IMF WORKING PAPER

WP/95/111

INTERNATIONAL MONETARY FUND

European I Department

Exchange Rate Movements, Inflation Expectations, and Currency Substitution in Turkey

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November 1995

Abstract

This paper contains an empirical analysis of currency substitution in Turkey: a simple relationship between the share of foreign currency holdings in M2X on one side and movements in the exchange rate or inflation on the other is derived from a two-stage portfolio choice model. This relationship is estimated by band spectrum regression which allows to remove from the data the short-term cyclical components. The results show that the relationship between currency substitution depends mainly on long-term movements in the exchange rate, while the effect of inflation on currency substitution is not statistically significant.

JEL Classification Numbers:
C20, C29, E40, E41, F41, 053

1/ I would like to thank Thomas Reichmann for encouraging me to undertake this study and for his insightful comments at various stages of development. Discussions with Thierry Pujol and Carlos Vegh, who read the first draft, provided precious suggestions to improve both the exposition and the content. I am also grateful to Laura Papi for her comments and to Valerie Ball for her assistance. The views expressed are the author's alone and do not necessarily, reflect the view of the International Monetary Fund. For any shortcomings the usual disclaimer applies.

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Summary

Turkey has for the past several years (except 1994) experienced a high but steady rate of inflation. At the same time, a liberalization of the capital account has allowed the public to switch between domestic and foreign currency holdings at almost negligible transaction costs.

This paper investigates the changes in the public's holding of foreign currency in Turkey in response to transitory and permanent changes in the value of the domestic currency. Currency substitution is related to the credibility of economic policy: when a government is perceived to follow lax policies, especially in the fiscal area, money demand becomes unstable as individuals flee from domestic currency to avoid future inflation tax. By the same token, reverse currency substitution signals the public's belief that the government will not resort to debt monetization.

These effects are explained through a two-stage portfolio choice model that emphasizes the long-run relationship between the exchange rate and the share of foreign currency holdings in Turkey. In the first stage, agents choose the proportion of short- and long-term investments, while in the second stage they decide the allocation among different securities. The weight of each asset in the portfolio, including domestic and foreign currencies, depends on its expected return relative to its risk. A frequency domain method called spectrum regression is employed to analyze separately the effects of exchange rate and inflation movements on currency substitution. This method permits the effects of long-run and short-run fluctuations to be separated.

The estimates obtained in the paper unequivocally indicate that the share of foreign currency holdings in liquid assets displays a strong and rather stable relationship with exchange rate movements even when the long cyclical components are filtered out. The estimates also indicate that the relationship between the wholesale price inflation rate and currency substitution is never statistically significant. These results conflict with those obtained by using cointegration analysis and an error-correction mechanism, which had concluded that no long-run relationship exists in Turkey between currency substitution and currency devaluation.

I. Introduction

In Turkey, currency substitution has increased since 1989 when capital movements were liberalized. The share of Turkish lira (TL) holdings in M2X--a monetary aggregate that also includes the stock of foreign currency deposits held by residents in Turkish banks--has decreased from about 80 percent in 1989 to around 50 percent at the end of 1994; in other words the ratio of TL holdings to foreign currency holdings went from 4.5 in 1989 to roughly 1 in 1994 (see Fig. 1). At the same time, and for most of this period, inflation remained chronically high, at between 60 percent and 80 percent.

Currency substitution has been examined in a vast literature. The basic theory holds that economic agents convert their financial wealth into foreign currency when they expect risk-adjusted yields on foreign currency denominated assets to exceed returns on domestic financial securities. Two main approaches can be distinguished. The first is a two-stage model where agents determine their liquidity needs before investing in illiquid assets; the second emphasizes that money is an asset like any other and therefore its weight in an investor's portfolio is a function of its risk-adjusted return. This paper follows the former approach although it presents a distinctive point of view that highlights the role of the exchange rate and employs spectral analysis to disentangle the permanent component of time series variation.

The nature of this study is empirical: it shows that agents switch to foreign currency denominated assets in response to long-term cyclical movements in the exchange rate. Empirical literature on currency substitution relies exclusively on time domain econometric methods. This paper, however, uses frequency domain methods that have better small sample properties and provide an unconventional economic interpretation of the results. Also we argue that frequency domain methods can be used as an alternative to standard cointegration analysis which in the present case leads to conclusions conflicting with economic rationale.

Attention also should be drawn to the theoretical issues involved in band spectrum regression: although the underlying view is not precisely related to the concept of rational expectations in the sense of Muth (1960), it bears an intuitive affinity: one can interpret the permanent components as the "structural" part of the model and the transitory components as the unpredictable short-lived shocks. 1/

1/ This rational expectation parallel can be explained through an analogy with consumption theory: Engle (1974) points out that Friedman's permanent income has a natural interpretation in the frequency domain. Rational individuals modify their consumption behavior in response to long swings in their income. Here the hypothesis is that likewise individuals make portfolio choices based on long swings in the value of their domestic currency.

The rest of the paper is organized as follows: section 2 presents the derivation of the basic relationship; section 3 contains a simplified exposition of spectral methods; section 4 treats the application of the band spectrum regression to currency substitution analysis; in section 5 the results are presented; section 6 discusses the relevance of these results for policy making; finally, section 7 offers some considerations on the realism of the model and the robustness of the empirical findings.

II. Theoretical Background

Currency substitution has been analyzed in two contexts: (a) countries with high inflation, where economic agents try to elude the inflation tax by converting domestic assets into foreign assets; and (b) countries whose convertible currencies provide different money services in a production function. As Mizen and Pentecost (1994) point out, this latter approach focuses on the transaction role of money while the former emphasizes the investment and precautionary behavior of the public.

Case (a) is the relevant one for Turkey. Typically (see Mizen and Pentecost (1994)) a real money demand function for the domestic currency is expressed as

$$M_d/P = f_d(1+r,\ (1+r^*)*(1+x),\ \rho-\pi,\ \rho^* *(1+x)-\pi^*,\ Y) \qquad (1)$$

where M_d represents nominal domestic currency balances, P is the domestic general price level, r and r^* are the domestic and foreign nominal return on illiquid assets, respectively, x is the expected rate of depreciation of the domestic currency, ρ and ρ^* are the nominal returns on domestic and foreign liquid assets, π and π^* are the domestic and foreign rates of inflation, and finally Y is a measure of aggregate real income.

Equation (1) has been tested in various functional forms and for different countries. However, it must be stressed that the arguments of f_d in equation (1) are all linked: the rate of depreciation, at least in the long run, depends on the expected inflation rate differential, i.e., $x = x[E(\pi-\pi^*)]$ 1/, and the nominal interest rates by definition are

$$1 + r \equiv (1 + R)/(1 + \pi)$$

where R denotes the real interest rate.

The real money demand for foreign currency, M_f/P, has a form analogous to equation (1); therefore, instead of focusing separately on real money balances in domestic and foreign currency one can consider the ratio M_d/M_f with the variables expressed in domestic currency. This allows to obtain a much simpler relationship than equation (1) for three reasons.

1. If agents make their investment decisions in two steps, choosing first the proportion of financial wealth invested in liquid assets and

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1/ Note that $E(\pi-\pi^*)$ is a short notation for the conditional expectation $E(\pi_{t+1}-\pi^*_{t+1}|I_t)$ where the subscripts refer to discrete time intervals and I_t is the information set at time t.

subsequently the portfolio of illiquid securities, R and R^* affect only the first stage, not the choice between M_d and M_f. This assumption is consistent for example with the preferred habitat hypothesis postulating that the investors' objective is to generate a stream of returns at specific points of their lifetime. However, we believe that this two-stage approach can be justified by the existence of transaction costs: long-term investments (and we could also include durable goods in this category) are less liquid because they are subject to higher transaction costs. If transaction fees are in percentage terms, in a high inflation environment they become more important. 1/ Hence individuals minimize transaction costs by making an optimal choice once and for all. Put differently the substitution between liquid and illiquid assets is hampered by the existence of transaction costs, and for this reason investors need to make their choice sequentially.

2. If we assume that the relation between M_d/M_f and Y is homogeneous of degree zero, i.e., the fraction of wealth agents convert into foreign currency does not depend on their income, then Y does not influence the ratio M_d/M_f. This simplification although crude (for example, it neglects transaction costs that might prevent the poor from holding foreign currency deposits) is fairly accurate because the bulk of foreign currency transactions is carried out by large investors. Moreover, from an empirical point of view, the inclusion of income in the regression raises an unsolvable problem: Turkey has a large informal sector; during a recession a number of economic activities especially the least profitable go unrecorded, so the national account data overstate the effect of economic cycles on lower income households.

3. If individuals are risk neutral, the difference between ρ and ρ^*, by a no-arbitrage argument, must reflect the difference in expected inflation.

With this in mind, the ratio M_d/M_f will be a function of exchange rate depreciation and the inflation differential

$$M_d/M_f = F(x[E(\pi-\pi^*)],\ \pi-\pi^*) \tag{2}$$

1/ Consider the following example: an investor purchases an asset for TL 100 paying 10 percent in transaction fees. Assume the asset yields zero real return. When inflation is 100 percent at the end of the holding period the asset is sold at TL 200 plus another 10 percent transaction fee. So the investor obtains TL 180 net of transaction costs out of an initial outlay of TL 110. The nominal return is therefore about 64 percent and the real loss roughly 22 percent. When inflation is zero the initial outlay is TL 110 and the asset is sold at TL 100 less the 10 percent transaction cost. So, out of a TL 110 initial investment the investor gets TL 90, with an 18 percent loss.

Assuming that individuals form rational expectations and that the inflation follows a Markov process, one can further simplify equation (2) into

$$M_d/M_f = F(x). \tag{3}$$

To summarize, the analysis of currency substitution in a high inflation economy like Turkey can be greatly facilitated by focusing on the ratio of the domestic over the foreign currency balance, by assuming that the exchange rate in the long run reflects the inflation differential and that (risk neutral) agents separate their decisions over short-term and long-term investments. If agents are risk-averse, equation (3) would still be valid to the extent that the exchange rate reflects the change in risk-adjusted return on money balances.

The argument presented in this section relies crucially on the long-run relationships between the exchange rate and the expected inflation differential: therefore, the appropriate empirical method to estimate equation (3) must separate the short-term from the long-term dynamics. The next section is devoted to this topic.

III. Frequency Domain Analysis of Permanent Versus Transitory Movements

Spectral methods have rarely been employed in econometrics, partly due to their computational difficulty and intricacy. Modern computers make the first problem irrelevant, while a brief heuristic argument should help to clarify frequency domain analysis. The presentation here will be synthetic, as the reader can find an exhaustive treatment of spectral methods in many textbooks, e.g., in Priestley (1981).

The spectral density function (or spectrum) of a covariance stationary stochastic process is defined as the Fourier transform of its serial correlation function. In general, a transform "maps" a function from its natural functional space to another, while preserving certain characteristics. A transform is useful if it simplifies certain operations. The Fourier transform is suitable because it maps functions from the space of square summable sequences $l_2(-\infty,\infty)$ (i.e., the space to which covariance stationary processes belong) into the space of square Lebesgue integrable functions on $[-\pi,\pi]$, denoted by $L_2[-\pi,\pi]$. The Fourier transform preserves both the linear structure of the space and the distance between points, i.e., it is an isometric isomorphism. Its usefulness consists in the fact that it simplifies the calculation of the convolution of two sequences: the Fourier transform of the convolution of two sequences is the product of their Fourier transforms.

Heuristically the Fourier transform converts information contained in the correlation function--i.e., the dependence between increasingly distant observations--into information on the contribution of each frequency component to the total variance of the process. Stated differently, the spectrum decomposes the variance of a covariance stationary stochastic process into the sum of uncorrelated cyclical components of different periodicity. Therefore, by using spectral analysis the empiricist shifts its focus from the dependence structure of successive events to the relative importance of cycles in the evolution of a phenomenon.

What is the advantage of spectral analysis in the study of currency substitution? In time domain often models are not intended to explain every feature of the data, e.g., war periods, seasonality, changes in regime etc. Analogously in frequency domain models could be appropriate to explain the links between certain frequency components but not between others. Equation (3) rests on the premise that the ratio M_d/M_f in the long run is influenced only by the depreciation rate, a claim that translates into asserting that equation (3) describes better the links between low frequency components than those between high frequency components of the spectrum. Low frequency components of the spectrum characterize long cycles, while high frequency components account for short cycles; the former are associated with permanent components in a time series and the latter with transitory components.

The band spectrum methodology, presented in the next section, is designed to verify whether the frequency domain coefficient estimates of equation (3) improve as we remove certain frequency components. Specifically, we purge the series from the noise generated by short cycles and check if the regression with the filtered data yields better results.

IV. Band Spectrum Regression

Band spectrum regression was proposed by Engle (1974) as an alternative to classic regression analysis having better characteristics in terms of small sample properties, seasonal adjustment, and treatment of error in the variables. 1/ One should add that band spectrum regression could be employed to explore equilibrium relationships between nonstationary variables that appear not to be cointegrated, as shown in section 5 below. From our perspective the most appealing feature is the possibility to filter out selected cyclical components.

Following Engle (1974) the k-th element of the discrete Fourier transform of a time series y_t with $t = 0, 1,2,\ldots,T-1$ and $k = 1,2,\ldots, T$ is defined as

$$w_k\, y/\sqrt{T}$$

where y is the column vector of T observations on y_t, w_k is a row vector $w_k = [1, \exp(i\theta_k), \exp(2i\theta_k), \ldots\ldots, \exp((T-1)i\theta_k)]$ and $\theta_k = 2\pi k/T$. The periodogram of y_t is

1/ As an aside, the Engle method is entirely based on the periodogram and therefore does not involve the choice of a window that introduces an element of arbitrariness in the spectral estimate (on this topic see, for example, Priestley (1981)).

$$\phi_Y(\Theta_k) = |w_k\ y|^2 \qquad (4)$$

The cross periodogram between two series y_t and z_t is likewise

$$\phi_Y(\Theta_k) = (w_k\ y)\blacklozenge(w_k\ z)$$

the symbol ♦ representing complex conjugation.

Although the periodogram is a biased estimator of the spectrum, for our purposes it is sufficient that the sum of the elements in the periodogram is a consistent estimator of the sum of the spectral values, i.e., the total variance of the variable (see Engle (1974) for details).

A simple regression equation

$$z = \beta y + \epsilon \qquad (5)$$

can be transformed into

$$\underline{z} = \beta \underline{y} + \underline{\epsilon} \qquad (6)$$

where the underlined symbols represent the Fourier transform of the variables times $\sqrt{T}$ so that (6) is a regression equation with complex variables. The Best Linear Unbiased Estimator (BLUE) of ß turns out to be the OLS

$$\beta^* = (\underline{y}\blacklozenge\underline{y})^{-1}\underline{y}\blacklozenge\underline{z} \qquad (7)$$

The distinction between permanent and transitory components entails that the model of equation (3) is valid for certain frequencies, but not for others; specifically we postulate that it is valid only for low frequency components. The regression equation (6) can be transformed by a selector matrix A where the elements in the main diagonal are equal to 0 in correspondence of the frequencies to be excluded and are equal to 1 in correspondence of the frequencies to be included. Regression (6) is then written as

$$A\underline{z} = \beta A\underline{y} + A\underline{\epsilon} \qquad (8)$$

and the estimator of ß in equation (7) is accordingly modified as

$$\beta^* = (\underline{y}\blacklozenge A\blacklozenge A\underline{y})^{-1}(\underline{y}\blacklozenge A\blacklozenge A\underline{z}) \qquad (9)$$

One should also make sure that the matrix A selects a meaningful regression model because the estimator (9) is BLUE only if the specification in (8) is the right one, otherwise the β^* is unbiased but inefficient. So it is important to verify that the exclusions are valid. The analogous of the t-test and F-test in time domain can be obtained by noticing that the residual

$$A\underline{z} - A\underline{y}\beta^* = A\underline{u} = \underline{Mz} = \underline{M\epsilon}$$

and the estimator of $E(\epsilon'\epsilon)$ is

$$s^2 = (A\underline{u})\blacklozenge A\underline{u}\ (T'-K)^{-1}$$

where T' is the number of included frequencies.

Band spectrum regression was criticized by McCallum (1984) who argued that "... long run propositions involve expectational relationships which have little or nothing to do with low frequencies per se, so that such an association is inappropriate in a fundamental sense". Since this critique addresses some basic issues in econometrics, we deem important to clarify the nature of our study in the light of McCallum's argument. Suppose that the econometrician wants to test the hypothesis that $\beta = 1$ in the relationship of the general form

$$z_t = \alpha + \beta y_t + \epsilon_t \tag{10}$$

where the independent variable follows a first order autoregressive process

$$y_t = \mu_0 + \mu_1 y_{t-1} + v_t$$

with $\mu_1 < 0$. McCallum correctly argues that if the variable z is influenced by the expectations on future values of y, i.e.,

$$z_t = \theta + E(y_{t+1}) + u_t$$

given that $E(y_{t+1}) = \mu_0 + \mu_1 y_t$ equation (10) can be written as

$$z_t = (\theta+\mu_0) + \mu_1 y_t + v_t \tag{11}$$

which shows that an OLS regression would always reject the hypothesis $\beta = 1$ even if it is built in the model. The same logic applies to any ARIMA structure that y_t might display. This identification problem of course is not solved by using a band spectrum regression, because the relationship (11) holds at all frequencies. In essence, McCallum stresses that one should not confuse rational expectations relationships with long cycles comovements or, in other words, low frequencies components with conditional mathematical expectations.

In what sense then should one interpret the expectations in equation (2) and in general in the model in section 2? Consider the permanent income hypothesis: individuals form rational expectations on both the transitory and permanent component of their income, but their consumption behavior is influenced only by changes in their permanent income. Analogously, in the present context we want to test if and how the public reacts to permanent changes in the value of the domestic currency.

V. Empirical Results

The discussion in the last section leaves still some questions open. The easiest pertains to the functional form of F in (3): the portfolio balance approach leads to a log-linear specification

$$\log(M_d/M^f) = \alpha + \beta \log(x) + \epsilon \tag{12}$$

Taking the periodogram on both sides, equation (12) can be transformed from a relation between temporal sequences of data into a relation between cyclical components

$$\underline{\log(M_d/M^f)} = \alpha + \beta\ \underline{\log(x)} + \underline{\epsilon} \tag{13}$$

where, as before the underlined symbols indicate the Fourier transform times $\sqrt{T}$.

The second point refers to stationarity. As mentioned above, the spectrum has a meaningful interpretation only if the series is covariance stationary: this property must be verified. The data we use are monthly observations of the Central Bank of Turkey (CBT) definition of M2, the foreign exchange component of M2X, the market exchange rate between the Turkish lira (TL) and the U.S. dollar, and the WPI in the period from December 1989 to September 1994. This time span was chosen because, although foreign currency deposits were allowed since December 1983, the capital account was liberalized only in August 1989. The Augmented Dickey Fuller test on all the variables with up to 15 lags, shows that they are nonstationary in levels and in logarithms. The result does not change when the stationarity around a trend is tested. Therefore the regression in (13) was estimated with the variables in first differences, i.e.,

$$A\underline{\Delta\log(M_d/M^f)} = \alpha + \beta\ A\underline{\Delta\log(x)} + \eta \tag{14}$$

where η denotes the error term.

The third point focuses on the criterion for selecting the periodogram ordinates in the band spectrum regression. Again economic theory does not indicate a way to separate transitory and permanent components. However, by progressively removing the low frequency components from the variables in (14), one can verify the strength of relation (14) at shorter cycles and vice versa. In other words, we propose to estimate (14) for a sequence of matrices A_i whose elements on the main diagonal a_{ii} are set to zero proceeding from the top i.e., $a_{ii} = 0$ for i = 1 to T. 1/ The regressions will then have the following form

$$A_i\underline{\Delta\log(M_d/M^f)} = \alpha + \beta\ A_i\underline{\Delta\log(x)} + \eta \tag{15}$$

If the results of the regression improve when the low frequency components are filtered away, one can assert that relation is stronger between transitory components, while if the opposite is true permanent

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1/ A second sequence of matrices could in principle be used where the elements a_{ii} are set to zero proceeding from the bottom, i.e., $a_{ii} = 0$ for i = T to 1. In other words, the frequencies could be removed starting from the highest. But in this case the estimates of the coefficients would be complex numbers.

components have a predominant role in shaping the links between the variables.

Finally, for completeness and to offer a comparison, equation (15) is estimated twice, first employing as regressor the log difference of the exchange rate and then the log difference of the WPI. 1/ The WPI has been employed rather than the CPI because in Turkey WPI follows closely the GDP deflator and therefore is considered the relevant variable for economic policy. In any case, we performed the same analysis with the CPI data and the results, which are available on request, were qualitatively the same.

The graphs in Figs. 3-5 show, respectively, the estimates of the ß's in the sequence of regressions (15) where the independent variable is the difference in the logarithm of the exchange rate LT/US$, the relative t-tests and the relative F-tests. The following three figures differ from the previous ones in that the regressor in the sequence (15) is the log difference of the WPI. Given the sample size of 58 observations, i.e., 57 first differences, T was set equal to 37, i.e., in the last regression of the sequence only 20 observations were left.

Two features of the graphs are noteworthy.

1. In both sequences of regressions--with the exchange rate and the WPI--the coefficient estimates display always the right negative sign, but the estimates obtained with the exchange rate fluctuate much less (most beta estimates cluster in the interval [-0.6, -0.7]) and exhibit higher t-statistics.

2. When inflation is used as regressor (Fig. 6), the t-tests show that the parameter estimates in the sequence of regressions (15) are not significant at conventional levels (Fig. 7)

3. The Chow tests are remarkably similar for both regressors (Figs. 5 and 8), and always fail to reject at the 5 percent significance level the null hypothesis that the exclusion of the frequency components yields different estimates.

The interpretation of these results point in the same direction: currency substitution is a response to changes in the exchange rate, in particular permanent ones, while the theoretical link between currency substitution and inflation is not corroborated by the data, no matter what spectral components one considers.

Finally, it is important to address the question of how band spectrum regression compares to standard econometric techniques, in particular cointegration. Cointegrated variables are tied in a long-run equilibrium relation, so in the present case it would have been meaningful to test for

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1/ The regressions were performed using a MATLAB code written by the author which is available on request.

cointegration and resort to an error correction mechanism to investigate the links between currency substitution and either exchange rate or inflation. However, employing a standard methodology (see, for example, Hamilton (1994) ch. 19), i.e., OLS on (12) and verifying whether the residuals have a unit root, leads to accept the hypothesis of no cointegration. Details of the results are available on request, but the essential point is that band spectrum regression constitutes an alternative to cointegration in the analysis of long-run relationships and yields more meaningful results in this case where absence of cointegration would have led the researcher to conclude that no long-run relationship exists between currency substitution and currency devaluation.

VI. Policy Implications

The main policy implications of this study are threefold.

1. An exchange rate anchor, could be highly effective in a stabilization program. A wide literature on stabilization programs (see, for example, Kiguel and Liviatan (1988)) emphasizes that even when economic measures produce a rapid improvement in the fundamentals, in particular fiscal indicators, a nominal anchor is crucial to break the downward rigidities of inflationary expectations. In fact, in situations where the public might take a long time to realize that fundamentals have permanently improved, a nominal anchor, which is an efficient signaling mechanism, speeds up the adjustment process by shifting expectations. The choice of a nominal anchor however is controversial. Calvo and Vegh (1992a, 1992b) argue that in countries with a high degree of currency substitution an exchange rate anchor is more efficient because "[...] the relevant money supply, which includes the domestic value of foreign currency circulating in the economy, will be consistent with any price level depending on the value of the exchange rate". This paper provides strong empirical support for their view.

2. In a country like Turkey the exchange rate anchor should (if possible) be revised more or less every six months. Predetermined exchange rates constitute an effective nominal anchor in the initial stages of a stabilization program, but later they might become a strait jacket. Many countries, especially in Latin America, have experienced that real appreciation of the domestic currency--prompted either by capital inflows or by the dynamics of nontradables prices--might steer the stabilization plan off track. Therefore, policymakers have to weigh the benefits of a nominal anchor against the risk of damaging the competitiveness of the export sector. But if the usefulness of the nominal anchor is seen in terms of its signaling effect in the early phase of a stabilization, a predetermined exchange rate or even a predetermined rate of devaluation should not necessarily last indefinitely. Then, and assuming that a non-destabilizing way to change the exchange rate commitment has been found, what would be an optimal time frame? If we look at Fig. 3 we see that the coefficient estimates and their significance increase as we remove the first ten periodogram ordinates, which correspond to cycles of more than six months.

Therefore, given the sample size (57 months) used in the analysis, one could think of six months as a reasonable horizon for an exchange rate anchor.

3. If currency substitution is the response to permanent changes, in order to revert the process, it is necessary to adopt permanent measures. Specifically, since the value of fiat money is determined by the credibility of the government's commitment to repay its obligations, only permanent changes in fiscal policy induce a reversion in currency substitution. Conversely, shifts in the ratio M_d/M_f are a clear indication of the public's confidence in the current economic outlook. A nominal anchor is obviously not a substitute for sound macroeconomic policies, hence attempts to prop up the exchange rate in the absence of substantial reforms are likely to backfire. For example, an interest rate hike to sustain the exchange rate is only a short-term remedy, a sort of an emergency measure, but especially in a country with a large PSBR relative to the amount of domestic financial resources, its long-term effect is a further worsening in government finances and a consequent acceleration of the inflation rate.

VII. Some Final Thoughts

The empirical study presented in this paper demonstrates that, in Turkey, individuals have been substituting liquid assets denominated in TL for liquid assets denominated in foreign currency, in response to permanent changes in the value of the domestic currency expressed by the devaluation rate. On the contrary, changes in inflation do not appear to explain changes in foreign currency holdings.

Are these results crucially dependent on the simplifying assumptions made in section 2? In other words would this empirical study yield different results if some of those assumptions are relaxed? It is possible of course in theory, but in practice it would be extremely arduous. Consider, for example, the exclusion of interest rate variables in the regression equation, which might be judged unrealistic. This exclusion was justified in section 2 by assuming that individuals are risk neutral, so that the interest rate differential would be equal to the inflation differential. True, risk-neutrality might be seen as a too strong assumption, but if one believes that agents are risk averse, then the model should include not merely real interest rates, but expected risk-adjusted real returns. To clarify this point let us consider an example in which domestic money balances become "riskier" as a result of an increase in the government debt to GDP ratio, but the current inflation rate does not change because the government does not increase money supply. If the interest rate on domestic currency denominated assets goes up to compensate for this increase in risk, the ratio M_d/M_f would not change, despite the fact that real returns have gone up.

Since the risk of holding currency is linked to fiscal policy prospects it is hard to evaluate and it is doubtful that past volatility would be a meaningful measure. Moreover, finance theory holds that--in equilibrium--the weights of individual securities in a portfolio depend on their return relative to their nondiversifiable risk. But to calculate this risk one has to determine the covariance of an individual security with the "market portfolio". 1/ An impressive literature in finance is devoted to empirical tests of equilibrium models and to find measurable definitions of a market portfolio. Something analogous in the context of currency substitution would require a massive amount of data and--even if feasible--it is unlikely that it would significantly alter the results of this paper. In fact, if information spreads evenly and the agents correctly assess its implication for price movements, in the long run exchange rate dynamics will reflect to a large extent the changes in the risk-adjusted returns.

In conclusion, the approach followed in this paper seems to provide a meaningfully accurate description of reality, whose intrinsic simplicity and testability largely offset the noted shortcomings.

1/ One must also notice that in empirical finance risk is calculated from past price volatility, but an analogous measure for currency is not equally meaningful.

Fig. 1 - Ratio of domestic to foreign currency components in M2

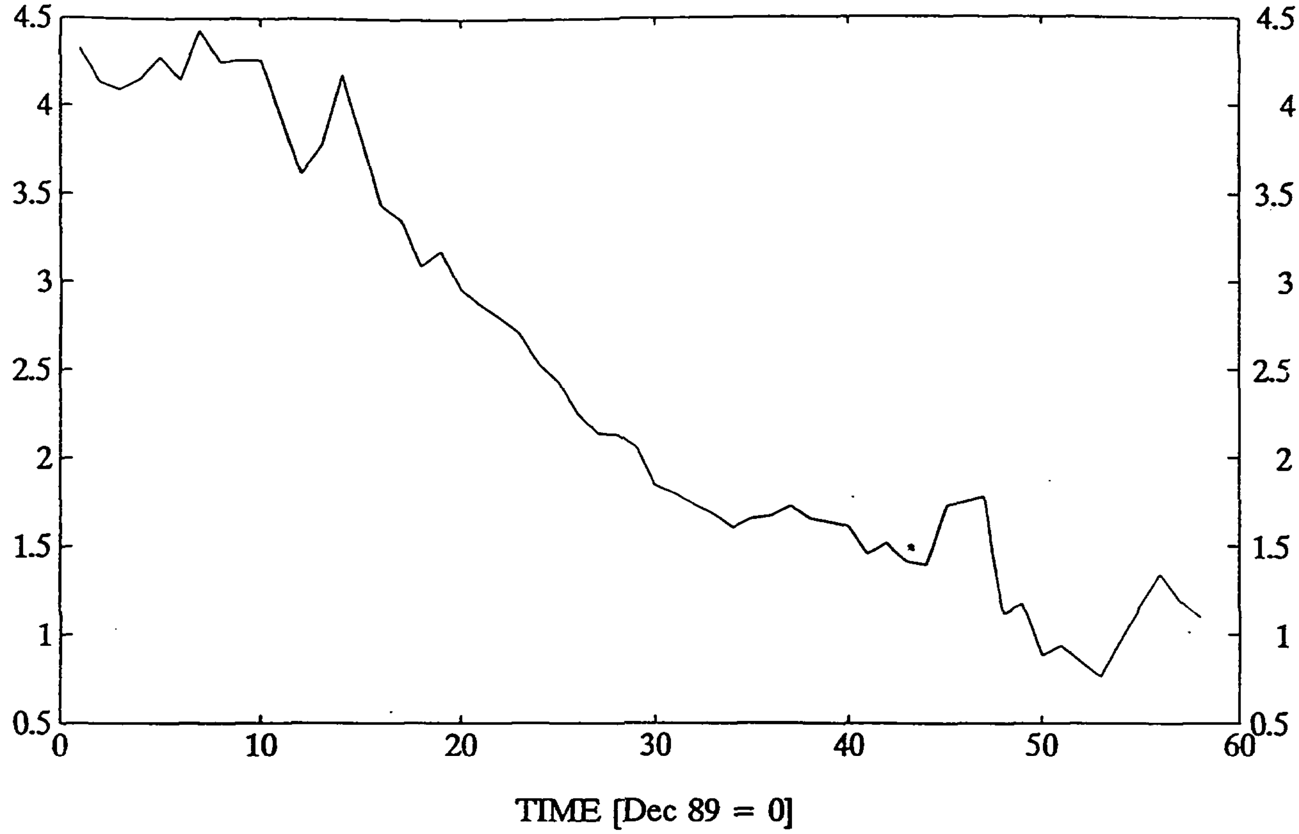


Fig. 2 - Exchange rate TL per US$

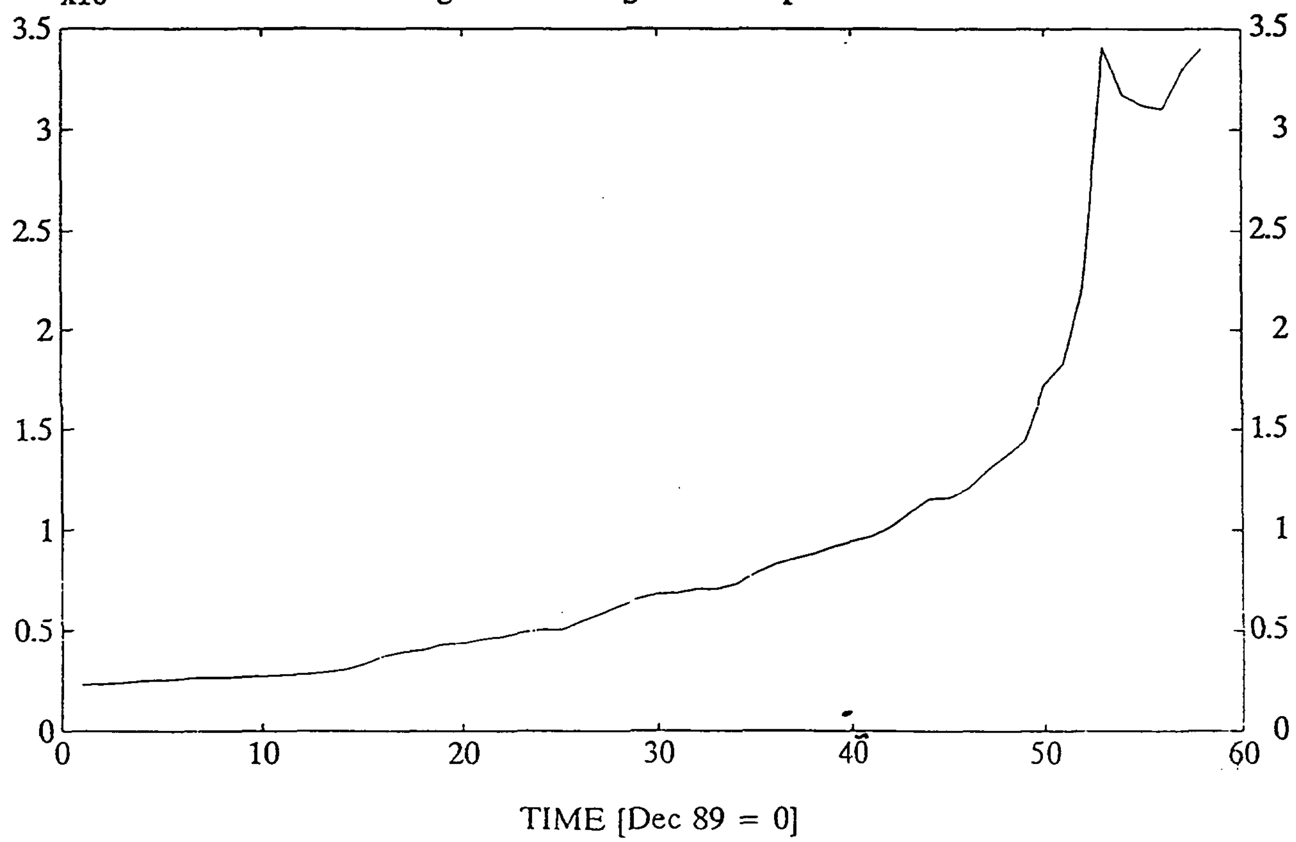


Fig. 3 - Band Spectrum Regressions - TL-US$

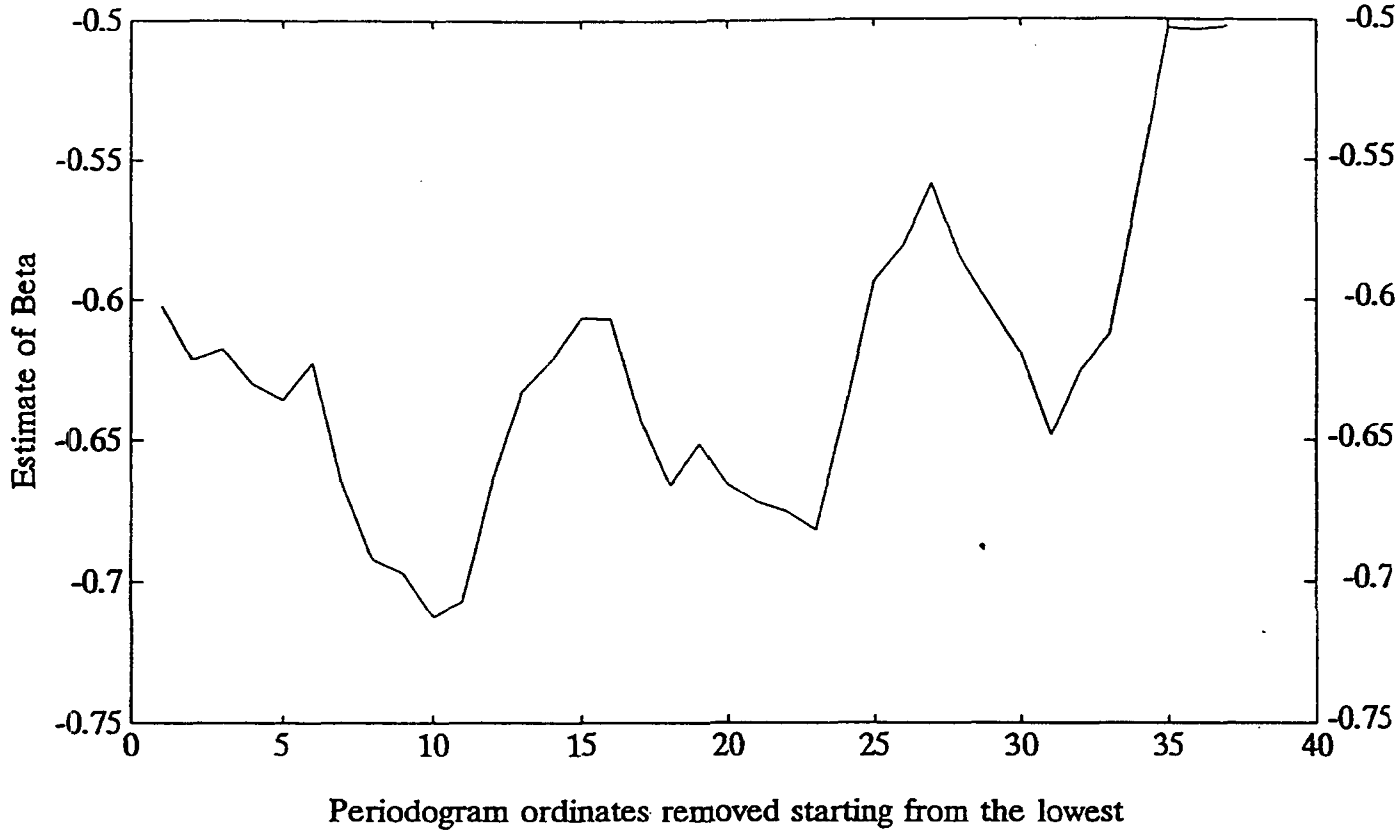


FIG. 4 - t-test on the Band Spectrum Regressions - TL-US$

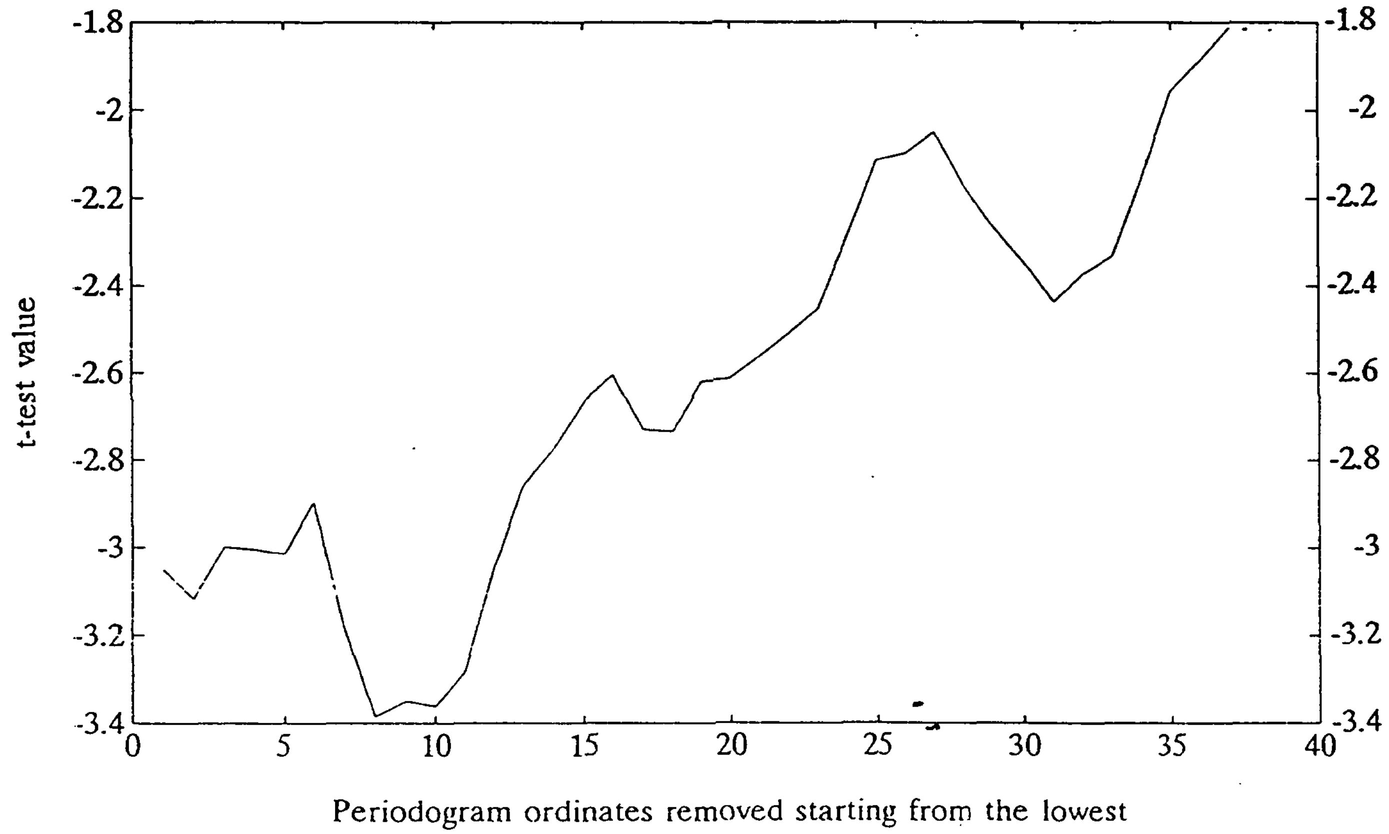


FIG. 5 - Chow test on frequency esclusion - TL-US$

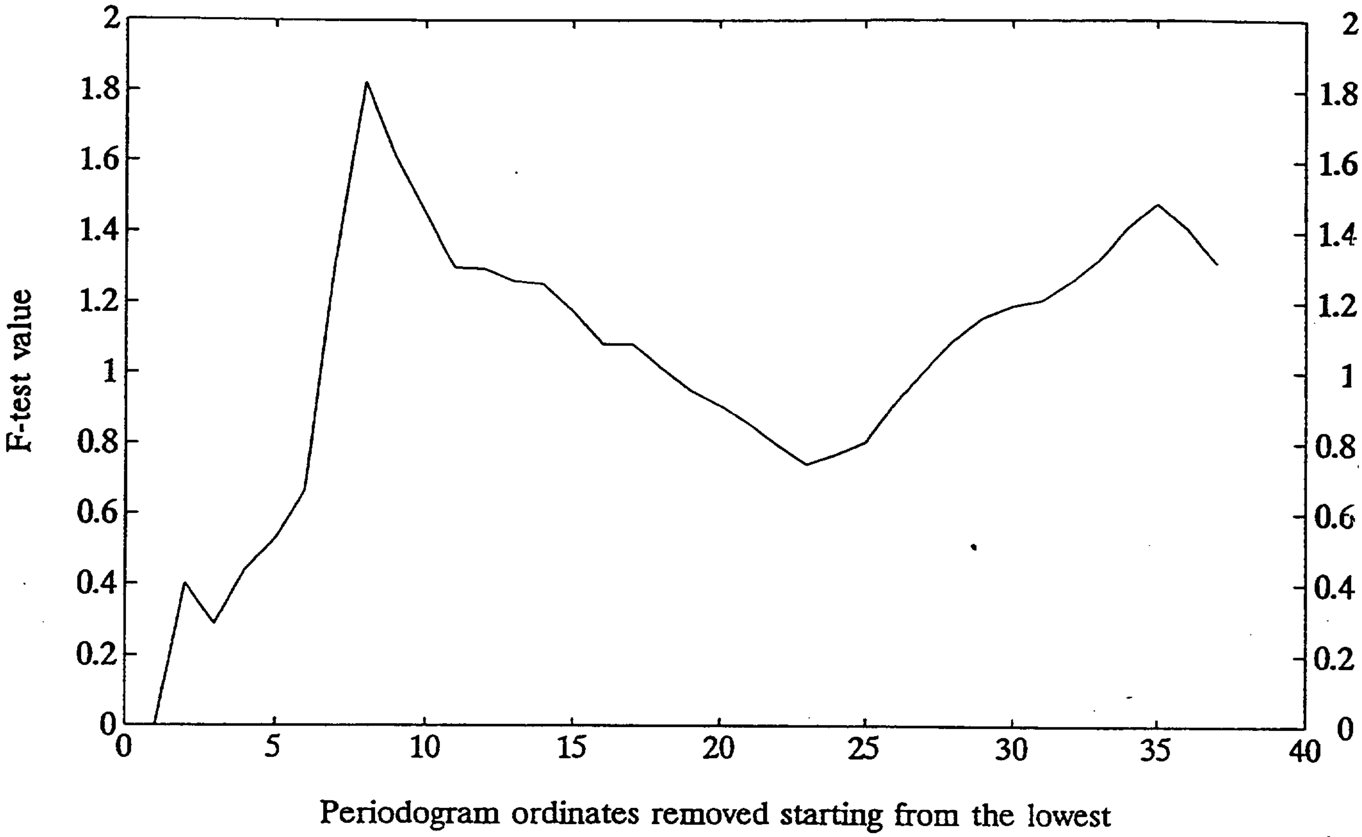


Fig. 6 - Band Spectrum Regressions - WPI

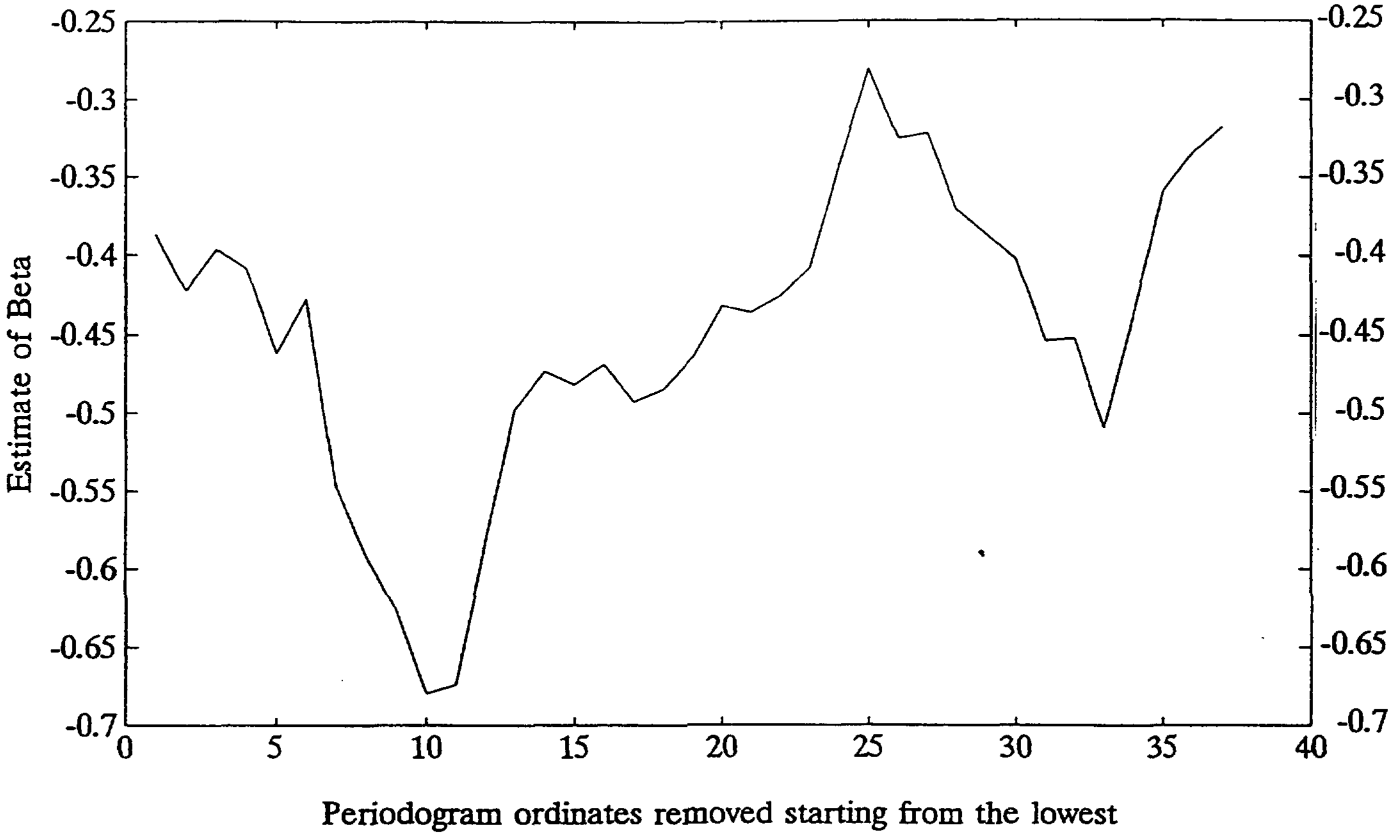


FIG. 7 - t-test on the Band Spectrum Regressions - WPI

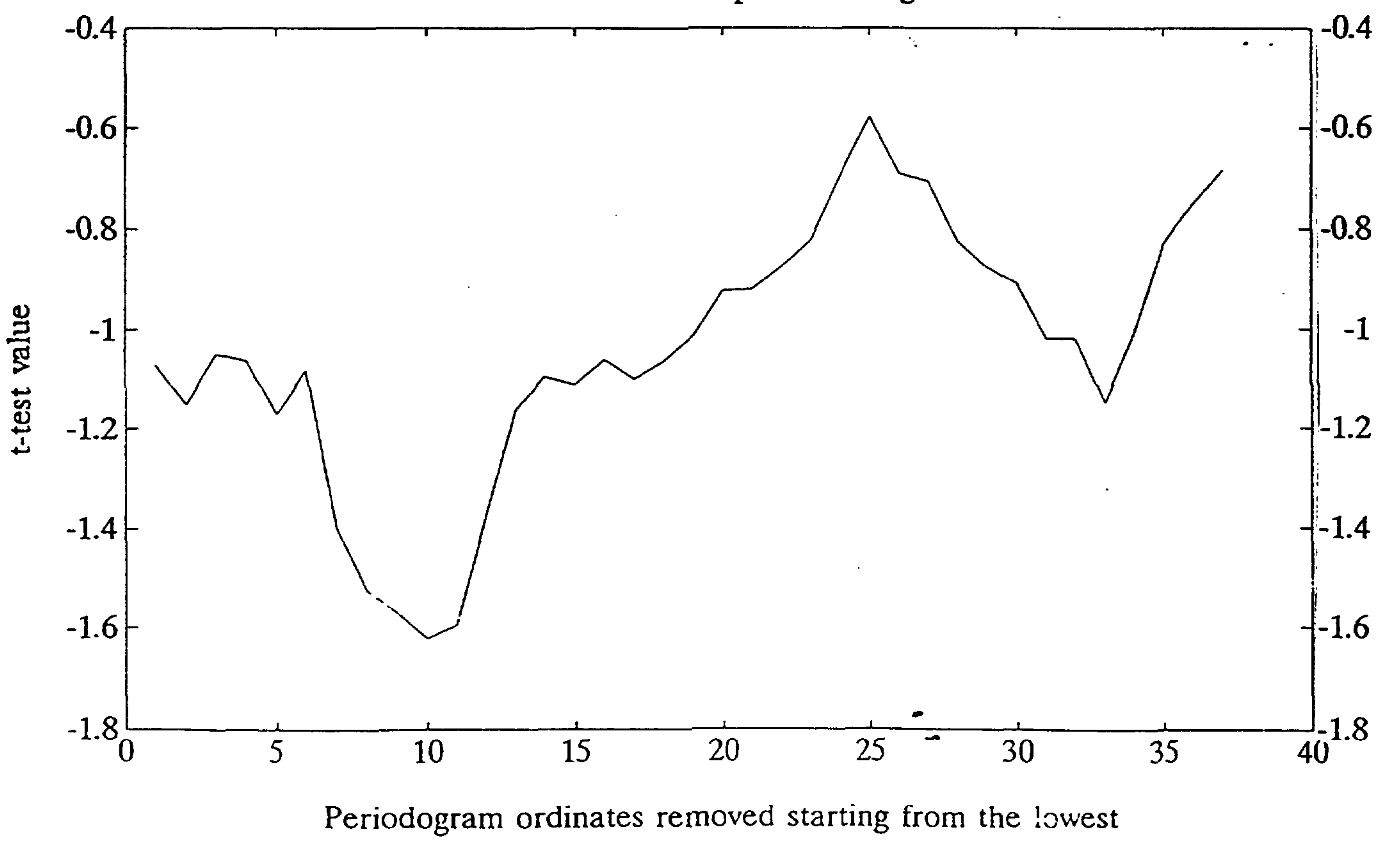
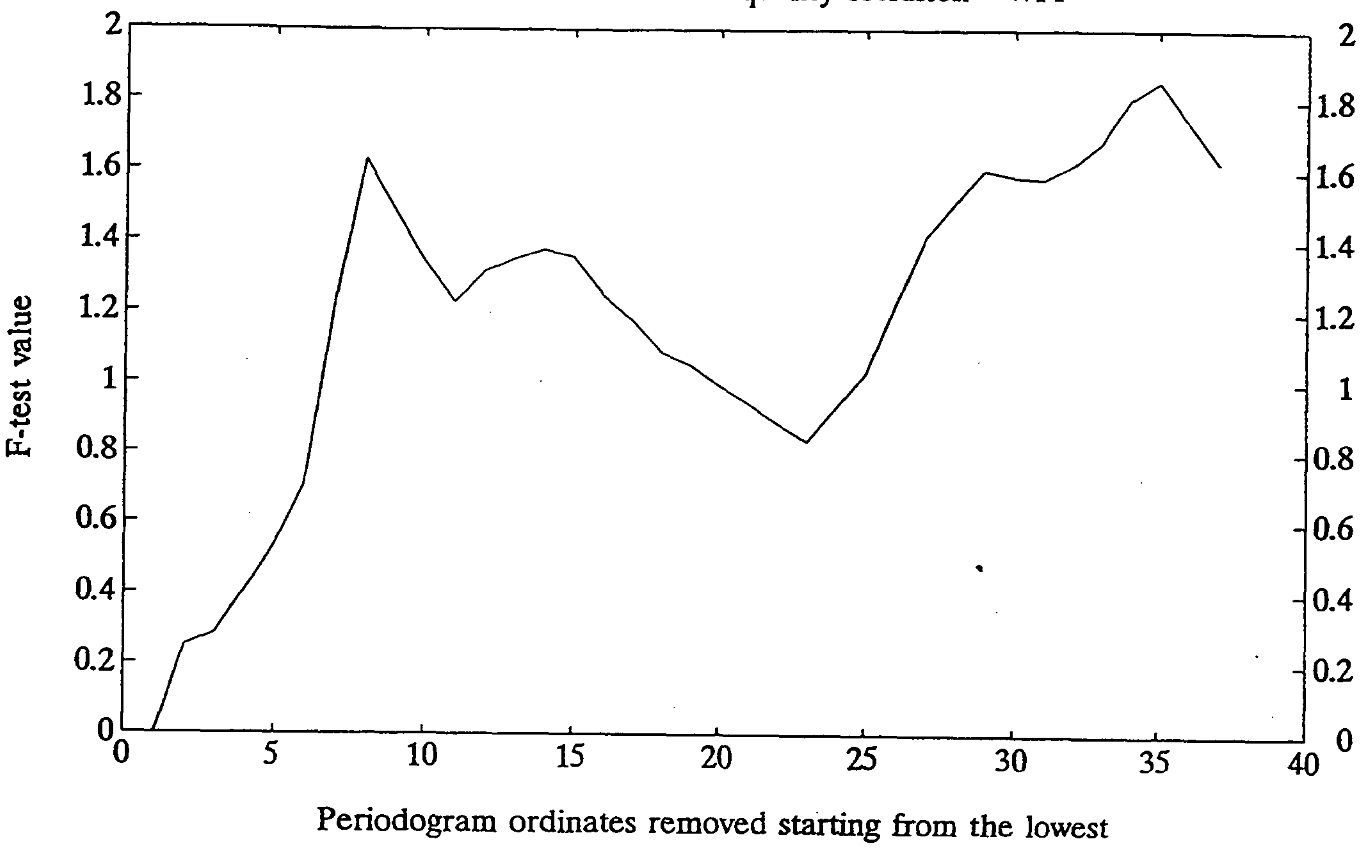


FIG. 8 - Chow test on frequency esclusion - WPI



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