SPECTRAL ANALYSIS
MONEY, INCOME AND PRICE, 1962-1987

A Thesis
Submitted to The Department of Management
and Graduate School of Business Administration
of Bilkent University
In Partial Fulfillment of The Requirements
for The Degree of

MASTER OF BUSINESS ADMINISTRATION

By
Sezgin ÖZYILDIRIM

July, 1990

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I certify that I have read this thesis and in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

Assoc. Prof. Ümit Erol

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

Assist. Prof. Gökhan Çapoğlu

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Business Administration.

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ABSTRACT

SPECTRAL ANALYSIS

MONEY, INCOME AND PRICE, 1962-1987

Sezgin ÖZYILDIRIM

MBA in Management

Supervisor: Assoc. Ümit Erol

July 1990, 48 Pages

In this study, the influence of monetary policy upon the price level and the real income over the business cycle is analyzed. The cross-spectral analysis, which is utilised in this study, minimises the effects of differential goverment policies. The observation period is from 1962 to 1987. The findings of the study show that the monetary policy has a significant influence upon the price level and so on the inflation as well.

Key words Monetarism, Keynesian, causality, stationary, spectral analysis, cross spectral analysis, phase diagram, gain diagram, coherence diagram

ÖZET

İZGESEL ANALİZ
PARA, REEL GELİR VE FİYAT DÜZEYİ, 1962-1987

Sezgin ÖZYILDIRIM
Yüksek Lisans Tezi, İşletme Enstitüsü
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Bu çalışmada para politikasının fiyat düzeyi ve reel gelir üzerindeki etkisi, devrisel dalgalar boyunca incelenmiştir. Kullanılan çapraz izgesel analiz, değişik kamu politikalarının etkilerini azaltmaktadır. Gözlem süresi 1962 ile 1987 arasıdır. Araştırmanın sonuçları, para politikasının fiyat düzeyi ve enflasyon üzerinde belirgin etkileri olduğunu gösterir.

Anahtar Sözcükler : Para, Keynezyen, nedensellik, durağan, izgesel analiz, çapraz izgesel analiz, faz diagramı, kazanç diagramı, tutarlık diagramı

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The determination of the income, the level of prices, output and the employment is an important concern of economics. Especially, in countries with persistently high inflation rates like Turkey, the determination of these parameters becomes more important.

The monetary policy plays a crucial role in the determination of these factors. Since, expansionary monetary policy is frequently exercised in Turkey, Turkey is a good research topic for investigating the effects of monetary policy on the price level and the output.

In this study, the econometric models are not used, so the need for imposing restrictions that normally apply in structural model approach is eliminated. The cross-spectral analysis, which is utilised in this study, minimises the effects of differential government policies. The long observation span (1962-1987) enables us to apply cross-spectral analysis within a framework that is free of a priori restrictions and less subject to policy factors.

2.1. THEORETICAL FRAMEWORK

The effect of money on the real activity of the economy is not an easy question and is open to several different economic interpretations. Some of the economists believe that the money supply is an important factor for determining prices and output but others do not believe this argument. Monetarist and Keynesian views are the two extreme points of this controversy.

2.1.1. KEYNESIAN

Keynesians believe that if there is an excess capacity (unemployment), then an increase in the money supply causes an increase in the real output. In Keynesian view, the economy can not reach full employment level automatically.

According to Keynesian viewpoint, an increase in the money stock causes an increase in the amount of money that households hold. So, they buy bonds and equities, and thus the interest rates decrease. Low interest rates encourage investment and consumption and the result of this is more demand than available supply. Therefore the prices start to increase and the real wages to decrease. Since real wages are lower, firms hire more labour and increase capacity, thus real output increases.

2.1.2. MONETARISM

2.1.2.1. CLASSICAL

Classical view is based on the assumption that the labour market is always in equilibrium with full employment. The equilibrium level of output is determined as a vector solution of Walrasian equations.

In its extreme form, the quantity theory states that price level changes because of the changes in the quantity of money. More specifically, price level moves in the same direction and proportion as the money supply.

The quantity theory of money can be formulated as MV = PQ . MV represents the spending of money during a period of time and PQ is the value of the goods on which it is spent.

The quantity theory implies a process by which changes in the supply of money can influence only the price level. Here, V and Q are independent of the supply of money. The process is an adjustment of the amount of money demanded by money users to the supply of money. If the money is disrupted by an increase in money supply (M), the excess of money over money demand is spent on goods, services and securities. If the level of real goods and services is given by Walrasian equilibrium conditions, and if money circulates at the same velocity (V), commodity prices P must rise until money demand and money supply are equated. Thus the excess supply

of money is dissipated by price inflation. So the price levels vary as a result of and in proportion to changes in the supply of money, given that V and Q are determined by exogenous factors and are constant in the short run.

2.1.2.2. NEO-MONETARIST

According to Milton Friedman, not only the quantity of money that is stated in the quantity theory, but also some other factors can affect the price level, however these factors are not as important as the money stock. Monetarism emphasises the importance of the growth rate of money stock in determining the rate of inflation in the long run and the real GNP in the short run (Durnbusch and Fischer, 1984:557-565).

Milton Friedman, in Role of Monetary Policy states that if we increase the quantity of money at a faster rate, this initially lowers the nominal interest rates. This expansionary monetary policy also stimulates spending through investment and consumption. People expects prices to be stable, and wages stays same for some time. It takes time for people to adjust to the new state of demand. Producers increase output and labour demand because of the expansion in aggregate demand. However, this scenario is only the beginning of a longer-term process. As, one man's spending is another man's income, rising income raises the liquidity preference schedule and the demand for loans. Since, there is an unanticipated rise in demand, prices increase. All these factors changes the direction of interest rate movements. According to Milton Friedman interest rates

return to their initial level in one or two years. A higher rate of monetary expansion will not lower the interest rate. Even it may be lead to higher nominal rates than initial nominal interest rates. Also expansionary monetary policy may cause the expectation of higher prices spiralling up at a faster rate, and this increase in expected inflation is the cause of the increase in nominal interest rates given the Fisher hypothesis (Friedman 1968:94).

2.2. HYPOTHESES

Economic theory as a scientific theory, posits a number of hypotheses subject to empirical verification. A set of these economic hypotheses attempts to explain how the economy actually operates. In this study, monetary theory and related hypotheses are tested for Turkish economy. The role that money plays in the economy is subject to opposing views both in theory and empirical reality. This study mainly tests the influence of money supply on prices and output within the following two frameworks.

Keynesian Framework

The Keynesian framework implies that if there is an excess capacity in the economy, an increase in the money supply affects both prices and output. If there is no excess capacity the only variable subject to change as a result of money innovations is price level.

In Turkey; given the excess capacity as an empirical reality

Keynesian hypotheses may have a certain validity theoretically. This hypothetical validity needs to be tested empirically.

Monetarist Framework

Monetarists argue that even if real output increases in the short run; over the business cycle (in the long run), the change in money supply affects only the overall prices.

In this study, the competing hypotheses derive from these alternative frameworks. The hypotheses are tested by utilizing spectral analysis to shed light on the business-cycle characteristics of the money-output-price relationships.

2.3. CAUSALITY

Money and income can be related in four different ways. First, money can cause income. Second, income can cause money. Third, there may be a feedback between the money and income link. So, money causes income and income causes money. Fourth, both variables can be affected by another factor, for example income and money can be jointly determined by the budget deficit.

Thus, an economically meaningful relationship between money and

income could exist in a variety of different forms, each of which can be explained differently. Answer to these questions show how active or passive monetary authority is in the generation of real output movements.

A monetarist can explain the link between money and income by claiming that an increase in money supply causes people to spend more money. More money leads to a rise in the quantity of goods produced, and then the price of goods. However in Keynesian case, the link from money to income is indirect. Money affects real economic activity only if it first affects interest rates. Only then the movement in interest rates affect investment, which in turn affects total demand in the economy, which finally affects income (Beyond Monetarism).

So, in the Keynesian case, increasing money stock does not always mean more income. But in the view of a monetarist, money works more directly. Although, Monetarist and Keynesian interpretations of strength of the link between money supply and the level of income are not the same, both share a common idea that money supply is exogenously determined with respect to income.

In The Monetary History of the United States, Milton Friedman and Anna Schwartz found positive correlation between the behaviour and the stages of the business cycle (Schwartz 1987). Disturbances in the rate of change in the money stock set in train a cyclical adjustment mechanism in which additional disturbances from time to time causes the output fluctuations. The growth rate of money increases during cyclical

expansions and falls during contractions. The peak rate of money growth occurs early in the cyclical expansions while minimum levels of money growth occurs in the troughs of the recessions.

On the other hand, adherents of real business cycle view believe in the existence of a reverse causation from income to money. When the economy begins to expand, firms hire more workers, implying an increase in wages, and the firms increase their money balances to cover these added expenses. Similarly the recently hired workers demand more money than before. Thus, an expanding economy creates the need for an expanding supply of money. Rather than reacting to an increase in money thrust upon them by monetary authority, people may simply demand more money from banking system in anticipation of their needs. In other words, money is an endogenous variable which is responding to people's needs rather than monetary authority's policies. In this particular sense; money is endogenous to real income movements.

3.1. WHY SPECTRAL ANALYSIS

In the analysis of the economic relations, the use of spectral methods provides more detailed information than traditional econometric model building methods. Some important advantages of spectral methods are as follows;

1. In the traditional methods, the fitting of models to the available data is an essential part of the analysis but spectral methods do not emphasise on model building. This property of spectral analysis may be very useful when the relationships are complex and model fitting is very difficult.

2. In the analysis of economic relations which are specific to business cycle movements, spectral analysis and particularly cross spectral analysis enables great flexibility. As business cycle is not periodic, the duration of each cycle vary between two years and twelve years. Because of the superposition of these cycles, it may be difficult to observe each cycle by visual inspection. So, cross spectral analysis is an appropriate tool to analyse all these varying periods between two and twelve years rather than focusing on one specific period.

3. Since spectral analysis enables us to decompose the data into frequency components, we can analyze the long run (low frequency) or short run (high frequency) relationships separately. In certain applications, this property can be used to remove seasonal effects or it can be used to

remove all but the random component from a series.

In this study, in order to test the Monetarist versus Keynesian view; we prefer to focus on business cycles (low frequency movements) by filtering out the high frequency (short-run) components of the relationships. For example, in the Monetarist view, it should be reminded that an increase in the money supply causes an increase in the output in the short run, but not over the business cycle.

4. In the analysis of economic relations; spectral analysis enables us to eliminate the effect of transitory shocks by filtering out the high frequency components of the series and this renders it possible to analyse the permanent and systematic relations which are specific to low-frequency band.

5. The tests of causality in time domain may yield inconsistent results, if causing factor does not lead the affected variable at all frequencies in the frequency domain. Since, spectral analysis decomposes the lead-lag relationships along all the frequency cycles, it overcomes this problem (Erol 1988:395).

3.2. SPECTRAL ANALYSIS

Spectral analysis provides a way of characterising time series. It decomposes the time series into sine and cosine waves of different frequencies which have an amplitude that makes up the original series. In

order to undertake frequency domain analysis, the stochastic time series should first be converted into a covariance stationary form. A series can be written as:

$$X(t) = \sum_{j} a_j (\cos w_j t + \sin w_j t)$$

where

w_j is the angular frequency of j^{th} component

a_j is the amplitude of j^{th} frequency component

The spectral density function is a decomposition of the variance into components contributed by each frequency. It shows the contribution of each cycle to the variance of the original signal.

$$R_x(\tau) = E\,[X(t+\tau)X(t)]$$

$$S_X(f) = \mathcal{F}\,[R_X(\tau)]$$

$R_X(\tau)$ is the autocorrelation function of stationary process X(t)

$S_X(f)$ is the spectral density function of X(t)

$\mathcal{F}$ is the Fourier transformation

This ability of spectral analysis to decompose a variable into its frequency components enables us to observe the contribution of each cyclic movement to the variance of the series.

3.3. CROSS SPECTRAL ANALYSIS

Just as the spectral analysis provides a way of analysing a single random process (time series) in terms of frequency components; cross spectral analysis provides a way of analysing interrelationships between two random processes for each frequency component. The cross covariance function is a direct analogue of the auto covariance function.

$$R_{XY}(\tau)=E[X(t+\tau)Y(t)]$$

Also the cross spectral density function is similarly defined as spectral density function.

$$S_{XY}(f)=\mathcal{F}\ [R_{XY}(\tau)]$$

Although the cross spectrum summarizes all the information in the series, it can not plotted directly. Coherence, gain and phase diagrams are used to analyze how the frequency w component of X(t) is correlated to the frequency w component of Y(t).

The *coherence* (C) is the square of the correlation coefficient between the corresponding frequency components of X(t) and Y(t). It measures, by cycle, how much the percentage variation of one series can be explained by that of the other series. In particular, the extreme values, zero and one, correspond to complete lack of correlation and the maximum correlation, respectively. Coherence is defined as follows;

$$C(f) = \frac{|S_{XY}(f)|^2}{S_X(f)\, S_Y(f)}$$

The *phase* (P) is a measure of the phase difference between the corresponding frequency components. It is measured in fraction of a cycle that Y leads or lags X. Phase is defined as follows;

$$P(f) = \frac{1}{2\pi} \arctan\left(\frac{-\mathrm{Im}(S_{XY}(f))}{\mathrm{Re}(S_{XY}(f))}\right)$$

Phase diagram can be interpreted by observing its shape. If one of the variables has a fixed time lag to the other, for example $Y_t = \alpha X_{t-k} + \varepsilon$, the f-frequency of X_t can be represented by

$$a_t \cos(2\pi f t + \theta)$$

and the corresponding component of Y_t is

$$\alpha\, a_{t-k} \cos(2\pi f(t-k)+\theta) = \alpha\, a_{t-k} \cos(2\pi f t + (\theta - 2\pi f k))$$

The phase lag between Y and X at the frequency f is $\theta-(\theta-2\pi fk) = 2\pi fk$. Thus, a phase diagram, whose shape is a straight line, is called *fixed time-lag*. The slope of this line is equal to $2\pi k$ as seen in figure 1.

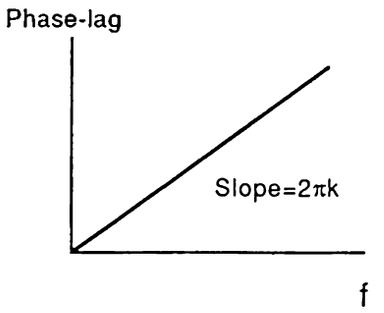


Figure 1. Phase diagram of Fixed Time-Lag

If the shape of the diagram is a horizontal line as seen in figure 2, it indicates the phase lag is constant for all frequencies.

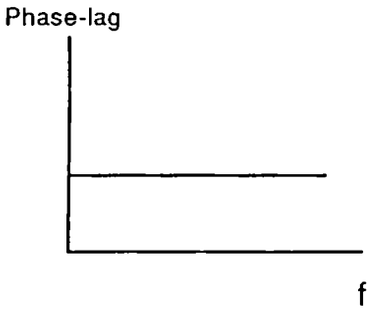


Figure 2. Phase diagram of Fixed Angle-Lag

When frequency decreases, the time lag between the corresponding components becomes larger. This form of a phase diagram is called *fixed angle -lag.*

The *gain* (G) indicates the frequency specific regression coefficient. Gain is defined as follows;

$$G(f) = \frac{|S_{XY}(f)|}{S_X(f)}$$

In static systems, the gain will be constant over all frequencies and the phase will be zero or a pure delayed lead or lag (fixed angle-lag). In dynamic systems the gain and the phase will be functions of frequency. (Scully 1973:387)

Determination of whether, a relationship is static or dynamic may be inferred from the fact that static systems have horizontal gain and phase functions while dynamic systems have sloped gain and phase functions.

3.4. SPECTRUM ESTIMATION

The tool, which is used to estimate the spectrum, is called the *periodogram* . The periodogram is the square of the absolute value of the Fourier transform of the data series at each frequency, all divided by the number of observations.

Although, for large sample size, the periodogram is an unbiased estimator of the spectrum, it is not a consistent estimator, since variance does not go to zero while sample size goes to infinity. The reason of inconsistency is that when the sample size increase, the number of points estimated on the spectrum increase. In order to make the periodogram a consistent estimator; smoothing procedures, which are called *windows,* can be used. A window mathematically is defined as a certain averaging process such as

$$S(j) = \sum_{k=-(n-1)}^{n-1} w_k I(j+k)$$

Rectangular and triangular windows are two most popular window type. A rectangular smoothing procedure gives the minimum variance but it leads to broadening of the peaks. A triangular window gives the spectrum much smoother appearance and is better at describing the shape of peaks. The choice of appropriate window type and width of the window is determined on the basis of empirical reality.

4. TURKISH CASE

Although, Cross-Spectral Analysis is a new method for Turkey, it has been utilised in the past analysing certain features of developed economies. The main problems in Turkish case are that the published series usually are not long enough to render a cross spectral analysis. This is partially related to the difficulty of finding monthly data for most series. In this study, since there is no published monthly GNP figure in Turkey, industrial production index is used as a proxy of monthly GNP or output of Turkish economy. It is hoped that the application of the method would provide valuable information about the lead-lag and causality relationship among money, output and prices.

More particularly, the cross-spectral analysis in this study is used to analyze the relationship between the money supply and the price level, and on the other hand the relationship between the money supply and the output in Turkey over the business cycles.

5.1. DATA

The observation period in this study is from 1962 to 1987. Monthly data is used. The variables considered are M1, M2 WPI and the industrial production index (IPI).

Two different money figures are used which are respectively M1 and M2. Both series are derived from the publications of Central Bank of the Republic of Turkey.

IPI is used as a proxy for monthly GNP of Turkish economy, since monthly GNP figures are not published in Turkey. This index is compiled by the Central Bank of the Republic of Turkey since 1988. The index covers almost 30 percent of the value added in the Turkish industry. The base year is 1984 and the series start from January 1962. This index is the only available series as a proxy for monthly GNP in Turkey.

The other variable is wholesale price index. This variable is used to test the effects of money on prices. The WPI used in this study is compiled from Treasury. The base year is 1960. WPI is used for domestic inflation since alternative measures of inflation such as CPI or GNP deflator are not available starting from 1960.

5.2. SPECTRAL TRANSFORMATIONS

5.2.1. STATIONARITY INDUCING TRANSFORMATIONS

The first step in spectral analysis is the transformation of non-stationary time series into a stationary form. All the time series (M1, M2, WPI, PI) used in this study contain upward trends in their means and also in their variances. These properties of first and second moments are the indicators of non-stationarity in the series.

In order to transform the data into stationary form; two types of transformations are applied to each series. First, the natural logarithm of each series are taken to eliminate the trends in the variances. Second type of transformation eliminates the trend in the mean. The trends in the means of money series (M1 and M2) are eliminated by regressing the series on time and the trends in the means of wholesale price index and production index are eliminated by applying the first difference operation.

5.2.2. THE SELECTION OF SPECTRAL WINDOW

The choice of window type and width of the window is an empirical problem. No single window is theoretically best with respect to other type of windows. In practice, when the sample size is large enough to achieve adequate resolution, most of the window types yield comparable estimators (Koopmans 1974:309).

The bandwidth is a difficult parameter of the spectral estimator to determine. It describes the resolution of the spectral estimator. When the width of the window increases, this is accompanied by the smaller variances, but bias of the estimation increases. A sensible value is the square root of number of observation points (Engle 1976:101). The width of window does not increase as rapid as sample size.

In this study, both triangular and rectangular windows are used. Given that the results of the triangular window is much smoother than the flat window, triangular window results are presented. The only disadvantage of this type of window is large side lobes. This can be eliminated by tapering. The width of the window is chosen as 17, because, in this study sample size is 310 ($17=\sqrt{310}$).

6.1. THE RELATIONSHIP BETWEEN MONEY SUPPLY (M1) AND THE WHOLESALE PRICE INDEX

In Table 1 and Figures 3a-3c, the spectral relationship between the money supply and the wholesale price index is presented. M1 is used as the proxy for money supply in this presentation.

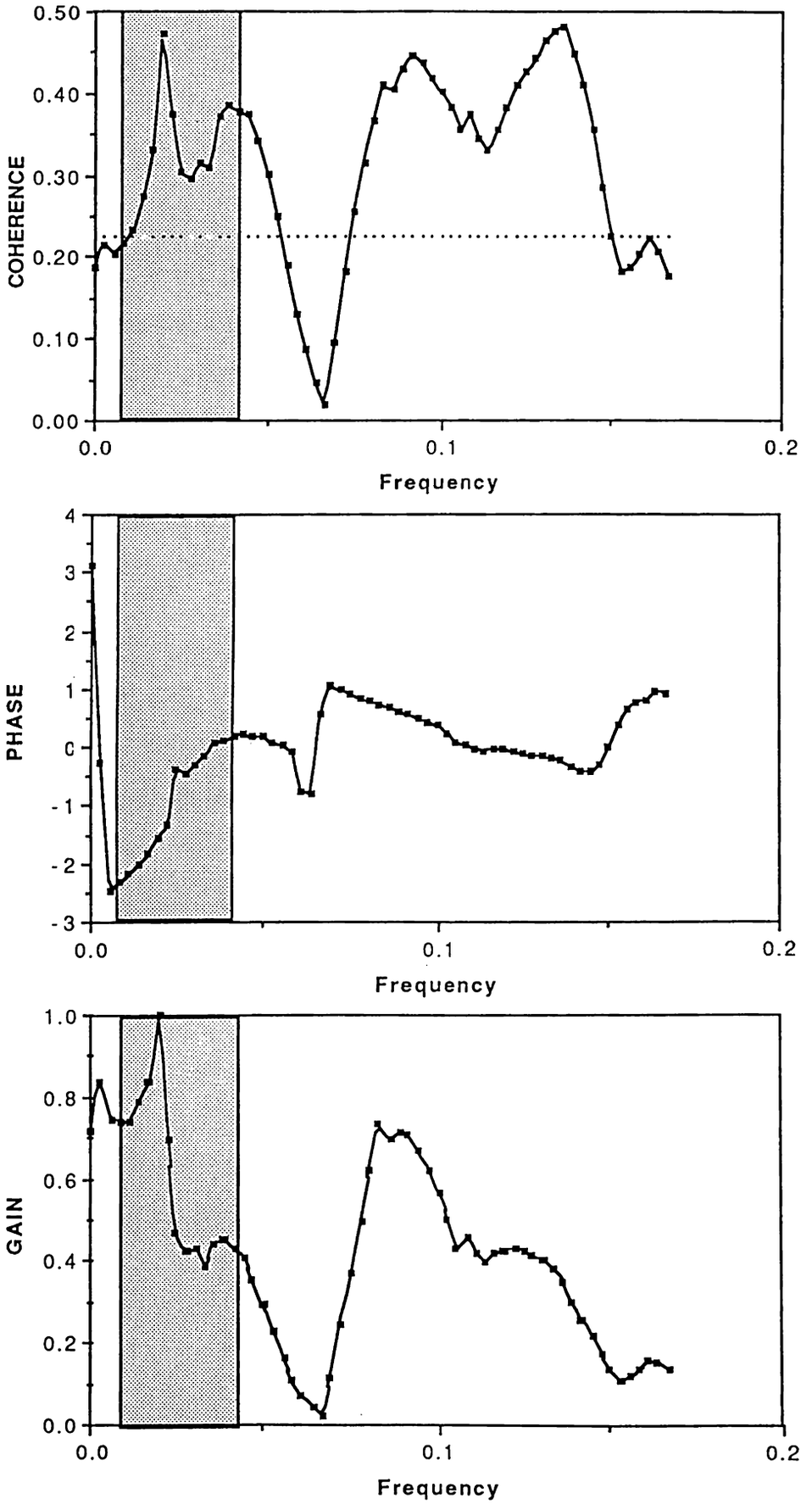
In the figures, the shaded area shows the business cycle. The vertical line at the left of this shaded area corresponds to a twelve year cycle and the vertical line at the right corresponds to a two year cycle.

Table 1. Cross-Spectral Estimates from Money Supply (M1) to the Wholesale Price Index.

Period in Months	K^2 (Coherence)	Gain	Phase
360	.2160	0.836	-.2611
180	.2048	0.747	-2.473
120	.2178	0.741	-2.329
90	.2332	0.737	-2.172
72	.2731	0.786	-2.008
60	.3320	0.837	-1.839
51	.4718	1.000	-1.556
45	.3762	0.695	-1.343
40	.3044	0.466	-.3822
36	.2957	0.425	-.4457
33	.3155	0.427	-.2861
30	.3096	0.387	-.1520
28	.3719	0.442	.09455
26	.3849	0.449	.1135
24	.3769	0.428	.1981

The coherence diagram in Figure 3a shows a strong correlation between money supply and the wholesale price index over the business cycle and there is a significant peak (0.47) between four and five years. Since, the triangular type window is used for smoothing procedure, the

Figure 3 : Cross-spectral analysis between the money supply (M1) and the wholesale price index



equivalent degrees of freedom (EDF) is 116 (3*310/8). According to Amos-Koopmans Tables, the significance level at 5 percent is 0.225 corresponding to this EDF. In Figure 3a, this significance level is shown by the dotted horizontal line. 0.47 correlation is higher than the boundary level (0.225). This implies a significant relationship between money supply and the wholesale price index. This correlation coefficient measures the degree of linearity between money supply and the price index. The phase and the gain diagram provides more detailed information about the nature of the relationship.

Figure 3b and Figure 3c shows the phase and the gain diagram of the relationship between money supply and the wholesale price index respectively. In the phase diagram, a trend is observed at the frequency band corresponding to the business cycle. This trend can be more easily seen in figure 4. As explained in section 3.3, the form of the phase is used to interpret the lead-lag relationship. The upward sloping trend is the indicator of a fixed time-lag.

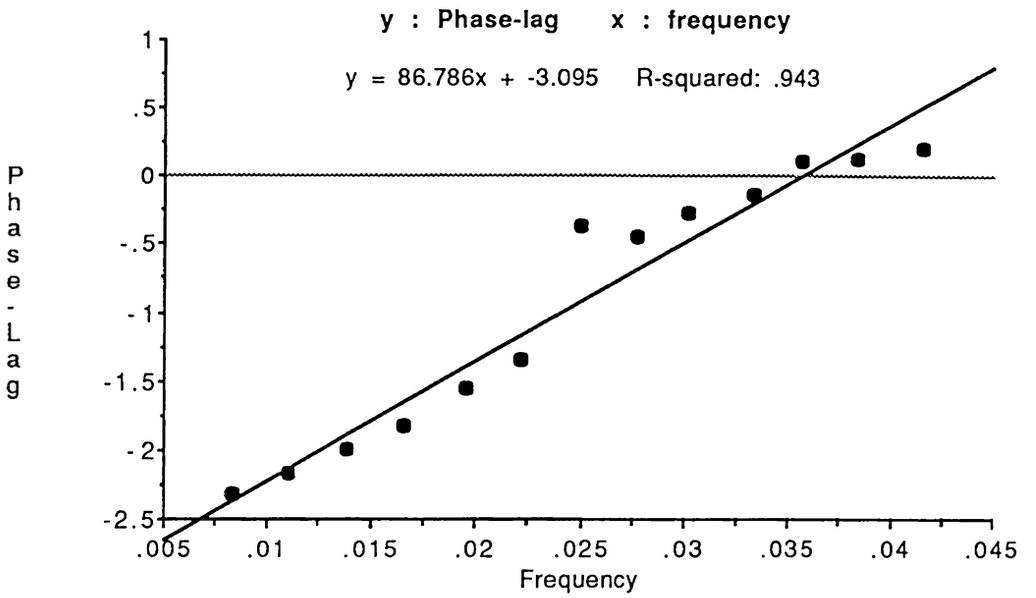


Figure 4 Phase-lag vs Frequency over the business cycles

A fixed time lag means that there is a constant time lead at the frequency band of interest. The constant time lead can be approximated by estimating the slope of the trend. In this study, since the frequency band of interest is the business cycle, the phase lag is regressed on the business cycle frequencies.

As seen in table 2, the results of the regression between the phase angle and the business frequency range, show a slope of 86.786 (R^2=0.943) over the business cycle. As explained in section 3.3 , this slope is equal to $2\pi k$. So, this slope should be divided by 2π to find time lead k.

$$k = \frac{86.786}{2\pi} = 14 \text{ months}$$

The result means that money supply leads price level on average by 14 months in the business cycles. The confidence interval with a 90%

significance level is between 12 months and 16 months.

Table 2.

Simple - Y : Phase-Lag X : Frequency

DF:	R-squared:	Std. Err.:	Coef. Var.:
12	.943	.239	-25.639

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Variance:	T-Value:
INTERCEPT	-3.095	.173	.03	-17.847
SLOPE	86.786	6.429	41.331	13.499

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	1	10.389	10.389	182.229
RESIDUAL	11	.627	.057	$p \leq .0001$
TOTAL	12	11.016		

Residual Information Table

SS[e(i)-e(i-1)]:	$e \geq 0$:	$e < 0$:	DW test:
.737	6	7	1.176

Since, the comparison of the regression coefficients at different frequencies are more important than real magnitudes of specific frequencies, normalisation procedure is applied to the gain diagram by dividing all the coefficients to the maximum of these coefficients.

The maximum of the gain diagram is in business cycle range. This fact supports the findings of the coherence diagram. Since the gain is a frequency specific regression coefficient, the change in the money supply has maximum effect over the business cycle.

Also, the gain and the phase diagrams imply a dynamic relationship between money supply and the wholesale price index, since the gain and the

phase diagrams are not constant over the business cycle. As explained in section 4.3, the gain and phase spectrums, which are functions of frequency, show a dynamic system. In other words; the type of relationship between the money supply and the wholesale price index changes over time.

6.2. THE RELATIONSHIP BETWEEN MONEY SUPPLY (M1) AND THE INDUSTRIAL PRODUCTION INDEX

In Table 3 and Figures 5a-5c, the spectral informations between the money supply and the industrial production index are presented. As in section 6.1, M1 is used as the money proxy.

In these figures, the shaded area corresponds to the business cycle. The vertical line at the left of this shaded area corresponds to a twelve year cycle and the vertical line at the right corresponds to a two year cycle. The dotted horizontal line shows the 90 % significance level.

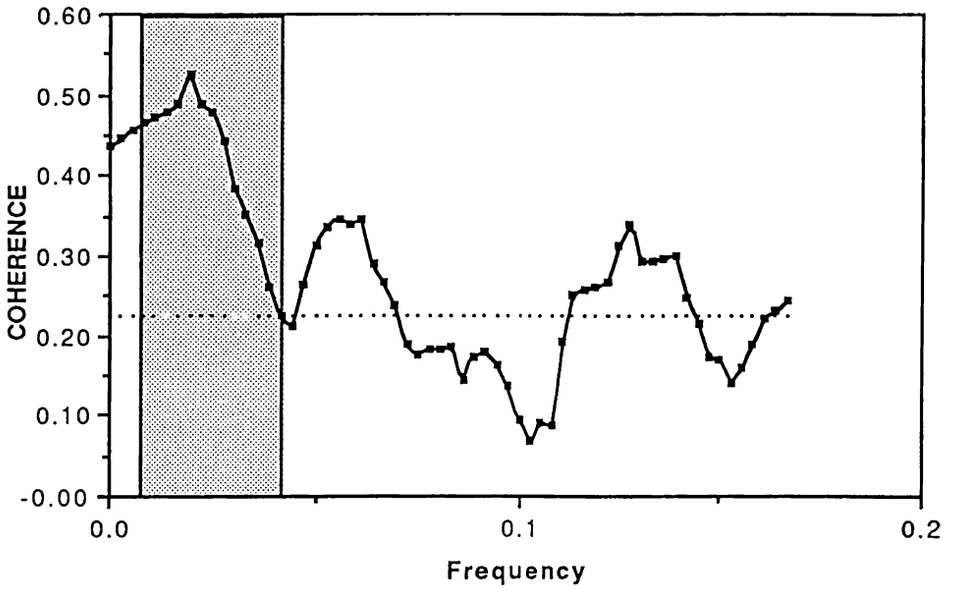
Table 3. Cross-Spectral Estimates from Money Supply (M1) to the Industrial Production Index.

Period in Months	K^2 (Coherence)	Gain	Phase
360	.4455	0.108	.2178
180	.4578	0.108	.2831
120	.4661	0.108	.3191
90	.4712	0.105	.3665
72	.4781	0.103	.4091
60	.4905	0.103	.4468
51	.5256	0.105	.4958
45	.4896	0.095	.3285
40	.4797	0.093	-.006038
36	.4428	0.088	-.1523
33	.3845	0.081	-.2235
30	.3537	0.080	-.2443
28	.3165	0.076	-.2187
26	.2623	0.068	-.1351
24	.2256	0.063	-.05180

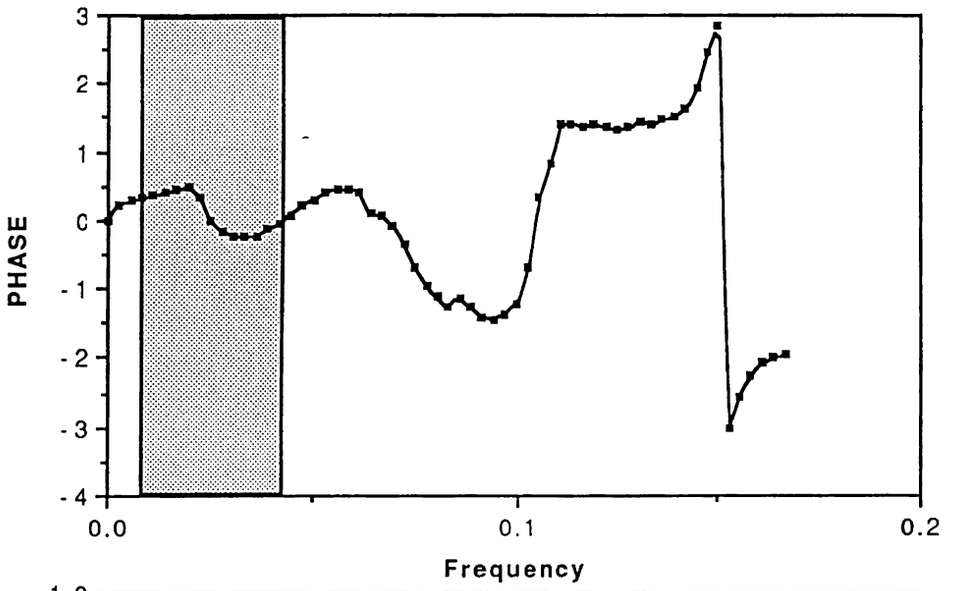
The coherence diagram in Figure 5a shows a significant correlation (0.53) between the money supply and the industrial production index. This correlation is higher than the correlation between the money supply and the wholesale price index. As, the window type and size is same, the significance level is same (0.225). So, this result may be interpreted as indicating that the correlation between money supply and the industrial production index is stronger than the correlation between money supply and the wholesale price index.

Figure 5b and Figure 5c show the phase and the gain diagrams of the relationship between money supply and the industrial production index, respectively. The phase diagram indicates a fixed angle lag oscillating around a phase angle of zero over the business cycle. When frequency increases, the deviation from the zero phase angle increases. This result indicates that the money supply and the industrial production index move

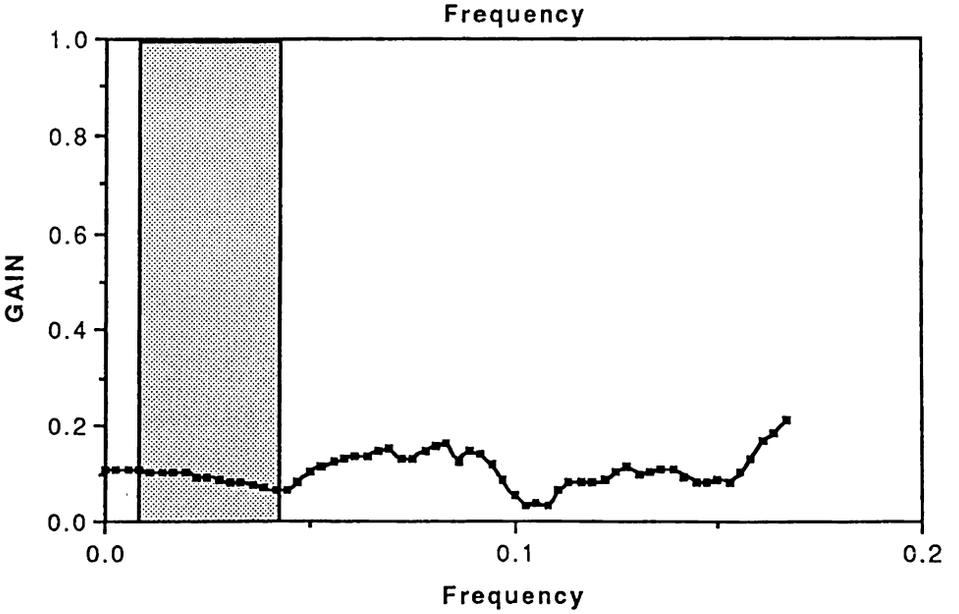
Figure 5 : Cross-spectral analysis between the money supply (M1) and the industrial production index



5a



5b



5c

simultaneously.

The gain diagram, which is presented in figure 5, is normalised by dividing the coefficients by the maximum of these coefficients. As seen in the figure 5c, the maximum of the gain diagram ,which is equal to 1, is out of the plotted range. The gain values in the business cycle range is very small.

The findings of both the phase and the gain diagrams do not confirm the findings of the coherence spectrum. This suggests that the strong correlation implied by high coherence values is spurious in nature resulting from a co-movement of both series with business cycles rather than representing a genuine causal relation.

As explained in section 4.3, the horizontal gain and the horizontal phase spectrums over the business cycle indicates to a stable model which does not change over time.

6.3. THE RELATIONSHIPS AMONG MONEY SUPPLY (M2), THE WHOLESALE PRICE INDEX AND THE INDUSTRIAL PRODUCTION INDEX

In section 6.1 and 6.2, M1 was used as proxy for the money supply, but in this part of the study, M2 is used as proxy for the money supply. The results of this analysis is presented in Tables 4 and 5, and in figures 6 and 7. As seen in these tables and figures, the results do not change, and only

small variations are observed between two approaches using different proxies.

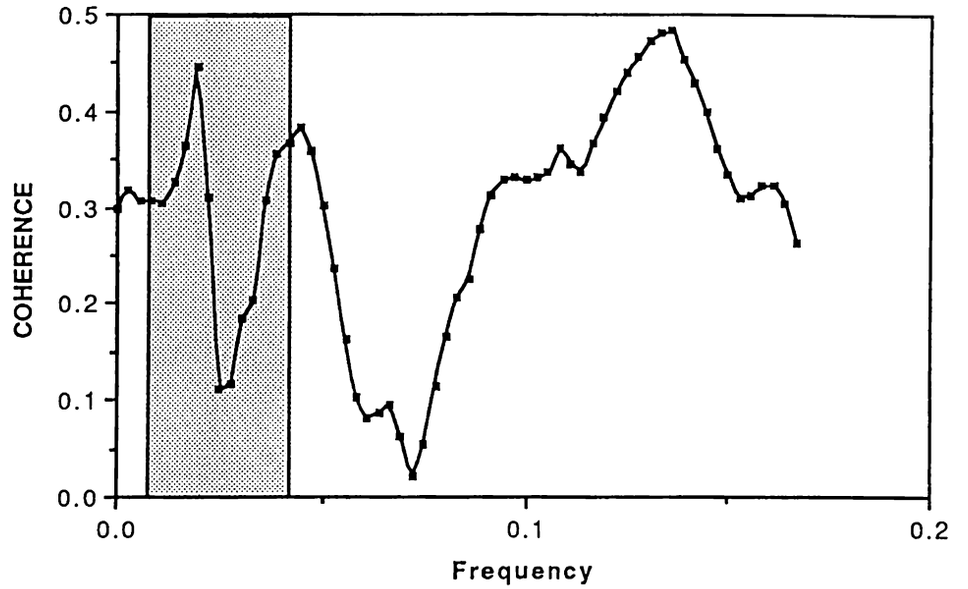
Table 4. Cross-Spectral Estimates from Money Supply (M2) to the Wholesale Price Index.

Period in Months	K^2 (Coherence)	Gain	Phase
360	.2996	0.948	3.142
180	.3184	1.000	-2.799
120	.3061	0.902	-2.711
90	.3070	0.837	-2.635
72	.3056	0.768	-2.537
60	.3262	0.740	-2.379
51	.3648	0.720	-2.196
45	.4461	0.735	-1.875
40	.3091	0.445	-1.795
36	.1105	0.132	.003509
33	.1165	0.131	.3156
30	.1851	0.195	.2864
28	.2034	0.198	.2928
26	.3058	0.283	.4327
24	.3548	0.323	.3124

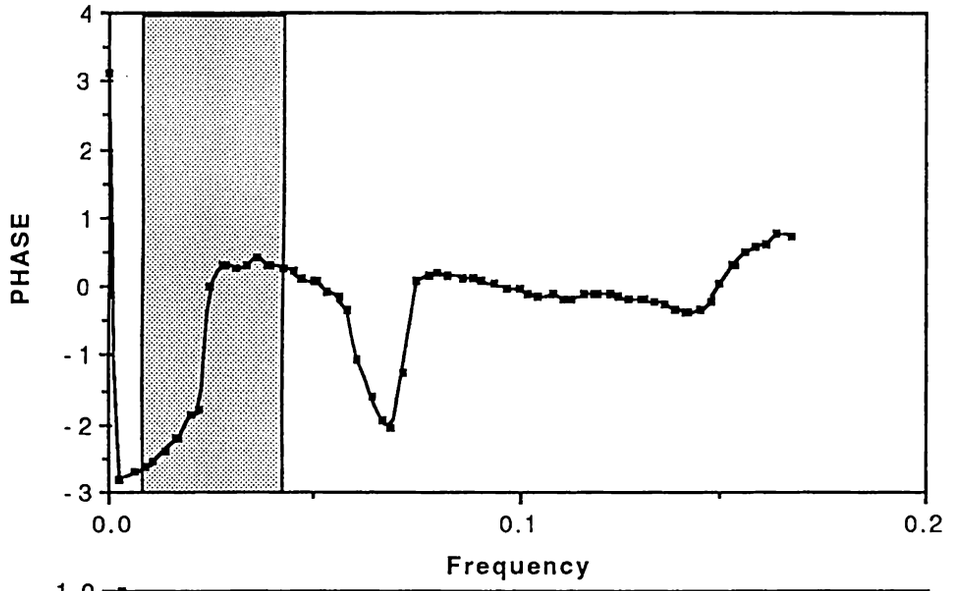
Table 5. Cross-Spectral Estimates from Money Supply (M2) to the Industrial Production Index.

Period in Months	K^2 (Coherence)	Gain	Phase
360	.5665	0.147	.1371
180	.5733	0.145	.1591
120	.5693	0.141	.1820
90	.5524	0.132	.2208
72	.5337	0.123	.2533
60	.5195	0.117	.2847
51	.5255	0.112	.3452
45	.4766	0.098	.1952
40	.4628	0.096	-.1326
36	.4009	0.085	-.2367
33	.3517	0.079	-.3477
30	.3362	0.081	-.3718
28	.3033	0.078	-.3465
26	.2615	0.072	-.2764
24	.2504	0.075	-.1671

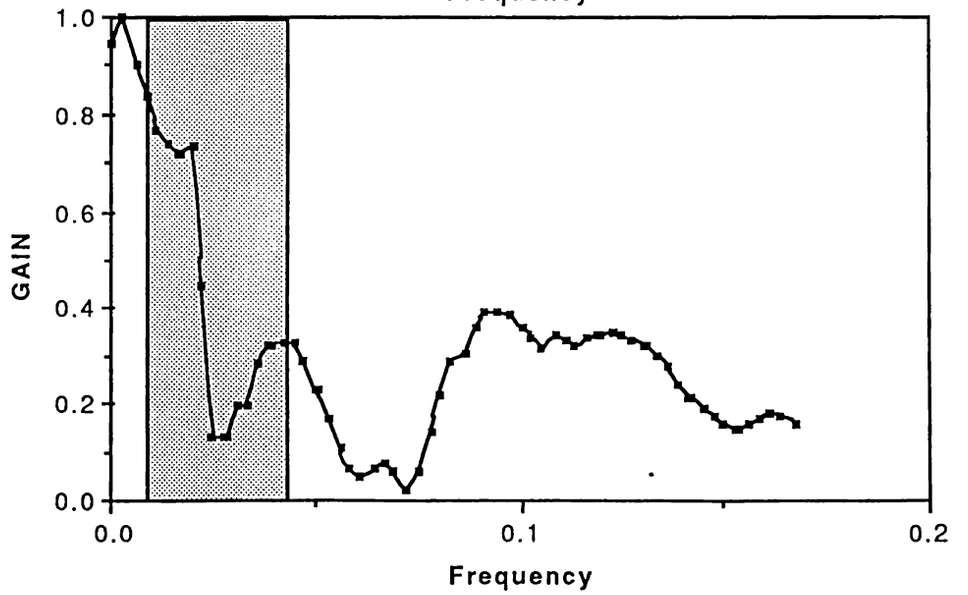
Figure 6 : Cross-spectral analysis between the money supply (M2) and the wholesale price index



6 a

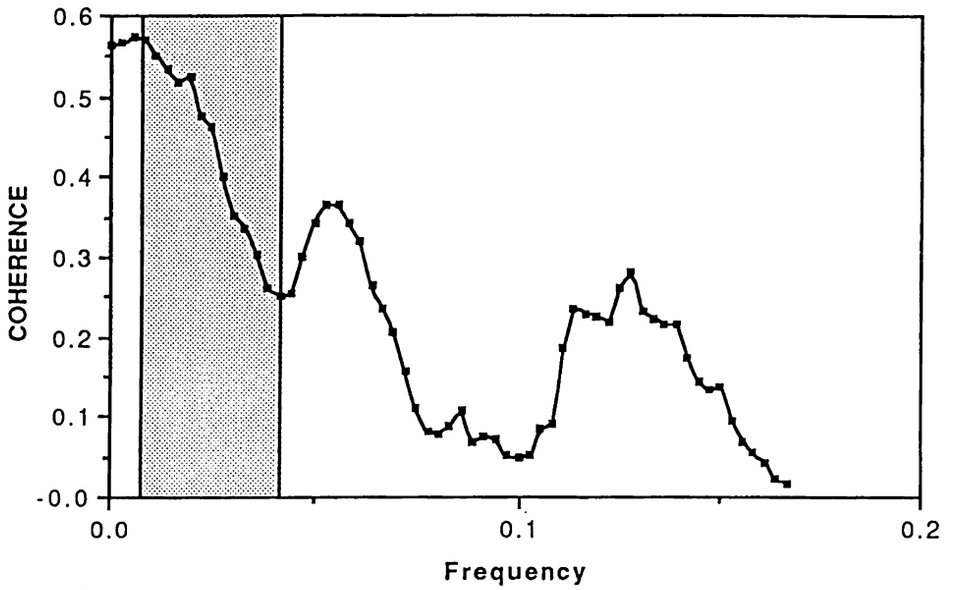


6 b

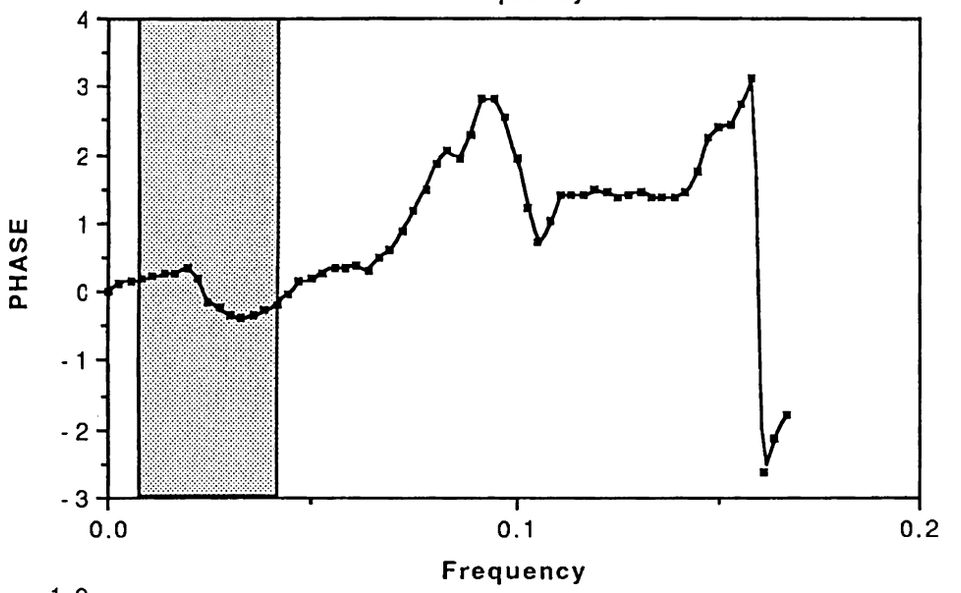


6 c

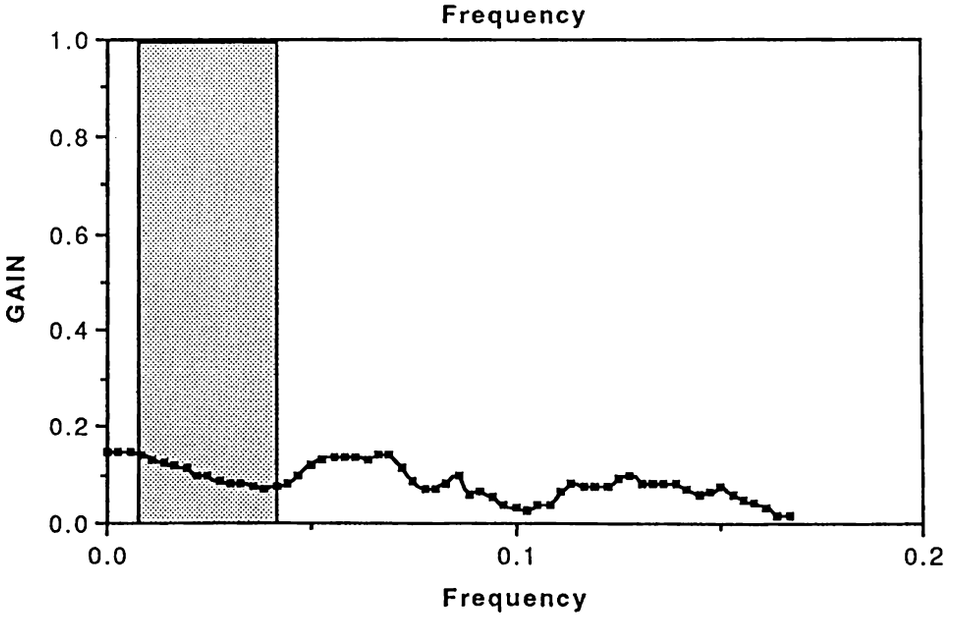
Figure 7 : Cross-spectral analysis between the money supply (M2) and the industrial production index



7 a



7 b



7 c

Table 6 : Summary of The Results :

Relationship between Money Supply and Wholesale Price Index	Relationship between Money Supply and Production Index
1 There is a significant correlation over the business cycle.	1 There is a significant correlation over the business cycle.
2 Money supply leads price level about 14 months.	2 Money supply and the production index moves simultaneously.
3 The relationship between the money supply and the price level is dynamic.	3 The relationship between the money supply and the output is static.
4 The money supply and the price level is causally related.	4 The money supply and the real output is not causally related.

7.1. MONEY AND PRICE LEVEL LINK

The coherence diagram presented in section 6.2, shows a high and significant correlation between the money supply and the price level over the business cycle. This result is also verified by the results of the gain and the phase diagram.

In the gain spectrum, the gain values over the business cycle is higher than the other frequencies and it has a peak between three and four years. As explained in section 6.1, the money supply leads the price level between 12 and 16 months. Temporal asymmetry suggests that the variable which is causative agent should have lead over the variable which is affected (Erol 1988:395). In the phase spectrum, the continuous lead of the money supply over the price level along all business cycle frequencies indicates that the causative agent of the temporal asymmetry is the money supply.

These findings show that the money supply and the price level are causally related. The money supply causes the price level. This result supports both Monetarist and Keynesian views. In order to conclude which of the view is more relevant for Turkey, this result must be merged with the result of the next section.

7.2. MONEY AND INCOME LINK

The coherence diagram presented in section 6.2, shows a high

correlation between the money supply and the output over the business cycle. However, the finding of high correlation does not imply that they are causally related. Variables may be correlated but they may be causally unrelated. The reason for this high but possibly spurious coherence values may be explained by the existence of common factors driving both series.

The low gain values and the zero phase lag between the money supply and the output over the business cycle confirms the fact that these two variables are not causally related. If the money supply causes the output, there would be a phase difference between these variables. The reason for this contradiction among the coherence, gain and phase spectrums as mentioned above, may be a third variable that causes both the money supply and the output. This third factor can be the capital accumulation process.

Since, the money supply and the output are not causally related, the Monetarist view is more relevant in Turkey. Since, there is an excess capacity (unemployment) in Turkey, in order to accept the Keynesian framework, the money supply and the output should be causally related.

8. CONCLUSION

This study analyzes the influence of monetary policy upon the price level and the real income over the business cycle.

The findings of the study show that the monetary policy has a significant influence upon the price level and so on the inflation as well. These two variables are causally related over the business cycle. However, the monetary policy does not have a significant influence upon the real income. Neither the money supply causes the income nor the income causes the money supply. These results support the fact that the monetary authority is passive in the generation of real output movements in Turkey.

If these two results are combined, it verifies the Monetary framework in Turkey. Since, Turkey is a developing country, this result is expected. Change in the money supply causes change in the price level but do not cause any change in the real output. So, the expansionary monetary policy provokes the inflation in Turkey.

The relationship between the money supply and the price level corresponds to a dynamic model which changes over time. This information can be used in the construction of macro-econometric models.

In short, this study is an evaluation of the monetary policy practised in Turkey and sets up a groundwork for further research in similar avenues.

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