D.E.Ü. İ.İ.B.F. Dergisi
Cilt: 11, Sayı: I, 1996, ss.175-190

EXCHANGE RATES AND DOMESTIC PRICES:
A Test of Causality

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ABSTRACT

This paper empirically investigates the direction of causality between the exchange rate and the price level in case of Turkey. Hsiao's causality test is conducted on the pairs of the monthly WPI - exchange rate and the CPI - exchange rate series over the period of the period of the controlled flexible exchange rate regime in Turkey. The causality test is also applied to four subperiods within the controlled fexible exchange rate regime. The reults indicate a unidirectional causality running from the price level to the exchange rate between 1981-1993, whereas a feedback when the first six months of 1994 are included in the sample period. It is concluded that, the causal relationship implied by the PPP theory characterizes the period between 1981-1933, but a vicious circle should be suspected in 1994.

1. Introduction

Persistently hign inflation rates and continuously depreciating currency since the late 1970's seem to become the characteristics of the Turkish economy. Despite many measures taken, neither the inflation rate could be reduced nor the Turkish lira could be prevented from depreciating since then. For example, TL/$ ratio that was about 90 in the beginning of 1981 rose exponentially reaching 35,000 in October 1994. The price level, as measured by the wholesale price index (WPI) and the consumer price index (CPI), also followed similar pattern. It is generally perceived that there is close relationship between the exchange rate changes and the inflation rate. Indeed, the relationship between the exchange rate and the prices was established in the literature long ago, and there exist several different views on that. In this paper, the relationship between the exchange rate and the domestic prices is empirically investigated taking different views concerning the direction of causality into consideration. By doing so, we can determine the theoretical approach that can best characterize the controlled (managed) floating exchange rate regime in Turkey on the grounds of a causality test. Since the sample period is quite long, the subperiods within the sample period will be also investigated to find out whether any changes in the direction of causality occur during this period.

The organization of the paper is as follows. First, there different approaches to the relationship between exchange rate and prices will be

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briefly presented and their implications concerning the direction of causality will be hypothesized under the concept of Granger causality. Then, Hsiao (1981)'s causality test will be conducted on the pairs of WPI - exchange rate (TL/$) (henceforth ER) and CPI-ER series covering the period from 1981.05 to 1994.06, and also different subperiods. It should also be noted that the beginning date is also the beginning of the managed (controlled) flexible exchange rate regime in Turkey. Finally, the test results will be discussed in section 5.

2. Relationship between Exchange Rate and Prices

The relationship between the exchange rate and prices was first states by the Purchasing Power Parity (PPP) theory of exchange rate determination. Although, different versions of PPP can be traced to the 16th century, it was developed and made popular by Gustav Cassel in 1920's. PPP theory is based on "the law of one price" and it basically states that the exchange rate is determined by the domestic price level compared to the price level abroad, and changes in the exchange rate are determined by the domestic inflation rate relative to the inflation rate abroad (Officer, 1982).

To some economists PPP simply characterizes the equilibrium relationship, hence it does not necessarily imply that causation runs in one direction. Nevertheless, the proponents of the PPP generally portray it as unidirectional causation running from the domestic prices to the exchange rate (Dornbush, 1988:268; Isard,1987:4), especially under floating exchange rate regimes (Kreinin,1977:323).

The second approach can be related to the balance of payments view. According to this view, the domestic inflation is caused by the exchange rate change prompted by the adverse balance of payments developments (Montiel,1989). The move toward flexible exchange rate regimes in the early 1970's has created a significant interest in the inflationary effects of the exchange rate changes[1]. Exchange rate movements are thought to affect the domestic price level mainly through the prices of imports. The channels through which domestic inflation is affected by the exchange rate changes are explained in Dornbush and Krugman (1976) and in Woo (1984), among others. Many studies, that have modified Keynesian models of inflation by including import prices or exchange rates as explanatory variables, attempted to measure the effects of exchange rate movements on the domestic price level (Sachs,1985; Koch et al,1988; Adrangi et al,1989; among others). In this approach, by construction of models, the causation runs from the exchange rate to the domestic prices.

The third approach is the vicious circle hypothesis which states, in short, that under floating exchange rate regime, an exchange rate

depreciation due to exogenous (real or monetary) disturbances initially causes the domestic inflation to rise through an immediate increase in the price of imported goods. The increase in the inflation rate is followed by a further depreciation of the exchange rate. Therefore, this process may trigger a self-reinforcing inflation-depreciation cycle which is called a vicious circle (Basevi and DeGrauwe, 1977). Although labor market and monetary policy are also key factors in explaining the vicious circle[2], the analysis in this paper will be confined to the exchange rate-price level side of the vicious circle hypothesis in which bi-directional causality between the exchange rate and the domestic prices is assumed (Öniş and Özmucur, 1990:137).

The implications regarding the direction of causality of these three simplified approaches can be hypothesized, with respect to the concept of causality developed by Granger (1969), as follows:

(i) unidirectional causation running from the domestic prices to the exchange rate will imply the PPP approach;

(ii) unidirectional causation running from the exchange rate to the domestic prices will imply the second approach related to the balance of payments view;

(iii) bi-directional causality (i.e. a feedback) will imply the vicious circle approach.

To test these hypotheses, Hsiao's bivariate causality test, which treats all the variables as endogenous without imposing a priori restrictions, will be conducted on the pairs of WPI-ER and CPI-ER.

3. Concept of Causality and the Model

Granger (1969) defines the concepts of causality, feedback and instantaneous causality. Suppose that there are only two variables X_t and Y_t. If past values of X_t in addition to the past values of Y_t helps predict Y_t better than only the past values of Y_t, it is said X_t "causes" Y_t and denoted by $X_t \Rightarrow Y_t$. If X_t causes Y_t, and also Y_t causes X_t, a feedback is said to occur, and denoted by $X_t \Leftrightarrow Y_t$. If the current value of Y_t is better predicted when the current value of X_t is inclided in the prediction that it is not, it is said instantaneous causality occurs. However, Granger (1988) argues that instantaneous causality is never the case in economics. In addition, if neither X_t causes Y_t, nor Y_t causes X_t, it is said that X_t and Y_t are independent of each other.

With these definitions, Granger (1969) has provided a testable kind of causality. One crucial point in conducting Grange's causality test is the determination of the maximum order of lags of the variables. Hsiao (1981)

provides a powerful test of causality based on Granger's concept of causality and Akaike's final prediction error (FPE) criterion, so that the optimum order of lags of the variables can be determined without arbitrary choice of lag order.

Suppose that Xt and Yt are two stationary time series with zero means, then the bivariate autoregressive model to be estimated is

$$X_t = \sum_{j=1}^{M} a_j X_{t-j} + \sum_{j=1}^{M} b_j Y_{t-j} + u_t \qquad (1)$$

$$Y_t = \sum_{j=1}^{M} c_j X_{t-j} + \sum_{j=1}^{M} d_j Y_{t-j} + v_t \qquad (2)$$

$$X_t = a_j(L)X_t + b_j(L)Y_t + u_t \qquad (1a)$$

$$Y_t = c_j(L)X_t + d_j(L)Y_t + v_t \qquad (2a)$$

where, $a_j(L) = \sum a_j L^j$, $(j=1,\ldots,M)$, and L is the lag operator (i.e. $L^j y_t = y_{t-j}$). M is the maximum lag order. u_t and v_t are zero mean white noise innovations. The estimation of the FPEs requires a sequantial procedure. First, the regression of (1) is run by using only the lagged values of X_t by varying its order of lags from 1 to M. Then, the FPEs are estimated by the following formula:

$$FPE_x(m,0) = \left(\frac{T+m+1}{T-m-1}\right)\left(\frac{Q_x(m,0)}{T}\right) \qquad (3)$$

where, $Q_x(m,n)$ is the sum of squared residuals (SSR) obtained from (1), and m is the lag order, and T is the number of observations. The minimum FPE determines the optimum order of lags (m).

In the second step, the variable X_t is treated as controlled variable holding the order of lags at (m), the other variable Y_t is treated as manipulated variable, again by varying its order of lags (n) from 1 to M. The SSRs obtained from these regressions are used in (4)

$$FPE_x(m,n) = \left(\frac{T+m+n+1}{T-m-n-1}\right)\left(\frac{Q_x(m,n)}{T}\right) \qquad (4)$$

to find the minimum FPE which determines the optimum lag order. If the minimum FPE computed by (4) is smaller than the minimum FPEcomputed by (3), it is said Y_t causes X_t. This procedure is also repeated for (2).

4. Data and Estimation Procedure

The data that will be employed are the monthly WPI (1981=100) and CPI(1978-1979=100) of Turkey, obtained from the publications of the State Institute of Statistics, and the (TL/$) exchange rate as the monthly average of buying rate obtained from the Monthly Bulletins of the Central Bank of Turkey. There are 158 observations covering the period from 1981.05 to 1994.06. The former date represents the beginning of the managed (controlled) flexible exchange rate regime in Turkey.

4.1 Test for Stationarity

The time series used in the causality test are supposed to stationary[3]. Hsiao (1981) states that using nonstationary data will not yield correct estimates of the FPEs. Granger (1969) also states that in the nonstationary case, the existence of causality may alter over time. Thus, before the application of tests, the series should be checked whether they are stationary. If they are nonstationary, they should be transformed to stationary series. To determine whether the series are stationary, the Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1979, 1981) will be applied to the monthly series of WPI, CPI and ER. The ADF test is designed to detect whether the series contain unit root (whether they are nonstationary). Dickey and Fuller (1979,1981) also provide tabulated critical values for different cases. Thus, the model for the ADF test is

$$\Delta X_t = a_0 + a_1 \text{time} + a_2 X_{t-1} + \sum_{i=1}^{k} a_{2+i} \Delta X_{t-i} + e_t \qquad (5)$$

where, Xt is the natural logarithm of the WPI, CPI and ER. The lag length (k) is selected by the significance of the coefficients on the lags. The null hypothesis to be tested is H_0: $a_2 = 0$. As can be seen from Table 1 in appendix, the variables in levels are found to be nonstationary, the first differences are stationary.

4.2 Test for Causality

Since the stationarity condition has been met, Hsiao's causality test can

be applied to the first differences of the log of WPI, CPI and ER series. First, each variable is regressed on uts own lagged values varying the order of lags from 1 to 15. That means 15 regressions are run for each variable, and the SSRs of the regressions are used in **(3)** to compute the FPEs. The FPEs are given in Table 2 in appendix where the minimum FPEs are at lag 1 for each variable.

In the second step, each variable is treated as a controlled variable holding the order of lags at 1 as determined in the first step, and the other variable is treated as manipulated variable by varying its order of lags from 1 to 15, once again. The FPEs of these regressions are computed by using **(4).** The results are given in Table 3 in appendix.

When the Table 2 and 3 are compared, it is found that inclusion of the manipulated variables reduce the FPE of the controlled variable, in each case. Therefore, it is concluded that a bidirectional causality between exchange rate and the price level (both WPI and CPI) is observed under the period covering from 1981.05 to 1994.06. The direction of causality can be shown as

WPI $\Leftrightarrow$ ER Sample Period: 1981.05-1994.06

CPI $\Leftrightarrow$ ER

which indicates a feedback between the pairs.

The direction of causality under the period considered here (which is a feedback) is in favor of the causality implied by the vicious circle hypothesis. However, these results are in contrast to the findings of Altınay (1991) who finds unidirectional causality from the price level to the exchange rate under the period berween 1981.01 and 1990.04 by using the same methods. Since the sample period is quite long and many policy changes occured during that period, it is worth to extend the analysis to cover subperiods within the sample period. In this respect, the behavior of the real exchange rate can provide us with some information on how to divide the the sample period into subperiods. As can be seen from Figure 1, the trend of the real exchange rate simply computed by (ER/WPI) demonstrates[4] two drastic changes in 1989 and 1994 (the real exchange rate computed by the CPI is similar to Figure 1). The downward trend in 1989 is interpreted as the appreciation of the Turkish lira in real terms.

Indeed, through 1988 and 1989 a number of changes in regulations was made to liberalize the exchange rate regime and the financial markets, and some restrictions on imports were relaxed in 1989 as well. All these developments caused the Turkish Lira to appreciate in real terms. In the beginning of 1994, however, Turkish economy experienced some major shocks both in the monetary sector and in the real sector. The TL/$ ratio and the inflation

rate rose sharply, and the Turkish lira depreciated drastically in real terms. Consequently, these two years, namely 1989 and 1994, can be used as a basis to make distinctions between the subperiods, since they reflect the major developments in Turkish economy.

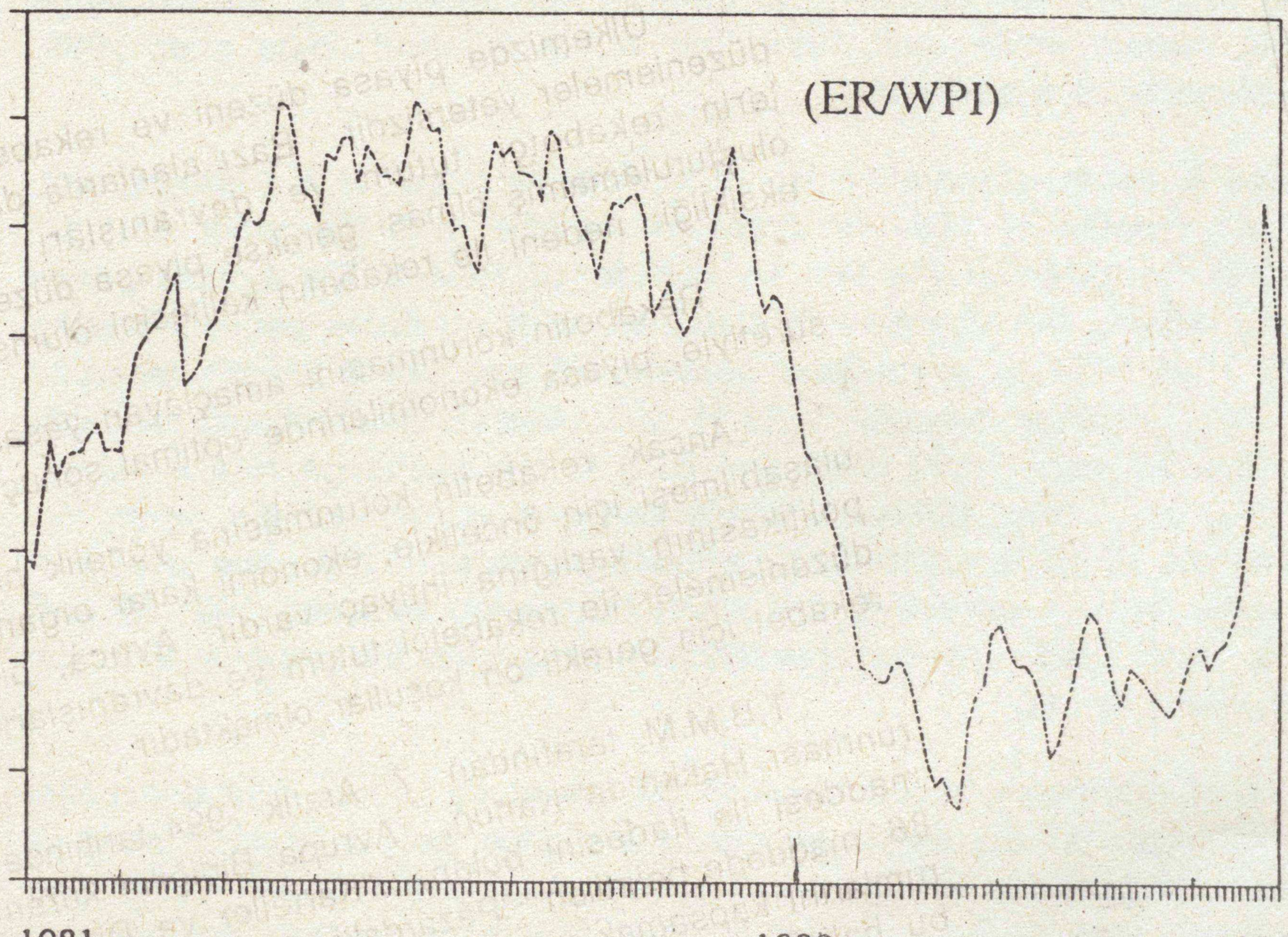

Figure 1. Real Exchange Rate between 1981.05 and 1994.06

Thus, the causality test is conducted again for four subperiods covering from 1981.05-1988.12, 1989.01-1993.12, 1981.05-1993.12 and 1989.01-1994.06. The results, given in appendix, have interesting implications and they are summarized in Figure 2.

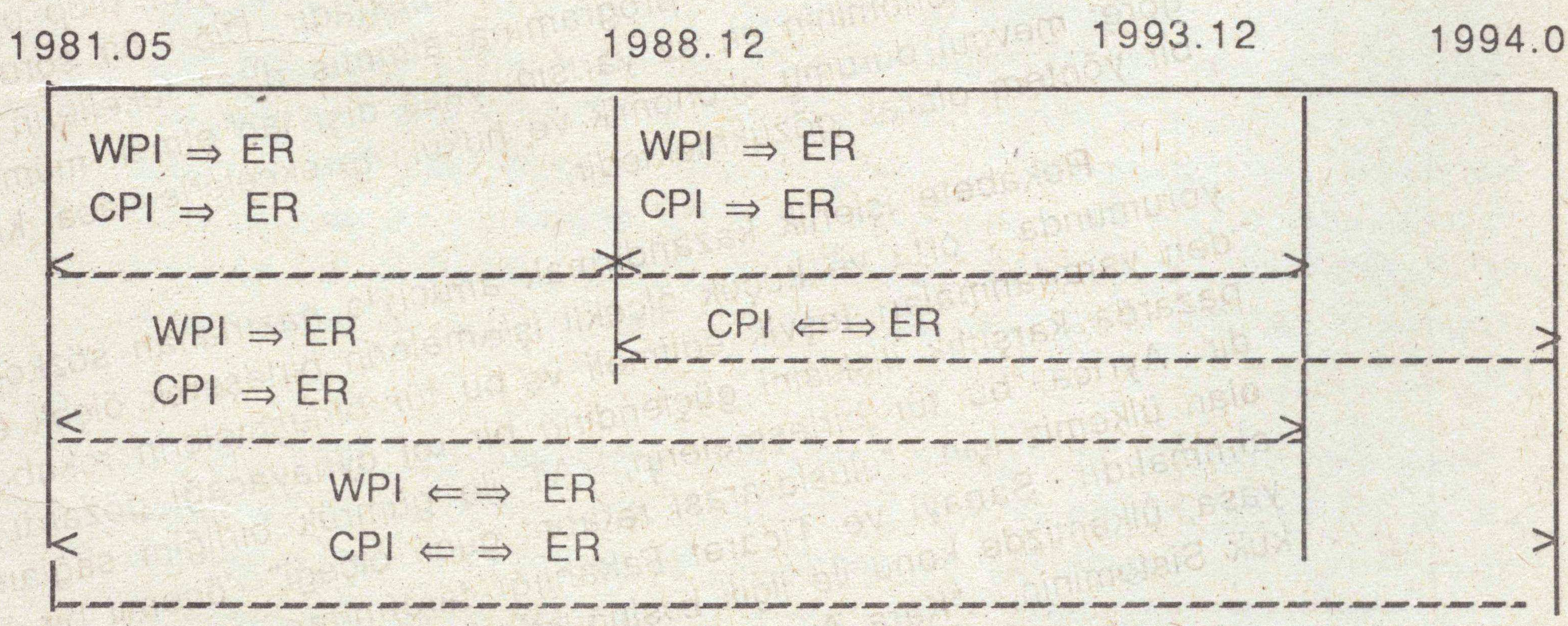

Figure 2. Direction of causality over different periods.

In the subperiods of 1981.05-1988.12, 1989.01-1993.12 and 1981.05-1993.12, the direction of causality runs from the price level (both WPI and CPI) to the exchange rate (ER) as implied by the PPP theory. This result may be explained by the fact that the Central Bank might have determined the exchange rate according to the PPP rule to kepp the real exchange rate within certain limits until 1989, but within different limits after 1989, probably because of a policy shift.

Since 6-month observation is not sufficiently large for a causality test, the first six months of 1994 is analyzed together with the other periods. Nevertheless, inclusion of the first six months of 1994 in the sample period significantly affects the direction of causality. In the sample period covering from 1989.01 to 1994.06, a feedback between ER and CPI is found[5], whereas over the sample period between 1989.01 and 1993.12 unidirectional causality running from the price level (WPI and CPI) to the exchange rate is found. Another example is that when the whole period is considered (i.e. when the first six months of 1994 is included), a feedback between the price level and the exchange rate is observed, but when the period between 1981.05 and 1993.12 is considered, one way causation running from the price level to the exchange rate is found.

Another interesting result revealed by this study is that a unidirectional causality running from the exchange rate to the price level is found in none of the subperiods investigated. In addition, the Augmented Dickey-Fuller test results indicate that all the variables in levels are nonstationary, but the first differences are stationary. In other words, the WPI, CPI, and ER series contain unit root, hence they are integrated of order one. As an extension to this study, a co-integration test can be applied to the price level and the exchange rate series to determine whether a long run relationship holds.

5. Conluding Remarks

In this study, the direction of causality between the monthly Turkish price level as measured by the WPI and CPI and the monthly exchange rate (TL/$) under the period covering from 1981.05 to 1994.06 and four subperiods are empirically investigated by using Hsiao's causality test. The causality test results can serve as preliminary to more sophisticated econometric models. Particularly, the concept "causality" is closely related to the concept of "exogeneity" which is central issue in the construction of econometric models.

Since the direction of causality over the period between 1981-1993 is in favor of causality implied by the PPP theory, the controlled or managed floating exchange rate regime can be characterized by the PPP view under the period between 1981 and 1993. This may also implicitly reveal the policy of

the Central Bank which might have determined the exchange rates by means of the PPP rule until the end of 1993. However, this claim cannot be made for 1994 on the basis of the test results.

When the analysis is extended to include the first six months of 1994, a feedback or bi-directional causality between the exchange rate and the domestic prices is found. In fact, in case of a feedback, it is likely that one or more variables may "cause" both the price level and the exchange rate. Although we cannot confidently establish that a vicious circle is occurring in 1994 by simply looking at the direction causality, at least it appears that 1994 is the year that a vicious circle should be suspected the most.

APPENDIX

TABLE 1. Augmented Dickey-Fuller Unit Root Tests

Sample Period: 1981.05 - 1994.06;

5% Critical value = -3.45

LEVELS			DIFFERENCES		
Variable	**Test Statistic**	**Lag Length**	**Variable**	**Test Statistic**	**Lag Length**
ln ER	0.66	2	Δln ER	-5.25	2
ln WPI	-0.14	2	Δln WPI	-6.09	2
ln CPI	-1.00	2	Δln CPI	-7.01	2

TABLE 2. Estimates of FPEs using (3).

(10^{-7})*FPEs of

M	WPI	CPI	ER
1	7530	5488	17652
2	7624	5553	17896
3	7721	5625	18143
4	7793	5695	18328
5	7782	5754	18396
6	7858	5809	18640
7	7940	5837	18877
8	8051	5863	18776
9	8075	5770	18890
10	8189	5847	19121
11	8123	5616	19386
12	8210	5514	19643
13	8320	5579	19890
14	8429	5658	20173
15	8515	5689	20447

TABLE 3. Estimates of FPEs Using (4).

M	WPI(1) ER	CPI(1) ER	ER(1) CPI	ER(1) WPI
	$(10^{-7})^*$ FPEs			
1	2494	2227	2843	2772
2	2506	2250	2833	2749
3	2538	2280	2843	2741
4	2544	2295	2780	2757
5	2577	2320	2783	2769
6	2596	2310	2818	2791
7	2621	2340	2850	2829
8	2659	2373	2890	2859
9	2683	2406	2927	2869
10	2722	2436	2965	2908
11	2752	2397	2976	2886
12	2777	2405	3018	2910
13	2815	2435	2925	2921
14	2812	2426	2942	2876
15	2825	2382	2984	2897

TABLE 4. Sample Period 1981.05 - 1993.12.

a) Unit Root Tests

5% Critical value = -3.45

	LEVELS			DIFFERENCES		
Variable	Test Statistic	Lag Length	Variable	Test Statistic	Lag Length	
ln ER	-1.02	2	Δln ER	-5.67	2	
ln WPI	-1.55	2	Δln WPI	-6.51	2	
ln CPI	-2.06	2	Δln CPI	-6.97	2	

b) Causality Test

Controlled Variable	Minimum FPE	Manipulated Variable	Minimum FPE
WPI(1)	0.0003293	ER(1)	0.0003342
CPI(1)	0.0003080	ER(1)	0.0003117
ER(1)	0.0003648	WPI(2)	0.0003351
ER(1)	0.0003648	CPI(4)	0.0003365

Numbers in parantheses are the optimum lags that give minimum FPEs. (M=12)

TABLE 5. Sample Period 1981.05-1988.12.

a) Unit Root Tests

5% Critical value = -3.45

	LEVELS		DIFFERENCES		
Variable	Test Statistic	Lag Length	Variable	Test Statistic	Lag Length
ln ER	-1.27	2	Δln ER	-4.92	2
ln WPI	-1.54	2	Δln WPI	-4.64	2
ln CPI	-1.56	2	Δln CPI	-4.96	2

b) Causality Test

Controlled Variable	Minimum FPE	Manipulated Variable	Minimum FPE
WPI(1)	0.0003653	ER(1)	0.0003705
CPI(1)	0.0003202	ER(1)	0.0003279
ER(1)	0.0003930	WPI(1)	0.0003653
ER(1)	0.0003930	CPI(1)	0.0003778

Numbers in parantheses are the optimum lags that give minimum FPEs. (M=12)

TABLE 6. Sample Period 1989.01 - 1994.06.

a) Unit Root Test

5% Critical value = -3.50

LEVELS			DIFFERENCES		
Variable	**Test Statistic**	**Lag Length**	**Variable**	**Test Statistic**	**Lag Length**
ln ER	-0.28	2	Δln ER	-5.18	1
ln WPI	-1.40	2	Δln WPI	-4.91	1
ln CPI	-1.76	2	Δln CPI	-4.46	2

b) Causality Test

Controlled Variable	Minimum FPE	Manipulated Variable	Minimum FPE
WPI(1)	0.0014185	ER(1)	0.0014605
CPI(1)	0.0009344	ER(1)	0.0009343
ER(1)	0.0041437	WPI(1)	0.0042237
ER(1)	0.0041537	CPI(1)	0.0039497

Numbers in parantheses are the optimum lags that give minimum FPEs. (M=12)

TABLE 7. Sample Period 1980.01 - 1993.12.

a) Unit Rood Tests

5% Critical value = -3.50

LEVELS			DIFFERENCES		
Variable	**Test Statistic**	**Lag Length**	**Variable**	**Test Statistic**	**Lag Length**
ln ER	-1.85	2	Δln ER	-3.91	3
ln WPI	-3.40	2	Δln WPI	-5.28	1
ln CPI	-4.40	2	Δln CPI	-5.16	2

b) Causality Test

Controlled Variable	Minimum FPE	Manipulated Variable	Minimum FPE
WPI(3)	0.0002854	ER(1)	0.0002952
CPI(3)	0.0002982	ER(1)	0.0003036
ER(1)	0.0003836	WPI(4)	0.0003258
ER(1)	0.0003836	CPI(5)	0.0003490

Numbers in parantheses are the optimum lags that give minimum FPEs. (M=12).

NOTES

1. The effects of the exchange rate movements can be viewed as inflationary in the short run.

2. The proponents of the vicious circle hypothesis agree that monetary accommodation sustains the inflation-depreciation cycle. Bilson (1979) and Bond (1980) explain the dynamics of vicious circle in de tail. See also Öniş and Özmucur (1990) for the vicious circle case in Turkey.

3. Stationarity here is taken to mean weak or covariance stationarity. That is, the mean and the variance of a time series do not change over time, and the covariance change depending on time interval.

4. In computing the real exchange rate, world prices are also taken into account. However, as Harberger (1989) states that under highly inflationary circumstances (which is thought to be the case in Turkey) world prices can be ignored.

5. There was no relationship (i.e. independence) between WPI-ER during this period.

ÖZET

DÖVİZ KURU VE FİYAT DÜZEYİ

Bu çalışmada döviz kuru ile yurtiçi fiyatları arasındaki nedensel ilişki önce teorik olarak incelenmiş, daha sonra Hsiao (1981)'nun önerdiği nedensellik testi aylık TEFE ve (TL/$) döviz kuru ile aylık TFE ve (TL/$) serilerine uygulanmıştır. Örneklem dönemi, Türkiye'de kontrollu dalgalı kambiyo rejimini yansıtan 1981.05 ile 1994.06 arasındaki dönemi kapsamaktadır. Ayrıca bu dönem içindeki dört alt dönem de incelenmiştir. Test sonuçları 1981-1993 dönemi arasında fiyat düzeyinden döviz kuruna doğru tek yönlü bir nedensellik arzederken, 1994 yılının ilk 6 aylık verileri örneklem dönemine dahil edildiğinde fiyatlar ve döviz kuru arasında iki yönlü nedensellik arzetmektedir. Böylece, 1981-1993 döneminde Satınalma Gücü Paritesi teorisinin öngördüğü nedensel ilişki geçerli iken, 1994 yılında fiyatlar ve döviz kuru arasında bir kısır döngü olması muhtemeldir.

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