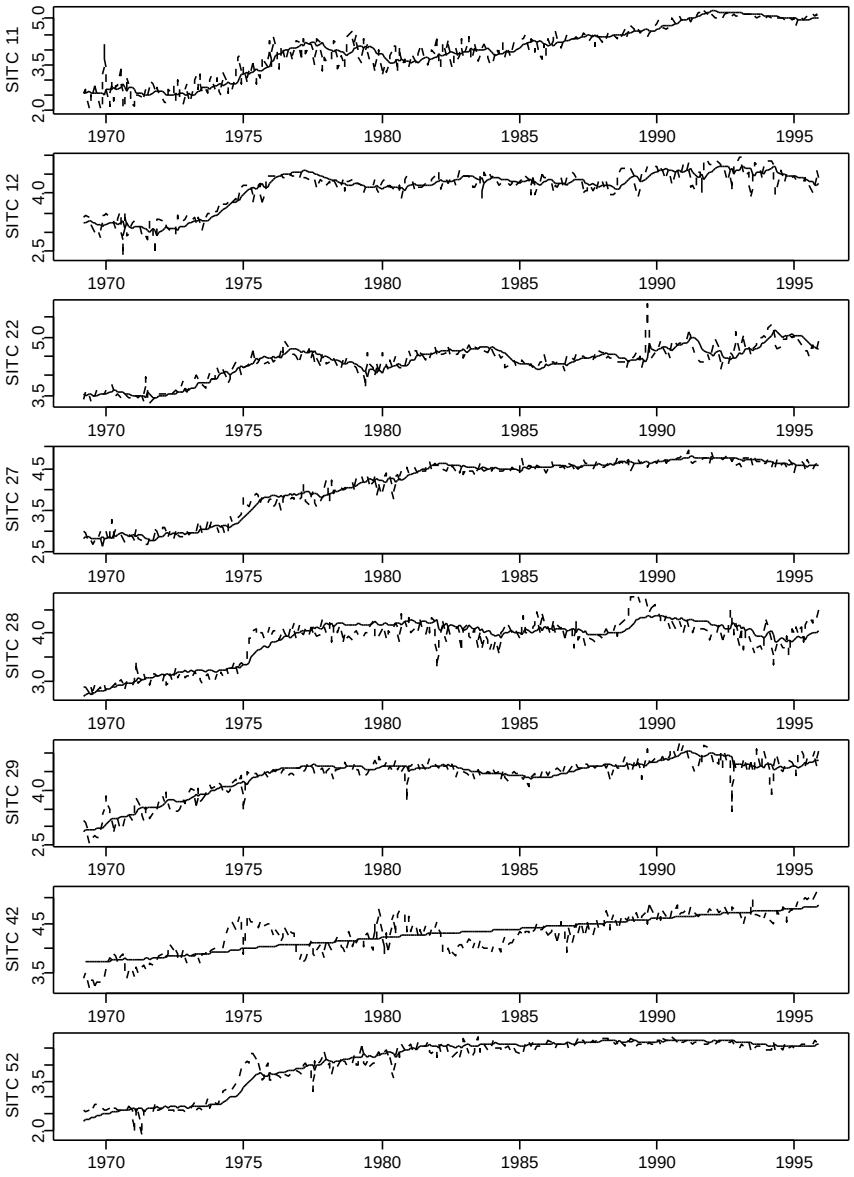


Figure 1. Unobserved Components Decomposition of Export Prices (continued)

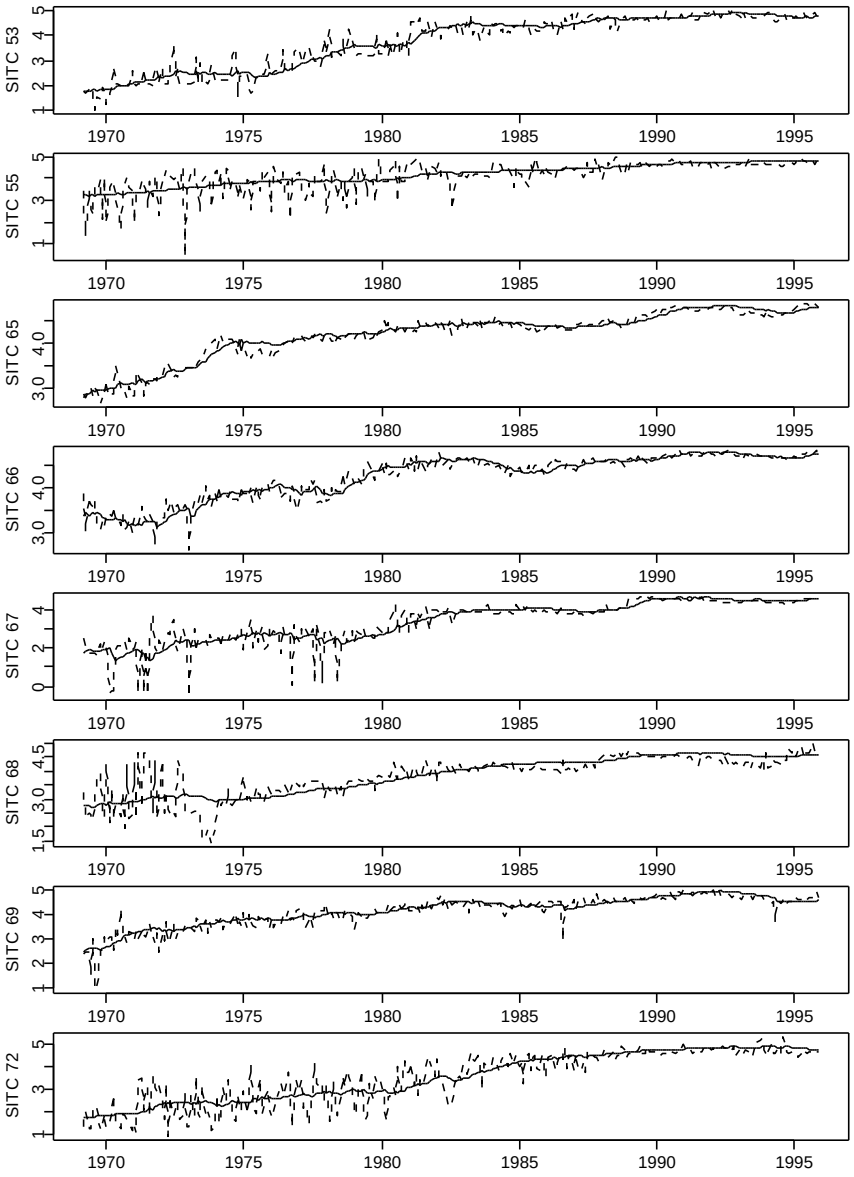


Figure 1. Unobserved Components Decomposition of Export Prices (continued)

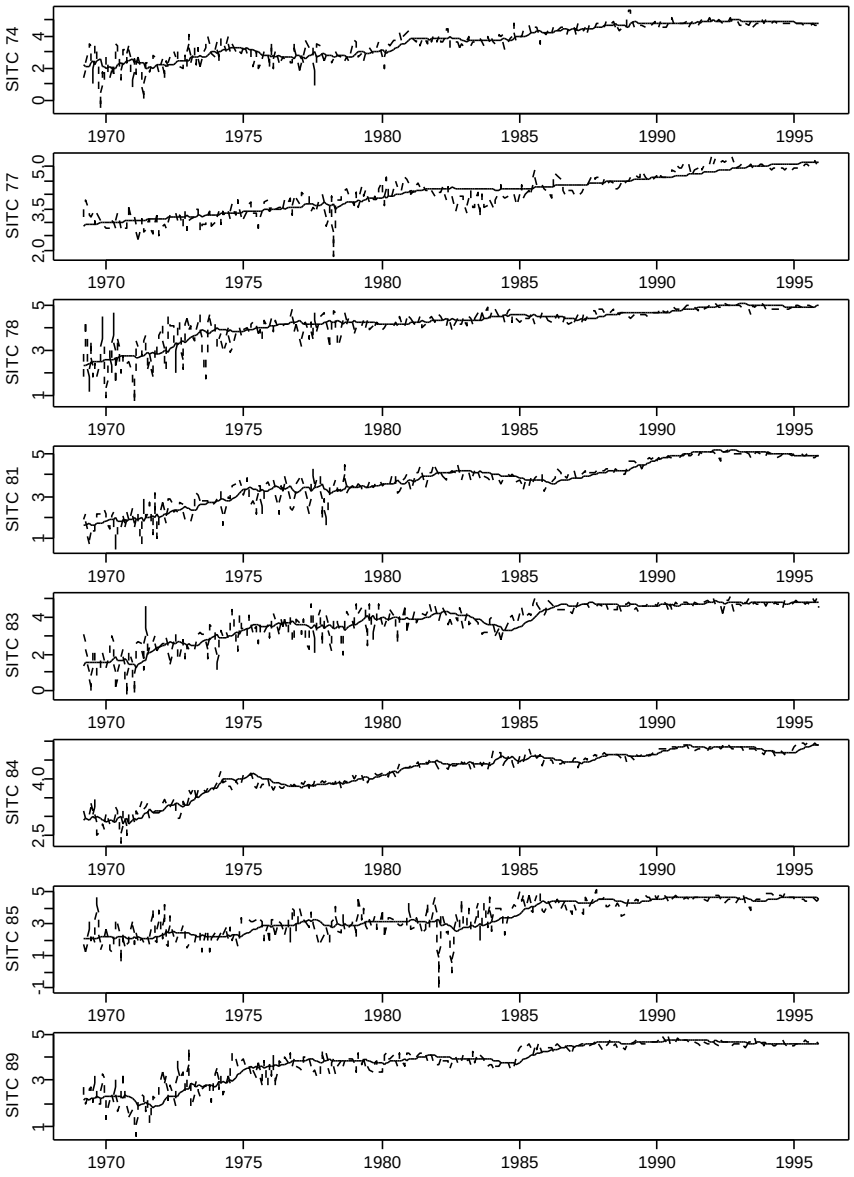
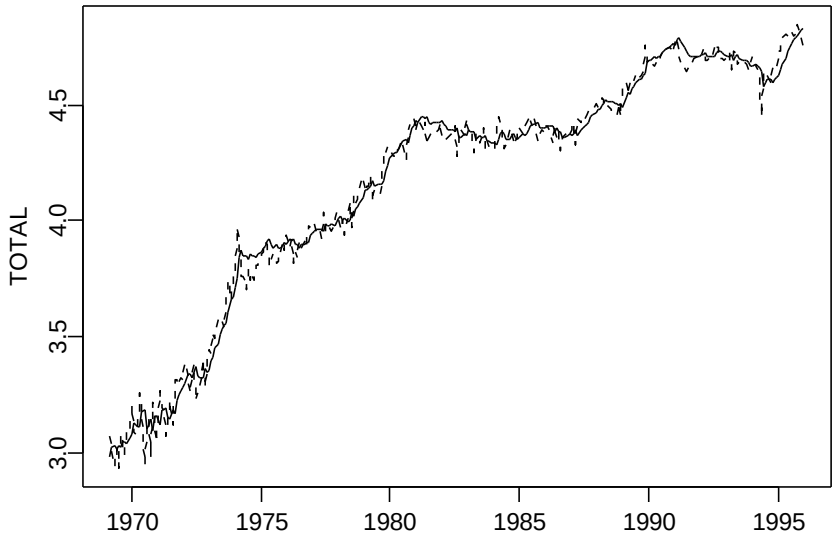


Figure 2. Unobserved Components Decomposition of Total Export Prices



Plots in Figure 1 show that all sectors except SITC 05 did not have long deviations from the trend in recent years. However, we see long deviations from the trend in some primary commodities sectors, among these are SITC 00, SITC 05, and SITC 42. Both SITC 00 and SITC 01 show moderate but long deviations from the trend. Peculiar feature of SITC 05 is noteworthy. Export price series for this sector hardly even gets closer to trend. Large deviations from the trend in SITC 42 are also noteworthy.

Estimates of s_w^2, s_u^2, and s_v^2 reveal important information about the sizes of trend and cycle components as well as the structure of the trend components. These estimates are given in Table 6. Estimated variance of the cyclical component, s_v^2, is much larger compared to the variance of the trend component, s_w^2, for all sectors as well as the total price series. This is a further evidence about our previous finding that the size of the cyclical component is much larger compared to the size of the permanent component. Estimates of s_w^2 are almost zero (after rounding) for all sectors. This represents further evidence that the permanent component is relatively small. We further note that the estimates of s_u^2 for most sectors are relatively larger than the estimates of s_w^2. This points out that there is a small and slowly varying permanent component. Plots in Figure 1 show that permanent components are actually slowly varying for all price series.

Table 1. Estimates of Unobserved Components Variances

SITC	s_u^2	s_w^2	s_v^2
00	0.0024	0.0000	0.2829
01	0.0016	0.0000	0.2321
03	0.0001	0.0000	0.1973
04	0.0000	0.0000	0.1955
05	0.0000	0.0000	0.0513
06	0.0031	0.0000	0.1818
07	0.0014	0.0294	0.2259
09	0.0000	0.0000	0.3541
11	0.0034	0.0000	0.2813
12	0.0030	0.0000	0.1907
22	0.0043	0.0000	0.1672
27	0.0018	0.0000	0.1175
28	0.0009	0.0000	0.1736
29	0.0017	0.0008	0.1995
42	0.0000	0.0000	0.1518
52	0.0010	0.0000	0.1596
53	0.0015	0.0000	0.2907
55	0.0002	0.0000	0.4984
65	0.0009	0.0000	0.0992
66	0.0023	0.0000	0.1385
67	0.0002	0.0676	0.5085
68	0.0000	0.0000	0.3873
69	0.0017	0.0000	0.2510
72	0.0010	0.0000	0.5209
74	0.0000	0.0000	0.4873
77	0.0000	0.0000	0.2735
78	0.0013	0.0000	0.4650
81	0.0028	0.0000	0.3699
83	0.0042	0.0000	0.5329
84	0.0024	0.0000	0.1294
85	0.0025	0.0000	0.6384
89	0.0021	0.0000	0.3609
Total	0.0018	0.0000	0.5099

VI. SUMMARY AND DISCUSSION

The paper examined the time series behavior of primary and manufactured commodities export prices of Turkey. The movement in world prices can have significant effect on foreign exchange earnings of the Turkish economy. Exports gained a high significance in the Turkish economy following the adaptation of the export oriented economic policy, which replaced the import substation policy that were in effect since early 1960s, in 1980. Dependence of the Turkish economy on export earnings has been continuously increasing since then.

In recent years, like prices of many other primary commodities, prices of primary commodities Turkey exports have shown a secular decline vis-à-vis the export prices of industrialized countries' export prices. In response to this trend, Turkey attempted to increase the share of manufactured commodities in exports. However, primary commodities still account for the bulk of total exports. Prices of primary commodities relative to manufactured commodities have been continuously declining since early 1980s. Worldwide abolishment of the fixed exchange rate system and switch to flexible exchange rate system has increased the volatility of international prices. These developments together with increased dependence of the Turkish economy on exports made the movements in export prices a potential destabilizing force. This study examined the characteristics of export price series of 32 individual sectors using the unobserved components model. The unobserved components model allows one to decompose a time series into trend and cycle components. One can recover the relative importance of each component from this decomposition. The evaluation of each component over time can also be uncovered from the unobserved components model. This paper obtained significant information about the time series properties of the Turkish export prices series using the trend-cycle decomposition based on the unobserved components model.

The trend-cycle decomposition from the unobserved components model reveals a significant finding. We found that export price series of all sectors were subject to a considerable slowdown in the growth rate after early 1980s. This slowdown is secular and not associated with the cyclical component. Thus, recent weakness in export prices is permanent and requires structural policies and adjustments. We further showed that the slowdown in the growth rate for the sectors in the primary commodities group is generally deeper than the slowdown in the manufactures group. This points out to a deteriorating terms of trade. We further found that there are long deviations from the trend in some primary commodities.

REFERENCES

BEVERIDGE, S. and C.R. NELSON, (1981), "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the 'Business Cycle", ***Journal of Monetary Economics*****, 7**, 151-174.

CLARK, PETER K., (1987), "The Cyclical Component of U.S. Economic Activity", ***Quarterly Journal of Economics***, **102,** 797-814.

GRILLI, R. E. and Mow CHENG YANG, (1988**)** "Primary Commodity Prices, Manufactured Good Prices, and the Terms of Trade of Developing Countries: What the Long-run Shows?" ***The World Bank Economic Review*****, 2,** 1-48.

HARVEY, A. C., (1985), "Trends and Cycles in Macroeconomics Time Series"*,* ***Journal of Business and Economic Statistics*****, 3,** 216-227.

REINHART, M. C. and Peter WICKHAM, (1994), "Commodity Prices: Cyclical Weakness or Secular Decline?" ***IMF Staff Papers*****, 41,** 175-213.

Von HAGEN, J., (1989**),** "Relative Commodity Prices and Cointegration", ***Journal of Business and Economic Statistics*****, 7,** 497-503.

Appendix 1. Description of the Export Sectors Used in the Study (SITC,Rev.3)

SITC	Description
00	Live Animals other than Animals of division 03
01	Meat and Meat Preparations
03	Fish, Crustaceans, Molluscs, and Aquatic Invertebrates, and Preparations thereof
04	Cereals and Cereal Preparations
05	Fruits and Vegetables
06	Sugars, Sugar Preparations, and Honey
07	Coffee, Tea, Cocoa, Spices, and Manufactures thereof
09	Feeding Stuff for Animals (not including unmilled cereals)
11	Beverages
12	Tobacco and Tobacco Manufactures
22	Oil Seeds and Oleaginous Fruits
27	Crude Fertilizer and Ores (excluding coal, petroleum, and precious stones)
28	Metalliferous Ores and Metal Scrap
29	Crude Animal and Vegetable Materials, n.e.s.
42	Fixed Vegetable Fats and Oils; Crude, Rafined or Fractionated
52	Inorganic Chemicals
53	Dyeing, Tanning, and Coloring Materials
55	Essential Oils, Resinoids, and Perfume Materials; Toilet, Polishing, and Cleaning Preparation
65	Textile Yarn, Fabric, Made-up Articles, n.e.s. and Related Products
66	Non-metallic Mineral Manufactures, n.e.s.
67	Iron and Steel
68	Non-ferrous Metals
69	Manufactures of Metals, n.e.s.
72	Machinery Specialized for Particular Industries
74	General Industrial Machinery and Equipment, n.e.s. and Machine Parts, n.e.s.
77	Electrical Machinery, Apparatus, and Appliances, n.e.s. and Electrical Parts thereof
78	Road Vehicles (including air-cushion vehicles)
81	Prefabricated Buildings; Sanitary, Plumbing, Heating, and Fitting
83	Travel Goods, Handbags, and Similar Containers
84	Articles of Apparel and Clothing Accessories
85	Footwear
89	Miscellaneous Manufactured Articles, n.e.s.
Total	General Total, includes all other sectors in addition to 32 listed above

Appendix 2. Shares of SITC Divisions in Total Exports

SITC	1970	1975	1980	1985	1990	1995
00	2.70	1.81	3.40	2.21	1.57	0.61
01	1.09	1.86	0.88	1.11	0.19	0.11
03	0.59	0.89	1.06	0.73	0.53	0.39
04	0.25	0.26	3.58	1.69	0.57	2.04
05	25.50	23.20	32.20	11.70	13.30	10.10
06	0.82	0.23	0.47	0.84	0.20	0.91
07	0.51	0.19	0.74	0.44	0.62	0.58
09	0.02	0.02	0.06	0.29	0.56	0.95
11	0.09	0.12	0.12	0.08	0.10	0.41
12	13.40	13.10	8.03	4.15	3.40	1.76
22	0.54	0.35	0.22	0.09	0.06	0.08
27	2.79	3.19	5.29	2.39	1.85	1.15
28	3.43	4.59	1.64	0.72	0.82	0.90
29	1.75	2.00	1.37	0.55	0.70	0.46
42	0.06	1.29	0.22	0.58	0.95	0.94
52	0.95	0.45	0.75	0.75	0.88	0.70
53	0.11	0.05	0.01	0.41	0.19	0.25
55	0.27	0.10	0.18	0.32	0.90	1.04
65	4.32	7.82	11.80	13.10	11.10	11.70
66	0.65	2.99	2.52	2.81	2.77	2.81
67	0.52	0.90	0.98	11.00	11.50	9.12
68	1.38	0.84	0.56	1.21	1.78	1.26
69	0.10	0.84	0.46	2.21	1.23	1.66
72	0.08	0.35	0.19	2.17	0.32	0.68
74	0.01	0.13	0.14	2.21	0.50	1.06
77	0.23	0.15	0.49	1.15	1.62	3.57
78	0.07	0.55	1.71	1.38	1.07	3.37
81	0.01	0.03	0.15	0.16	0.35	0.56
83	0.00	0.01	0.01	0.22	0.28	0.16
84	0.73	5.86	4.50	15.10	25.60	28.30
85	0.02	0.24	0.01	0.24	0.28	0.53
89	0.19	0.30	0.29	1.17	0.72	1.52
Total (%)	63.10	74.70	84.00	83.20	86.50	89.70