HARMONIC ANALYSIS: THE APLICATION OF 'THEORETICAL CYCLES' TO THE ECONOMIC ANALYSIS

I INTERNATIONAL MEETING ON ECONOMIC CYCLES
Quantitative Methodology of Economic Cycles

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Abstract: The Fourier transformation of a stationary series allows to look at the different frequency components of the series. By isolating frequency components in a group of series, the possibility of the relationships between the series varying with frequency can be also analysed. The aim of this paper is to present evidence on the validity of the application of the spectral analysis to economic phenomena. The postulates of the quantity theory of money provide the basic framework for the application of this method to quantify economic theories.
The period analysed covers a great deal of the capitalistic stage, and it is focused on three European countries: Spain, France and Great Britain. For the purpose of this study, this period was selected because it presents very different phases, since throughout this long time, the classic gold-standard alternated with a fiduciary system as a result of the changes in institutional policy.
The main conclusion of this work is that the values of the parameters obtained from *theoretical cycles* -that result of the decomposition based on this analysis- are significantly closer to those postulated by quantity theory than those obtained from the time series data or from subsequent *empirical cycles*.

1. INTRODUCTION

The study of the cycle, fluctuations in aggregate measures of economic activity and prices over periods, constitutes and motivates a large part of macroeconomics. Sims (1990) consider that there are many macroeconomics variables whose cyclical fluctuations are of interest, and most economists would agree that fluctuations in these series are interrelated. It would seem to folow almost tautologically that statistical models involving macroeconomic variables ought to be the arena within wich macroeconomic theories confront reality anf thereby each other.

The different theories of economic cycle focus their attention in the explanation of the generation of oscillating movements in the economic variables. Within the monetary

theories of the cycle, the contribution of neo-classical economists in the reformulation of the quantity theory of money has special importance. If the production and the speed of money stay constants, the movements in price level would be explained by the movements in the quantity of money in circulation. However, Álvarez Vázquez (1996) considers that in this scheme there is no place for a theory of the cycles. Since the observed crises are attributed to irregular factors as they are the financial disturbances, the economic crises would not have why to be periodic.

In applied economics, as well as many other sciences, much of the work on time series analysis has been motivated by the desire to generate reliable forecast on future events. On the other hand, econometric models for time series data attempt to describe, or at least approach, the dynamic relationship between the variables under consideration. Because of the way econometrics has developed in recent years, the distinction between time series methods and the rest of econometrics has become much less clear, and Granger *et al.* (1997) state that it seems very likely that this will continue. In this sense, the aim of this paper is to present evidence on the validity of the application of the spectral analysis to economic phenomena, and thus, it has the purpose of approaching the dynamic relation between the variables under consideration and not generating predictions.

The Fourier transformation of a stationary series allows to look at the different frequency components of the series, at least to some extent. This idea was used in Granger *et al.* (1964) to test stationarity. By isolating frequency components in a group of series, the possible relationships between the series varying with frequency can be also analysed. Calling the technique band spectrum regression, Engle (1974) considered a simple time-domain regression, transformed it into the frequency domain and then used a test similar to the Chow test for structure stability to see whether the relationships were frequency dependent. This method is an obvious generalization of the familiar decomposition into " permanent " and " transitory " components and has interpretation advantages.

The quantity theory of money is a paradigm in econometrics. In relation to this, Hayek (1996 [1931]) states that since Fisher formulated the " equation of exchange ", the quantity theory of money is a typical example of " quantitative " economy, build up to admit statistical verification. Likewise, Schumpeter (1982 [1954]) concludes that with Fisher the statistical methodology becomes part of economic theory and ceases to be a mere tool. The postulates of quantity theory of money, formulated by the most important neo-classical economists, provide the basic framework for the application of this method to quantify economic theories. Thus, this study has been based on the fundamental principle that the construction of the theoretical framework is prior to any empirical work since the outlined relationships are not a result of statistical observations and they are not results, but postulates.

The period analysed covers a great deal of the capitalistic stage, and is focused on three European countries: Spain, France and Great Britain. For the purpose of this study, this period was chosen because it presents very different phases, since throughout this long

time the classic gold-standard alternated with a fiduciary system, as a result of the changes in institutional policy.

The main conclusion of this study is that the values of the parameters obtained from the *theoretical cycles* -that result of the decomposition based on the spectral analysis- are significantly closer to those postulated by quantity theory of money than those obtained from the available time series data or from subsequent *empirical cycles*. Therefore, this paper provides evidence of the validity of the application of the spectral analysis to economic phenomena.

It is generally accepted that the increase in the quantity of money, sooner or later, leads to an increase in prices. However, this is an extremely complex subject which arouses different opinions. The principal contributions of the neo-classical economics to the development of quantity theory are discussed in the next section. Section 3 is devoted to the description of the statistical method applied and the presentation of the empirical results. In the last section, the main conclusions are discussed.

2. POSTULATES OF THE QUANTITY THEORY OF MONEY

The quantity theory of money, from its formulation to the present time, has been subject to numerous revisions and criticism concerning the practical implications that the economic policies based on this theory would have on economic development. Hayek (1996 [1931]) points out that there are numerous historical examples that have shown the dependency of the productive activity on money, and concludes that the amount of money in circulation plays a prominent role in the determination of the full economic activity[1].

In order to analyse the existing views on the relationship between the quantity of money and prices, I will mention the two main approaches to economic analysis: the " real analysis " versus the " monetary analysis "[2]. The real analysis is based on the principle that all the fundamental phenomena of economy can be defined and analysed in terms of goods and services, their interaction and decisions made on them. The role of money is to assist transactions and, as long as it fulfils its role, it does not affect the economic process that runs just as it would in a barter economy. This is what is implied, in essence, by the concept of " neutral money ". Thus, money is of no interest when analysing the fundamental characteristics of economic processes. According to this approach, money is a " veil ", and the specifically monetary matters would be treated separately. The monetary analysis, on the other hand, introduces money into the basic framework of the analytical structure, and argues against the proposal that money is of secondary importance in the explanation of economic phenomena. This approach leaves behind the idea that the essential characteristics of economic activity can be represented by means of a barter model economy, and states that money can never be seriously considered as " neutral ".

Thus, the different theories on the real approach to economic analysis consider that the changes in money supply do not affect in any significant way the aggregated expenses, or the rate of inflation. Some authors admit that this relationship will only take place in the long term because there are other factors influencing the short term inflation rate, such as: fiscal policy, changes in the amount of consumption, growth of the population, or increases in production costs. That is to say, they consider real factors more important that monetary factors in the determination of price level. On the other hand, the monetary approach bases the explanation of the inflationist phenomenon on the behaviour of the quantity of money per unit of product. According to this approach, the changes in money supply produce changes in price level, although these changes, which cause an imbalance in economy, are later absorbed and so return to a state of equilibrium. In any case, certain discrepancies exist among the modern monetarists [Friedman (1992)] and some of the historical defenders of the quantity theory of money. For the former, the changes in money supply do not lead to exactly proportional changes in price level, which is the case for the latter.

At the present time, a certain level of agreement has been reached between both approaches on the importance of money in determining production and price levels. López González (1996) states that the disagreement is focused mainly on the quantification of this influence and on the determination of the most effective policies for the stabilisation of the economy.

2.1. THE NEO-CLASSICAL THEORY OF MONEY

The neo-classical theory of money did not break away from the work that J. S. Mill carried out. Nearly all the works of the most outstanding authors of this school, except those devoted to specific monetary problems, have been " real analysis ". That is to say, the model of the economic process was still, in essence, a barter model whose operation could be disturbed by inflations and deflations, but in spite of this, it was logically complete and independent with respect to money. However, most of the fundamental principles of the current theory of money were established at this stage.

If the facts of value and distribution are, according to this logic, independent from money and, in spite of this, it is recognised that money can have a disturbing effect, the need arises to define how money must behave so as not to influence the real processes of the barter model. Wicksell was the first to recognise this problem and coined the appropriate term: " neutral money "[3]. This concept just refers to the then predominant faith in the possibility of a " pure real analysis ". To the extent that the theory of money remained isolated, its main and almost sole problem was the exchange value or purchasing power of money[4]. The quantity equation is the simplest system of aggregates that contains the value of money. This itself, is not more than the statement of a formal relationship without any causal connotation. Nevertheless, in this scheme of analysis, this equation becomes the quantity theory of money, and much of the discussion on theory of money at the time took the form of arguments for or against this theory. This explains the resurgence of the quantity equation during this period, and Fisher’s theory of purchasing power of money is the most outstanding achievement of the time.

Fisher formulated the quantity equation and used it as the starting point for the theory of money. At that time, there was nothing new about the equation of exchange, since it had a clear precedent in the works by J. S. Mill[5]. This equation relates the level of prices (P) to the quantity of money in circulation (M), its efficiency or speed of money (V) and the physical volume of trade (T). The Fisher equation takes the following form:

$$P = f(M, V, T) = \frac{M.V}{T}, \text{ or} \tag{1}$$

$$M.V = P.T \tag{2}$$

This equation, formulated in this way, is no longer an identity but a condition for equilibrium. In it, Fisher does not claim that (M.V) is (P.T), nor that (M.V) is equal to (P.T) by definition, but that given values of (M), (V) and (T) tend " to produce " a certain value for (P).

Fisher claimed that the price level is " normally " the absolutely passive element of the equation and that, in any case of important fluctuation in price levels, (M) and not (V) or (T) varies sufficiently to be considered a explanatory variable. However, it does not defend the quantity theory of money in a strict sense, because he recognises the influence of (T) on (V) and on (M). This weakens the theorem, if it is understood as a long term proposal, because it introduces a relationship between the " independent variables " that interfere with the direct effects of the variations of (T) on (P). In his analysis Fisher emphasises that (M), (V) and (T) are only the " proximal causes " of (P), and that within these can be found other " indirect influences " on purchasing power, which act on the price level through the proximal causes.

Walras, in his attempt to validate the proposal that the practical control on the price level can be obtained by the control of the quantity of money, did not confine himself to simply claim that the value of money is inversely proportional to its amount, but he also tried to deduce it logically from the principle of marginal utility. However, given the conditions that he imposes, the quantity theory of money becomes trivial and of no value. If all the rest stays *strictissime* equal, it concludes, it is possible to make a given amount of transactions exactly equal by means of a smaller amount of monetary units, if all prices are reduced in the same proportion.

The similarity between the concepts that take part in the Fisher equation with the available statistical data, forced theoreticians to define their meanings precisely. Problems arose in relation to what prices should be included in (P) for the quantity equation, some of which were dealt with by Fisher[6]. The possibility of abandoning the concept of general price level of everything bought and sold with money and replacing it by several sectorial price levels was implicit in the Austrian authors who were reticent towards the concept of general price level[7]. In his introductory remarks, Fisher defines (T) as the amount of goods bought with money but adopts in his statistical work a wider concept that includes transferable securities. Problems also arise in the definition of (M), some of which had already been raised by Mill.

Most of the authors who analyse the monetary phenomena in this period emphasised the difference between money and credit, or " primary money " and " fiduciary money ", and thus, they showed reticence to include the checking deposits in the concept of money. But when they tried to specify the quantity equation, most of them, specially the North Americans who made most of the statistical work, included without reserves checking deposits, describing them as " cash in deposit ". (M) meant, essentially, lawful money, treasury notes without endorsing, bank-notes and checking deposits[8]. Wicksell is an outstanding example of an alternative definition of the quantity of money. This author limited (M) to cash and state notes without any title to be redeemed in gold. This exposition took to him to interpret, in the pre-classical line of Cantillon and other authors, bank notes and deposits as instruments to increase the speed of money defined in this way. In his analysis, bank reserves, far from having speed zero, as it was implied from the previous definition of (M), would have a very high speed, the Fisher's " virtual speed ".

This outstanding author made the difference between the amount of money (M) for cash and notes and (M') for deposits, formulating the equation as follows,

$$M.V + M'.V' = P.T \qquad (3)$$

that included a different speed (V') for deposits. In his analysis, he introduced two hypotheses. Fisher supposed, firstly, that a very stable relation between the " primary money " that people keep and the amount of average liquids that people deposit in current accounts exists. Secondly, he supposed that, in conditions of balance and for periods not too long, a very stable relation between the reserves of the banking system and the deposits in current account exists. In his scheme, the part of " primary " money plays a role that is not the one of current account deposits, because they continue being " cash in deposit ", but the idea that the variation on the amount of this money is governed by the variation of the amount of " primary money " is put forward.

The definition of the concept of speed of circulation depends on the concept of amount of money that is adopted. In the analysis of its determining factors, no significant advance with respect to Mill was not obtained[9]. Fisher analysed the determinants of the speed of circulation of money in economy from an aggregated point of view[10]. In particular, he took a slow growth of this variable, since in his opinion, it would be determined by institutional aspects that change slowly. On the other hand, he took that the total volume of transactions is related in a stable way to income. This relation would also be dominated by institutional aspects of slow evolution which, in any case, would cause that the quotient (T/y) fell smoothly over time. Thus, it is formulated the equation that links the amount of money and the nominal rent, where (V_Y) is the income speed.

$$M.V_Y = P.y \qquad (4)$$

Mauleón (1989, 40) claims that although Fisher did not formulate it in this way, here a function of demand of money is implicitly defined, since we can write,

$$M = K.P.y \qquad (5)$$

where ($K=1/V_Y$). Since Fisher supposes that (k) is a short term constant, this last equation would imply that the demand of real amounts of money for transactions will be a short term stable proportion of real income. If we also suppose, like it was usual at the time, that the level of activity of economy is given, since full employment is reached automatically, we obtain an explanatory equation for the level of prices, namely,

$$P = M.\left({}^{V_Y}\!/\!_{y} \right) = Q.M \qquad (6)$$

being (q) constant. Thus, we obtain an elasticity prices-amount of money of 1, which implies that the variations in the prices will be proportional to the variations in the amount of money.

It is not easy to establish a frontier between the economists who accepted the quantitative theory of money and those that rejected it. This theory always had declared enemies, mostly in Germany and France, who thought it was either untenable or useless. Much of the criticism was that was made had little value, because or it tried to refute proposals never affirmed by the quantitative theory of money, or it was often mistaken in the points in which this argument could have been a valid objection. However, some of these critics, among whom it Anderson must be highlighted, were able to set valid and significant truths, although nondecisive[11]. Wicksell (1978 [1898]), on the other hand, showed that the study of the works by Tooke and his followers had allowed him to arrive at the conviction that really, there is no monetary theory but the quantitative theory and if it is false, there is no monetary theory at all.

Within another set of questions, a limitation of the quantitative theory of money, is that it is only valid in a state of equilibrium, that is to say, that it is not applicable to what Fisher called " periods of transition ". For this reason, phenomena that " seem incompatible with this theory " will be shown frequently.

Until over 1930, the analysis of Irving Fisher was widely accepted. Friedman (1992) states that the interpretation of the monetary theory made of this analysis was that, in the change equation (M.V = P.T), the speed could be considered highly stable, that it could be taken as determined independently from the other terms of the equation, and, as a result of this, the changes in the amount of money would be reflected in the prices or in the production. This implied that the tendency of the prices, in any significant period, reflect the behaviour of the amount of money throughout that period.

In this context, the monetary policy was the fundamental instrument available to stabilise the economy. According to this author, the basic source of the Keynsian revolution and the reaction against the quantitative theory of money was the Great Depression of the 20s. This historical event was interpreted wrong, because it was

considered that the monetary policy, put to the test, had failed. It proved the inefficiency of the monetary policy to avoid the decline of economic activity, and this destroyed the credibility of the quantitative theory of money.

3. METHOD AND MAIN RESULTS

The spectral analysis is the methodological proposal that has been adopted in this study to carry out the assessment of the hypotheses of quantitative theory of money. The basic proposal of the spectral analysis claims that all periodical functions can be expressed as the sum of sinusoidal components, i.e.:

- That with a reduced number of harmonics it is possible to approach a function acceptably and

- The possibility of deconstructing the function in harmonics.

Spectral analysis or frequency-domain analysis is based on the pair of theorems [see, for instance, Anderson (1971, sections 7.3 and 7.4)] that proof that the autocorrelation sequence r_s of a discrete-time stationary series x_t has a Fourier transformation representation:

$$r_s = \int_{-p}^{p} e^{iws} dS(w), \tag{7}$$

where *S(w)* has the properties of a distribution function, and the spectral representation for x_t*:*

$$x_t = \int_{-p}^{p} e^{itw} dz(v), \tag{8}$$

where

$$E\left[dz(v)\overline{dz}(l)\right] = 0, \qquad v \neq l$$
$$= s^2 dS(v) \qquad v = l$$

where $s^2 = \text{var}(x_t)$, and the spectral function is given by:

$$s(v) = \frac{1}{2p} \sum_{\text{all } s} (r_s e^{iws}). \tag{9}$$

The trigonometrical series of Fourier present clearly advantages over the series of Taylor, because whereas the former demand the use of successive differential coefficients , the latter can represent a periodic function with finite discontinuities.

The spectral representation of x_t can be defined by saying that x_t is the sum of an uncountable infinite number of random components, each one associated to a particular frequency, and with each pair of components being uncorrelated. The variance of the component with frequencies in the range $(w, w+dw)$ is $s^2 dS(w)$ and the sum (actually integral) of all these variances is s^2, the variance of the original series. This property can be used to assess the relative significance of frequency components. Small, or low, frequencies correspond to long periods, as frequency = $2p$ (period)$^{-1}$, and thus to the long swings or cycles in economy if x_t is a macro-variable. High frequencies, near p, correspond to short oscillations in the series.

The obvious applications of univariate spectral analysis are to investigate the presence of cycles in the data. Therefore, the previous hypothesis plays a fundamental role as far as the repetitive nature of the phenomena is concerned. In the application of the spectral analysis to the temporal series, the problem can be solved by means of the processing of the tendency. Even though the concept of this component of the series of time is subject to a certain dose of abuse, we will suppose that it is another cycle, about which we only know the ascending or descendent section, whose period is greater than the size of the series. Thus, the free series of tendency is the one that will be approached by means of the spectral analysis.

We designated by (Yt) the free series of tendency. If (T) is the sample size, we can consider (T) coefficients and (T/2) spectral:

$$y_t = a_0 + \sum_{p=1}^{T/2-1}\left(a_p \cos p\nu_0 t + b_p \operatorname{sen} p\nu_0 t\right) + a_{T/2}\cos pt \qquad (10)$$

where (ω_0) represents the frequency, and ($a_{T/2}$) it is the coefficient corresponding to the higher frequency that we can consider, given the size of the series, known also as frequency of Nyquist.

The model can also be interpreted stochastically. We considered the first (k) harmonics individually and the remaining (T/2-k) are included in a single component considered an error and about which it is possible to postulate that it behaves as a random disturbance in the terms used in the econometric models:

$$y_t = a_0 + \sum_{p=1}^{k}\left(a_p \cos p\nu_0 t + b_p \operatorname{sen} p\nu_0 t\right) + e_t = C_t + e_t \qquad (11)$$

where (Ct) represents the determinist cyclical component and epsilon the random disturbance. Thus, the problem is reduced to the estimation of a model of multiple

regression with (a_0 a_p b_p, p=1..., T/2) coefficients and 2K explanatory variables (cos pw_{0t}), (sen pw_{0t}).

The spectral analysis allows the decomposition of the values of the series in orthogonal components, corresponding to the frequencies of Fourier. The value of the amplitude of the oscillation corresponding to the p^{nth} harmonic is given by

$$R_p = \pm\sqrt{a_p^2 + b_p^2} \tag{12}$$

the theorem of Parseval claims that the total variance of the series is distributed in (T/2) harmonics and decomposes it so that the contribution of the p^{nth} harmonic is given by ($R_p^2/2$):

$$\frac{1}{T}\sum \left(y_t - a_0\right)^2 = \sum_{p=1}^{T/2-1} \frac{R_p}{2} + a^2{}_{T/2} \tag{13}$$

being ($a^2T/2$) the contribution of the harmonic corresponding to the frequency π. The spectrum is a function of the frequency or period and is defined as:

$$I(p\nu_0) = I(\nu_p) = \frac{TR_p^2}{4p} \tag{14}$$

and in particular,

$$I(p) = \frac{Ta_{T/2}^2}{p} \tag{15}$$

we prove that:

$$\nu_0 . I(\nu_p) = \frac{2p}{T}\frac{TR_p^2}{4p} = \frac{R_p^2}{2} \tag{16}$$

so that the total area underneath the spectrum corresponds to the variance of the series. Therefore the peaks in spectrum indicate the periods or frequencies in which relevant regularities can exist, what must lead to the discovery of explanatory factors of the phenomenon.

A first step, therefore, in the method indicated, is the elimination of the tendency of the series of original data. This implies the application of the condition ceteris paribus that

formulates the theory in the analysis, since such tendency would measure approximately the displacement of the economic theory formulated in a static form [Álvarez Vázquez (1998)]. Thus, once the tendency has been eliminated, what we observe in the resulting series are the " empirical cycles " around the zero slope line. In that point, Álvarez points out, the quantitative analysis based on the " original series " or the empirical cycles is not suitable to measure the theories since the original series, as well as the empirical cycles, contain heterogeneous movements as far as the duration are concerned.

The analysis has to be based, according to this method, on the " theoretical cycles " of fixed and defined periods, that are obtained from the empirical cycle of each series by means of the decomposition based on the spectral analysis. This decomposition implies the introduction in the analysis of the formal hypothesis that economic cycles exist, that is to say, regular fluctuations, and it allows us to quantify the importance of the different periods observed in the evolution of the variable[12].

On the base of the postulates of the quantitative theory of money, the method described is applied to the historical series available of three European countries: Spain, France and Great Britain[13]. The period of analysis includes most of the capitalist stage of the economic development, in which Maddison (1986) differentiates five phases, which constitute the temporal frame defined to approach the measurement of quantitative theory of money[14]. They begin, in general, by some class of "shock of the system " which disturbs the patterns established, and they are identified, according to this author, by the great changes of tendency observed, consequence of the changes in the institutional policy. [Maddison (1995)].

The original series of the index of the cost of living and the amount of cash in France, for the period 1840-1913, appear in figure 1. In them, an increasing general tendency is observed, and from 1871 to 1895, a reduction in the index of the cost of living to the 1869 levels.

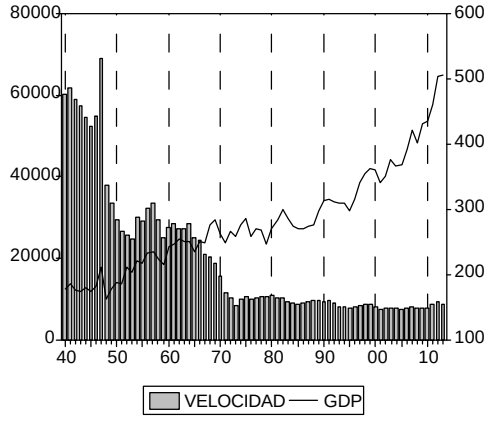

Figure 1: France: Cash and Cost of Living Index .
Source: Adaptation of MITCHELL (1992).

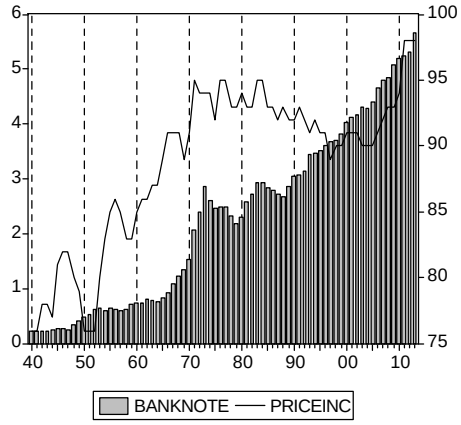

Figure 2: France Circulation Speed and GDP
Source: Adaptation of MITCHELL (1992).

Figure 2 shows the evolution, during this period, of the real GDP and of the speed of circulation of the money defined in this way. The high stability of this last variable from 1871 must be highlighted. On the other hand, and since there is no information available for some of the variables in the whole extension of the first phase, we will start the analysis of France and the rest of countries subject to this study, from the second phase, i.e. from 1871 to World War I.

The elimination of the tendency in the original series, which constitutes the first step of the method proposed, is made by means of the " method of the cord ". The result is the empirical cycles in figure 3. In the period analysed, the evolution of both series shows a clear similarity. However, heterogeneous movements as far as the duration are concerned can be observed. The difficulty to establish, on the basis of this evidence, the relationship between money and prices is based in this fact. The regression of prices on the amount of money, based on the empirical cycles, throws an estimation of the parameter based on these heterogeneous conditioned movements less important in the general evolution of the index of prices, that could correspond to " periods of transition " in the adjustment of the prices to the variations in the amount of money and, therefore, would lack interest in the analysis.

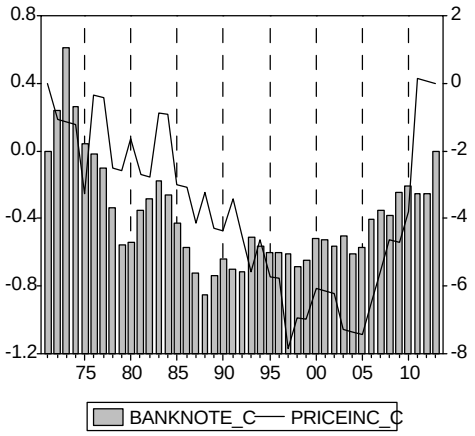

Figure 3: Empirical cycles 1871-1913

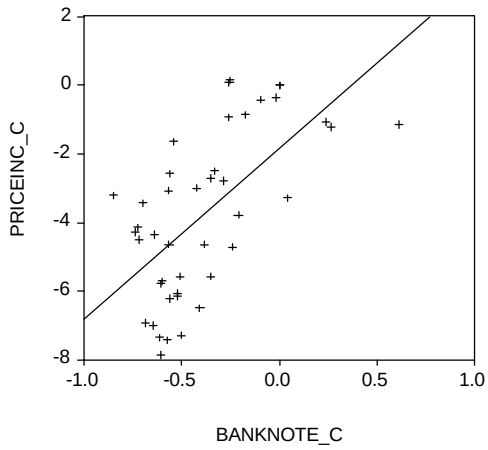

Figure 4: Atemporal Representation.

In the atemporal representation of figure 4, we observe the high dispersion existing around the regression line, as a result of the little degree of adjustment of the parameter considered in this way. Consequently, once the tendency of the original series has been eliminated and by means of the decomposition based on the spectral analysis, we obtain the theoretical cycles.

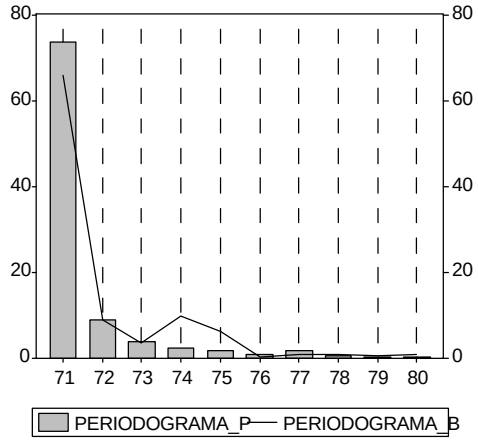

Figure 5: Spectrums of prices and amount of money.

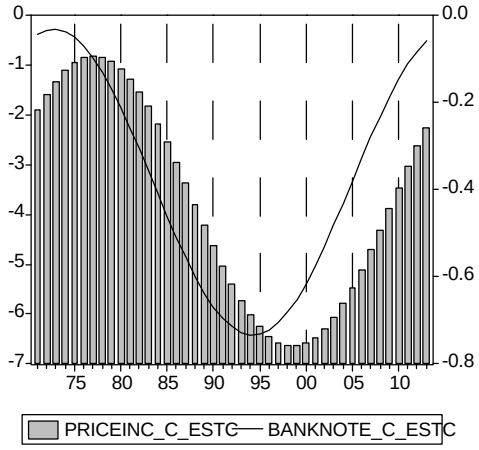

Figure 6: Theoretical cycles of prices and amount of money.

The spectrums of the series of money and prices are shown in figure 5.The 42-year cycles explain 74 % of the shifts in the prices and more than 66% of the shifts in the amounts. In these cycles, the spectrum shows " peaks " in both series and so, the regularities would have common amounts and prices, being this an indispensable requirement to be able to identify the relationship between the variables.

The relevant theoretical 42-year cycles are shown in figure 6. In them we can observe that the shift of money precede the shifts of prices, as it corresponds to the causality relation that formulates the theory. This is an explanation that contributes the use of this method to the analysis. From the theoretical cycles, and by means of obtaining the crossed coefficients of correlation, the dimension of the retardation in the effect of the variations in the amount of money on the prices is determined, which, , in this case, turns out to be three years.

In order to obtain the estimation of the elasticity prices-amount of money, the process is repeated again, applying the logarithmic transformation to the original series. The results obtained in the estimation on the parameters, starting off of the theoretical cycles of the variables in logarithm, are satisfactory. The elasticity prices-amount of money considered (1,10) has a value next to 1, and the elasticity prices-income is negative, as established by the theory. On the contrary, the results obtained in the estimation based on the original series, in logarithms, free or not of tendency, are not favourable to the postulates of the theory. This happens in the different phases analysed and also in Spain and Great Britain, what allows us to conclude that the estimation based on the theoretical cycles offers results closer to the theory, than those from the original series or from their empirical cycles.

The analysis of France in this phase has been made for the rest of the phases of the capitalist stage and also for Spain and Great Britain, considering, in addition to the definition of the amount of money by Wicksell, the alternative definition of the amount

that includes cash and current account deposits. The results obtained are summarised below, given the length of the detailed presentation.

The classic pattern-gold was the preponderant monetary system between the 1880 and the beginning of World War I, whose outbreak and development forced most of the countries to suspend its application. During the period in which it was in force, it offered a common solution to monetary problems of the period and provided a frame of exchange rates that, according to different authors (Martín Aceña, 1985, 280), contributed to the growth of international economy. From the analysis of France and Great Britain during most of the capitalist stage, we can conclude that the phase 1870 - 1913, in which the classic pattern-gold was effective, offers the most satisfactory results in the measurement of the quantitative theory of money of the whole period. In this phase, the variations in the amount of money showed a preference in time over the variations in prices, a condition necessary to be able to identify the causality relation that formulates this theory. Also, the elasticities considered are favourable to the postulates of the theory, in value as well as in sign.

The monetary system that was effective throughout most of the following phase, which includes the period 1914-1950, was the system of fiduciary pattern, and the analysis offers few conclusive results for both countries. The estimations of the parameters that measure the elasticity prices-amount of money in this phase, although favourable to the theory, mostly have values higher than 1, especially when cash is considered as a definition of the amount of money. In the last phase analysed, 1951 - 1973, few satisfactory results are obtained in both countries. The variations in the amount of cash do not seem to be the " next cause " that determines the general level of prices, and although M1 offers better estimations of the elasticity, it is not favourable to the postulates of the theory either.

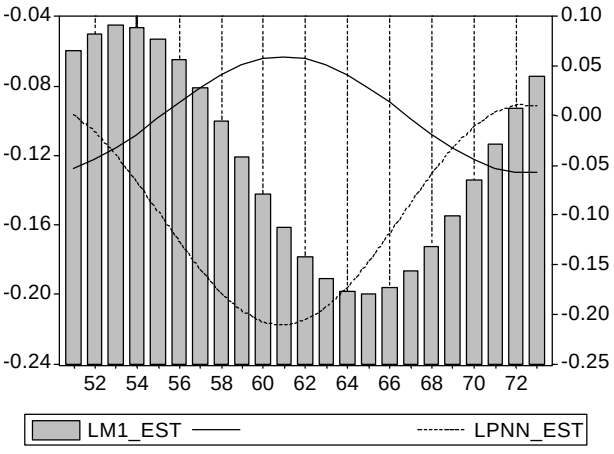

Figure 7: Spain: Theoretical 22-year cycles.

In Spain, the notes issued by the Bank of Spain could be converted in gold between 1876 and mid-1883, when the authorities suspended this convertibility, and the Spanish monetary system became a system of fiduciary pattern with a floating exchange rate. This fact caused, according to Martín Aceña (1985), the isolation of the economy of our country, as a result of the dissociation of the Spanish monetary system and the international monetary system. The results obtained in Spain during the capitalist stage are similar to the results obtained in France and Great Britain. However, the estimations of the elasticity prices-amount of money, are higher in Spain than in the rest of the countries .

Finally, it must be highlighted that the theoretical cycles resulting from the application of the spectral analysis present a clear correspondence with the facts. In figure 7, where the relevant cycles for the phase 1950-1973 are shown, we observe clearly reflected, in the evolution of the real PNN (LPNN EST), the boom of the Spanish economy, derived from the application of the 1959 Plan of Stabilisation and during all the stage of economic liberation that extended until 1973.

4. SUMMARY AND CONCLUSIONS

As for the validity of the method used to approach the measurement of the quantitative theory of money, note that the estimations of the parameters based on the theoretical cycles of fixed and defined periodicities that are obtained from the empirical cycle of each series by means of the decomposition based on the spectral analysis offer values much closer to those postulated by the theory than those obtained from the original series or from their empirical cycles. This is explained by the fact, already put forward by the neo-classic economists, that the quantitative theory of money is only valid in a state of equilibrium, not being, therefore, applicable to what Fisher called " periods of transition ". Apart from the limited applicability of the theory, this poses a serious problem, which Álvarez Vázquez (1998) explains saying that the concept of economic equilibrium is relevant in the methodological reasoning of econometry. If the economic theory is defined in terms of balance, this requirement must be fulfilled by the data on which the measurement relies.

The attempt to advance in the solution to this problem of econometry, which is implicit in the methodological proposal adopted in this study. The application of the spectral analysis to the scope of the economy allows to eliminate the heterogeneous movements in the variables that, on the base of this exposition, correspond to those states of imbalance or " periods of transition ". Summarising the previous argumentation, the data on amount of money, prices and rent, in the analysed periods and countries, allow to claim that the postulates of the quantitative theory of money correspond to the facts observed, within the limits already indicated.

On the base of previous exposition, it is possible to conclude that in the last years of the capitalist stage, the definitions of money formulated by the classic and neo-classic authors, are insufficient to approach the amount of money that circulates in an economy.

The estimations obtained for the elasticity prices-amount of money exceeds 1 in these phases. This fact suggests as a possible via to continue working the consideration of other ampler aggregates, in line with the postulates of modern economy. On the other hand, among the three countries analysed, France is the one that presents a greater stability throughout time in the speed of the circulation of the money, and it is the country that, in general, offers better results in the measurement of the theory. On this point, and considering the analysis made by phases, it must be emphasised that in all the cases, the periods with a greater stability in the speed of circulation offer more satisfactory results.

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[1] The restoration of pattern-gold in countries such as the U.S.A. and Great Britain, after World War I, is a clear example. The gold shortage that took place, caused a contraction of the monetary circulation, and this was decisive in the origin and dimensions of the Great Depression of the first decades of the century. According to Hayek, the benefits of the stabilisation of the value of money derive, essentially, from a generalised recognition of this fact.

[2] Schumpeter (1982 [1954]). Schumpeter claims that the history of economic analysis begins with a clear predominance of the real analysis that extends until the beginning of the 17thcentury. Aristotle and the scholastic doctors espoused him. Between 1600 and 1760, approximately, an interlude of predominance of the monetary analysis takes place. Becher, Boisguillebert and Quesnay are representative examples. This interlude finishes with the victory of real analysis that J. M. Keynes (1986 [1936]) dates in the controversy between Malthus and Ricardo, with the victory of the latter. Turgot and Adam Smith are outstanding examples of this predominance that extends over the 19th century. Other authors, such as López González (1996) propose the terms "monetary tradition" and "non-monetary tradition".

[3] Wicksell and Pigou are outstanding examples of the evolution of an economist from the faith in a model of exchange and the possibility of a " neutral money "to positions which assume that nothing can be said on economic processes, without talking about any particular behaviour behaviour of money.

[4] The contributions of Walras and the Austrian authors are some exceptions. Schumpeter (1982 [1954]).

[5] Mill in *Principles of Political Economy* (1848, 433) defined the exchange equation in detail:

"If we suppose that the amount of goods for sale and the times they are sold again are fixed, the value of money will depend on the quantity of money available and on the average times each coin is exchanged [...] Therefore, for a given amount of goods and a given number of transactions, the value of money is reversely proportional to the amount of products and thus, this is called speed of circulation of the former. And the amount of circulating money equals the value of all the goods sold divided by the figure that represents the speed of circulation.".

[6] In the appendixes of *Purchasing Power of Money* (1911).

[7] The current of opinion implies the idea of multiple levels of prices and prevailed in the *Treaty of money* de Keynes (1996 [1930]).

[8] The debate on this definition of the amount of money, was due to the fact that the noncirculating money had been excluded, that is to say, the liquid reserves of the banks and the money stored. To this, Kemmerer (Money and Credit Instruments..., 1907) adduced that it is of non significance, for the truth of the quantitative theory, whether the new money offered in exchange of merchandise is offered at once or slowly, or if it is not offered at all, as the money that does not circulate has speed zero.

[9] Until Pigou made his contributions to this subject, the concept of income speed was not identified clearly. However, Schumpeter (1982 [1954]) claims that it is not possible to do it, discrediting the economists of the period, who generally considered that the speed of circulation was constant, since several authors emphasised its dependency on the general situation of economy.

[10] The Cambridge school, although it reaches conclusions very similar to those from FISHER, , gives to its analysis a microeconomic approach. This school directs its attention to the variables that can be relevant to individual decisions on the demand of money for transactions, basically wealth and exchange rate. In order to arrive to the specific formulation of its model, it is supposed that wealth is proportional to the income and that the exchange rate is not too

relevant, getting the same mathematical expression than Fisher (Md/P=K.y). Nevertheless, this new approach allows to explain the process of adjustment of economy against variations in the amount of money. Supposing that income level is given by the balance of a 100% rate of employment, if the amount of money increases, people will find that their idle money is higher than desired, given the level of prices in force in the economy involved and they will try to remove the excess demanding any kind of goods. Since offer is fixed, the balance will be reached again when prices rise in the same proportion than money, so that, the real amounts are constant.

[11] Anderson, *Value of Money* (1917).

[12] The cyclical analysis, Maddison claims (1995), began with Clement Juglar (1856), who emphasised the regularity of economic activity. The previous authors had tended to interpret the interruptions of growth as fortuitous financial crises. In their analysis on the cycles, Juglar focused his attention on the monetary phenomena - expansions or contractions of the activity of the Central Bank, interest rates and prices. Later, the contributions to this subject have been numerous and outstanding.

[13] The data on the amount of money, prices and income used, have been taken from publications by Mitchell (1992) y Hernández Andreu (1996).

[14] Phases: 1820-1870, 1870-1913, 1913-1950, 1950-1973, and from 1973 onwards. Maddison (1995).