TThe Harvard Barometers: Did they allow for the Prediction of the Great Depression of 1929?

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ABSTRACT.
This paper reviews the possibility that the Harvard barometers would have been able to predict the Great Depression. Based on data from the ABC curves in August 1929, could the collapse of the stock market and the dramatic fall in economic activity have been predicted? It is now accepted that the Harvard barometers did not allow for the prediction of the crisis. This paper applies harmonic analysis, a well-known method at the time of the barometers, and a number of significance tests used at that historic moment. The Harvard barometers are broken down into sinusoid curves in order to check their forecast using the projection of these curves. The conclusion is: Harvard statisticians would have been able to predict the fall in speculation, as defined in curve A, but not the fall in business and money and credit conditions. Given this result, it is first questioned whether the detected regular fluctuations are an illusory effect of the composition of ABC curves, and second, whether it is useful to use such aggregate curves. It is concluded that, although aggregation does not have any predictive advantage, it is not the source of regularity.

KEYWORDS: Harvard barometers, Periodogram, Business Cycles Prediction.

JEL CODES: B23, C22, C43, E32.

1. THE STATE OF THE QUESTION.

Domínguez et al. (1988) state the account of Professor W.L. Crum, according to whom, in the summer of 1929, a statistician of the Harvard Economic Service "became alarmed when she noticed that the indexes indicated that a sharp downturn in economic activity was imminent" (p.595). From here on, these authors consider whether the Great Depression was predictable, especially based on the Harvard barometers, goods prices and the Irving Fisher stock market price indices, and a historic series of data. Using autoregressive vector models, they drew a negative conclusion.

This conclusion, according to which the Harvard barometers were not able to predict the crash of 1929, nor were statistical techniques of the time or indeed current methods, is accepted by the scientific community as an established truth. For example, Rötheli (2006) states: "The extent of misjudgement of the course of general business activity (i.e., industrial production) by prominent forecasting services was undeniable but, as Dominguez et al. (1988) document, the forecasting services cannot be faulted for remaining optimistic after the crash: even with the help of statistical methods of the 1980s and better data, the great depression could not have been forecast" (p.4).

The use of the ABC curves gives rise to further problems. Is it possible that the aggregation that produces them caused the unrealistic appearance of regularity? Álvarez et al. (2006) defend the correction based on the existence of regular fluctuations in the economic phenomena, which would not be the effect of the aggregation. At the same time, they maintain that it is futile to form curves based on aggregates: “no parece que tenga sentido agregar una curva ya agregada como el tipo de interés, en otra más agregada como las condiciones monetarias” [it does not seem to make sense to aggregate an already aggregated curve such as the interest rate, to another aggregated one such as the monetary conditions] (p.5).

In order to demonstrate this, they take the monetary conditions curve C, of the German Economic Institute, and compare it with the German interest rates. In fact, curve C contains the same medium and long fluctuations, and not all the short ones, meaning that aggregation does not create regularity, even though it does not offer any advantage.

This paper reviews this analysis for the Harvard barometers.

2. THE HARVARD CURVES.

The Harvard ABC curves are used in this paper. Fisher's indices are not used because their time frame is lesser.

As of 1919, on the basis of studies performed for the period prior to the First World War (1903-1914), the Harvard Economic Service (HES) generated and published three monthly curves or indices (or “barometers”) that should have described the state of the economy and allowed for the prediction of its future evolution. The basis used was not economic theory, rather empirical and inductive theory.

Each index was the result of a data cleaning process. The series that were selected were those thought to contain information about the evolution of the speculation, economic activity or money and credit. Seasonal movement was removed from each series. Then a selection of series was chosen that was thought to represent the cyclical movements and the percentage variance was calculated in relation to other interpreted series such as the long-term trend movement. An aggregate series was constructed reflecting the average evolution of the fluctuation of the entire group. The aggregate indices were displayed on one single chart and the relationship between the curves was studied.

Three curves were calculated using this process and their data can be consulted in Domínguez et al. (1988). Curve A, that would represent the speculation in which the cyclical series was the banking discount rate in New York and the prices of industrial companies' shares (a selection of 20 companies until September 1928, and 30 companies thereafter). In order to prove, in the case of the United States, the close relationship (validated for Germany by Álvarez et al. (2006)) between the Harvard curves' aggregate indices and the previously composed series that acted as their base, this paper considers the prices of the industrial companies' shares (dollars per share)[1] or ISP series.

The non-homogeneous business curve B in which, after various alterations, the cyclical series were bank credits and a price index of ten goods. The trend was reflected via the iron production series and the Trade Index.

The monetary curve C, in which the cycles were the interest rates applied to the commercial paper rates, and the trend of the interest rate average offered by the ten most important railway companies' bonds. In this case, the short term interest rates are taken into account: the series of commercial paper rates[2] or RCP interest rates series.

As a consequence, the HES maintained that the data series contained four movements: trend, cycle, seasonal variation and irregular movement. The explicit

[1] Source: NBER (details available at www.nber.org).

[2] Source: NBER.

procedure that was applied was the elimination of seasonal variation and of trends or non-recurring movement. In this way, the HES was hoping to obtain the empirical cycles. It is precisely this fact that allows us to apply the periodogram while only removing the series average.

The Economic Service studied the relationship between these three curves, as well as the distance between the highest and lowest values reached. A rise in curve C, accompanied by a fall in curve A, preceded the economic crisis. Between each one of these three movements, there would be a delay. In this way, they concluded what stage the economy was at and how it would evolve. However, the director of the HES, Warren Persons, later signalled that the observed relationship between the curves at the beginning of the 20's had been changing, primarily as a result of the interventions of the Federal Reserve. This fact forced the HES to introduce more interpretative and less mechanical analysis, reducing their own confidence in the predictive ability of the barometers.

In any case, the Harvard Barometers acquired an extensive scientific acceptance and had a great impact on businesses in the 20's. Similar data collection and handling systems were extended to European countries with a view to making predictions. However, their apparent incapacity to predict the start and the development of the Great Depression deprived the barometers of all appearance of veracity, which in turn led to their disappearance.

3. METHODOLOGY.

The method applied is harmonic analysis. The fundamental theoretical assumption is that regular movements exist that underlie and produce the observed changes. Therefore, it is assumed that the curves A, B and C may be broken down via the use of the periodogram. This means they collect empirical (observable) cycles, a product of removing the trend of the observed movements, and that these empirical cycles are separable in sinusoid functions.

Fourier's analysis had been employed by Moore (1914) as a method of estimating economic cycles. However, Persons, who had directed the development of the Harvard ABC curves, had a more empiricist vision of knowledge of the economic phenomena. Therefore, the ABC curves are an inductive attempt to establish the economic situation in the cycle and to be able to predict how it would develop. As this denied the existence of determinism in the economy, it assumed that the cycles are not regular, that they do not repeat the frequencies and that harmonic analysis is useless. In this sense, Crum (1923), another HES economist, criticised the regularity of the economic phenomena hypothesis. “We believe that the economic period should not be assumed constant” (p.24).

In conclusion, this paper is based on assumptions and applies procedures unrelated to the HES. However, it concerns methods that were well known at the time, to which a statistician of the Service could have routinely resorted.

Taking the data from January 1919 until August 1929 (128 months), the amplitudes may be calculated for each period, and, consequently, the contribution of each sinusoid to the variance of the variable to be explained. Subsequently, if there are relevant theoretical cycles, the sum of the significant theoretical cycles is checked to see whether it correctly predicts the subsequent movement of the curves from September 1929 until their end in November 1931 (The date on which the HES stopped calculating the curves). Criteria historically applied in August 1929 is used in order to determine the significance or relevance.

Formally, if f(t) is a periodic function, the values it takes are repeated at regular intervals of the independent variable t [f(t) = f(t + k·T)]. Consequently, the function may be broken down into harmonics and it is possible to estimate it with a reduced number of them.

$$f(t) = A + a1 \times \cos(t) + a2 \times \cos(2t) + \cdots + b1 \times sen(t) + b2 \times sen(2t) + \cdots$$

The simplest periodic function is the harmonic function with amplitude R, frequency w and phase F:

$$f(t) = R \times \cos(w \times t + F)$$

Where the size of the series is T = 2π / w.

Via the addition of various harmonics, a compound oscillation is obtained that may constitute a satisfactory approximation of the perceived economic phenomena (Alcaide et al. (1992)). If Y_t is a trend free series of size T, T coefficients and T/2 harmonics may be estimated:

$$Yt = a0 + \sum_{p=1}^{\frac{T}{2}-1} (ap \times \cos(p \times w_0 \times t) + bp \times sen(p \times w0 \times t) + a_{T/2} \times \cos(\pi \times t))$$

Where p is the order of the harmonic and $a_{T/2}$ is the coefficient corresponding to the highest frequency that we are able to estimate. By regression, the coefficients a_0, a_p, b_p, with the explanatory variables $\cos(p \cdot w_0 \cdot t)$ and $\sin(p \cdot w_0 \cdot t)$, may be estimated.

The square of the amplitude for one period is:

$$R^2 = a_p^2 + b_p^2$$

And it can be defined as an ordinate of the periodogram: $S = R^2 N$

Where *N* is the number of observations.

Greenstein (1935) used two contrasts in order to determine the relevance: Schuster (1906) and Fisher (August 1929). Schuster demands a minimum value of S in order to consider that a period is significant. S should be greater than or equal to the resulting value of the following expression.

$$P_s = e^{-S/\bar{S}} = 0.0 \quad 0$$

Where $\bar{S}$ is the average of S for Fourier's complete sequence.

Fisher proposed a more rigorous significance test than Schuster's. Defining m and *g* as:

$$m = \frac{N-2}{2}$$

$$g = \frac{R^2}{\sum R_i^2}$$

So P_g must not be greater than 0.05.

$$P_g = m(1-g)^{m-1}$$

From where the minimum value of S can be calculated so that the significance can be discovered.

4. RESULTS.

The periodograms of the ABC curves and the interest rate and industrial company share prices series are gathered below.

THE HARVARD CURVES PERIODOGRAMS.								
Curve A						Amplitudes		
Cosines	Coefficient	Sines	Coefficient	R^2	S	Rp	Contribution to the variance	%
x11	2.07	x21	-2.22	9.22	**1180.34**	3.04	0.60	60.45
x12	0.71	x22	-1.29	2.16	**276.99**	1.47	0.14	14.19
x13	0.31	x23	-0.60	0.46	58.69	0.68	0.03	3.01
x14	-0.20	x24	-0.42	0.21	27.10	0.46	0.01	1.39
x15	0.11	x25	-0.61	0.39	49.81	0.62	0.03	2.55
x16	0.16	x26	-0.54	0.32	40.82	0.56	0.02	2.09
x17	0.02	x27	-0.55	0.30	38.76	0.55	0.02	1.98
x18	0.01	x28	-0.52	0.27	34.50	0.52	0.02	1.77
x19	0.03	x29	-0.52	0.27	34.31	0.52	0.02	1.76
x110	-0.03	x210	-0.48	0.23	29.61	0.48	0.02	1.52
Curve B						Amplitudes		
Cosines	Coefficient	Sines	Coefficient	R^2	S	Rp	Contribution to the variance	%
x11	0.36	x21	-0.70	0.62	**79.35**	0.79	0.37	37.09
x12	0.23	x22	0.04	0.05	6.89	0.23	0.03	3.22
x13	-0.18	x23	0.18	0.06	8.06	0.25	0.04	3.77
x14	-0.56	x24	-0.39	0.46	**59.25**	0.68	0.28	27.69
x15	-0.05	x25	-0.35	0.12	15.97	0.35	0.07	7.47
x16	0.07	x26	-0.16	0.03	4.06	0.18	0.02	1.90
x17	0.14	x27	-0.18	0.05	6.61	0.23	0.03	3.09
x18	0.08	x28	0.00	0.01	0.83	0.08	0.00	0.39
x19	-0.03	x29	-0.04	0.00	0.37	0.05	0.00	0.17
x110	-0.02	x210	-0.14	0.02	2.68	0.14	0.01	1.25
x111	-0.08	x211	-0.20	0.05	6.09	0.22	0.03	2.85
x112	0.13	x212	-0.16	0.04	5.28	0.20	0.02	2.47
x113	0.00	x213	-0.06	0.00	0.47	0.06	0.00	0.22
x114	0.01	x214	-0.09	0.01	1.00	0.09	0.00	0.47
x115	0.08	x215	-0.05	0.01	1.09	0.09	0.01	0.51
x116	0.04	x216	-0.02	0.00	0.24	0.04	0.00	0.11
x117	0.09	x217	-0.06	0.01	1.47	0.11	0.01	0.69
x118	0.11	x218	-0.07	0.02	2.22	0.13	0.01	1.04
Curve C						Amplitudes		
Cosines	Coefficient	Sines	Coefficient	R^2	S	Rp	Contribution to the variance	%
x11	0.83	x21	0.70	1.19	**152.19**	1.09	0.65	65.48

x12	0.03	x22	0.29	0.08	10.68	0.29	0.05	4.59
x13	-0.13	x23	0.00	0.02	2.24	0.13	0.01	0.96
x14	0.00	x24	-0.61	0.37	**47.95**	0.61	0.21	20.63
x15	0.13	x25	-0.13	0.03	4.30	0.18	0.02	1.85
x16	0.01	x26	-0.23	0.05	6.51	0.23	0.03	2.80

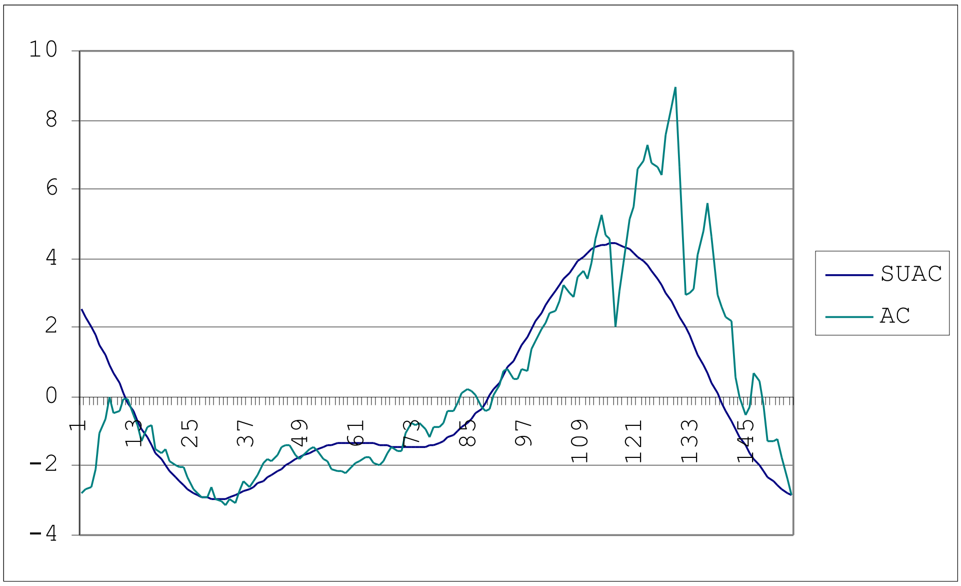
REFERENCE SERIES PERIODOGRAMS								
RCP (Interest rates)						Amplitudes		
Cosines	Coefficient	Sines	Coefficient	R^2	S	Rp	Contribution to the variance	%
x11	0.85	x21	1.05	1.84	**235.81**	1.36	0.64	64.49
x12	-0.14	x22	0.43	0.20	25.86	0.45	0.07	7.07
x13	-0.33	x23	-0.02	0.11	14.05	0.33	0.04	3.84
x14	0.04	x24	-0.75	0.57	**72.79**	0.75	0.20	19.91
x15	0.21	x25	-0.05	0.05	6.18	0.22	0.02	1.69
x16	0.03	x26	-0.13	0.02	2.23	0.13	0.01	0.61
x17	-0.01	x27	0.10	0.01	1.32	0.10	0.00	0.36
x18	0.04	x28	0.03	0.00	0.35	0.05	0.00	0.10
x19	-0.04	x29	0.03	0.00	0.26	0.05	0.00	0.07
x110	0.05	x210	-0.03	0.00	0.47	0.06	0.00	0.13
ISP (Industrial companies' shares prices)						Amplitudes		
Cosines	Coefficient	Sines	Coefficient	R^2	S	Rp	Contribution to the variance	%
x11	43.74	x21	-53.15	4737.58	**606409.9**	68.83	0.54	54.26
x12	19.32	x22	-27.77	1144.39	**146481.9**	33.83	0.13	13.11
x13	17.29	x23	-19.66	685.33	87721.94	26.18	0.08	7.85
x14	0.55	x24	-18.31	335.46	42939.27	18.32	0.04	3.84
x15	4.37	x25	-16.81	301.86	38637.59	17.37	0.03	3.46
x16	4.5	x26	-15.52	261.09	33420.08	16.16	0.03	2.99
x17	0.77	x27	-13.89	193.49	24767.18	13.91	0.02	2.22
x18	0.6	x28	-12.15	147.97	18939.54	12.16	0.02	1.69
x19	0.39	x29	-10.56	111.61	14286.1	10.56	0.01	1.28
x110	0.48	x210	-7.74	60.11	7693.68	7.75	0.01	0.69

The significant values, according to the criteria presented by Schuster and Fisher, are highlighted in bold.

It is observed that two periods are significant for each of the series.

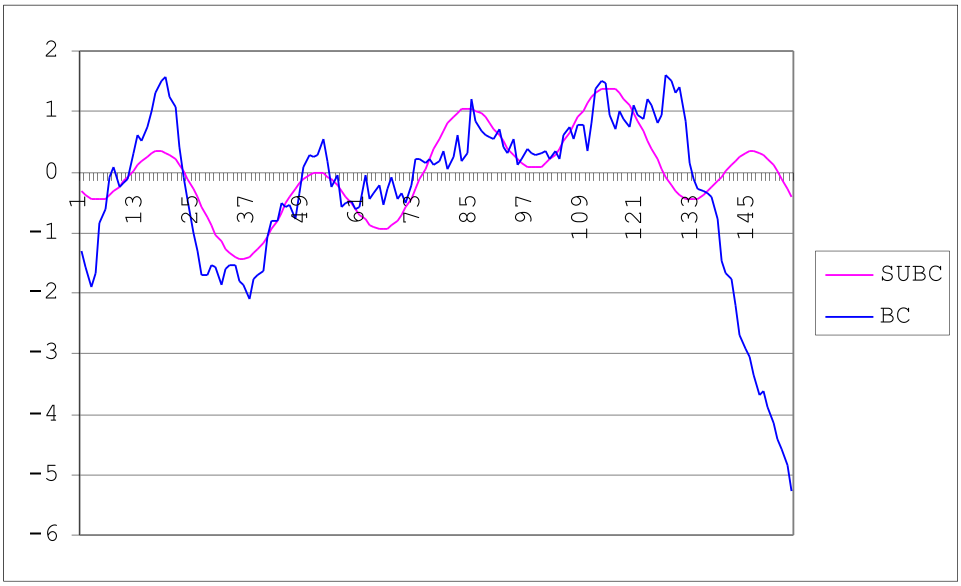
- In the curves A and ISPC, the theoretical movements of a 128 month period (frequency 1), and of a 64 month period (frequency 2) are significant. Between the two, they explain 75% of the variation in the A series and 67% in the ISPC series.
- In the curves B, C and RCP, the significant regular fluctuations have a period of 128 and 32 months. The sum of the two theoretical series explains 65%, 86% and 84% of the variance respectively.

In September 1929, using the data derived from the ABC curves until August, could an adequate prediction have been made about what was going to occur? It is possible to respond to this question by comparing the original series with the extrapolation of the relevant theoretical fluctuations. Letting speculation A series, from which the average has been subtracted, be known as AC, and the sum of the relevant theoretical cycles (128 and 64 months) be known as SUAC.



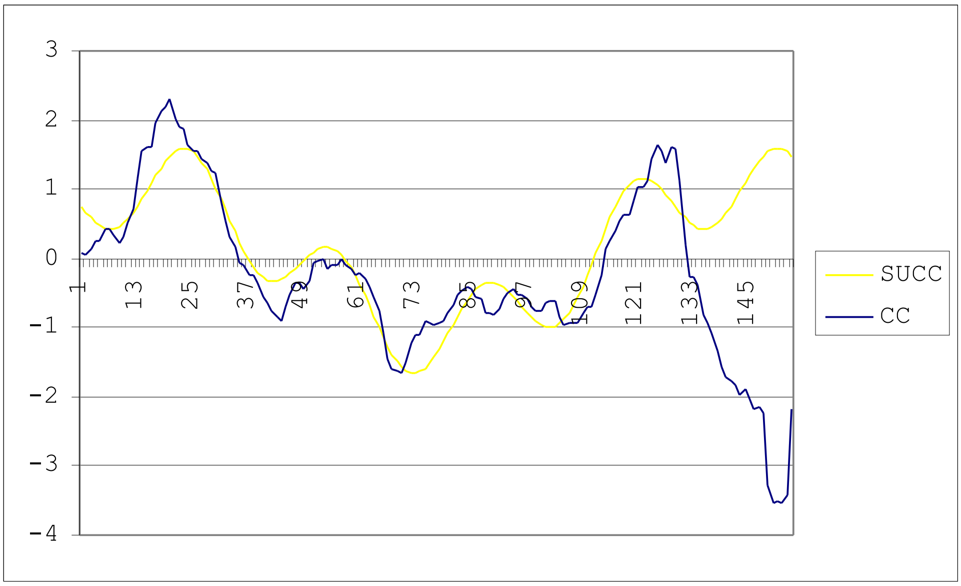
The theoretical cycles moved away from the data series during 1919, which may be explained by the fact that it was the immediate post-war period. In any case, the prediction is reasonable and, therefore, in September 1929, the sudden and sharp fall of speculation could have been predicted based on the data derived from curve A and the use of the periodogram.

The following graph depicts the business curve B and the theoretical adjustment by theoretical cycles (128 and 32 months).



During the 20's, the curve became well-adjusted to the data, following upturns and downturns in business and seeming to announce the crisis in 1929. However the prediction is clearly incorrect. The fall in the theoretical curve is much less severe and shorter than the drop in the real series.

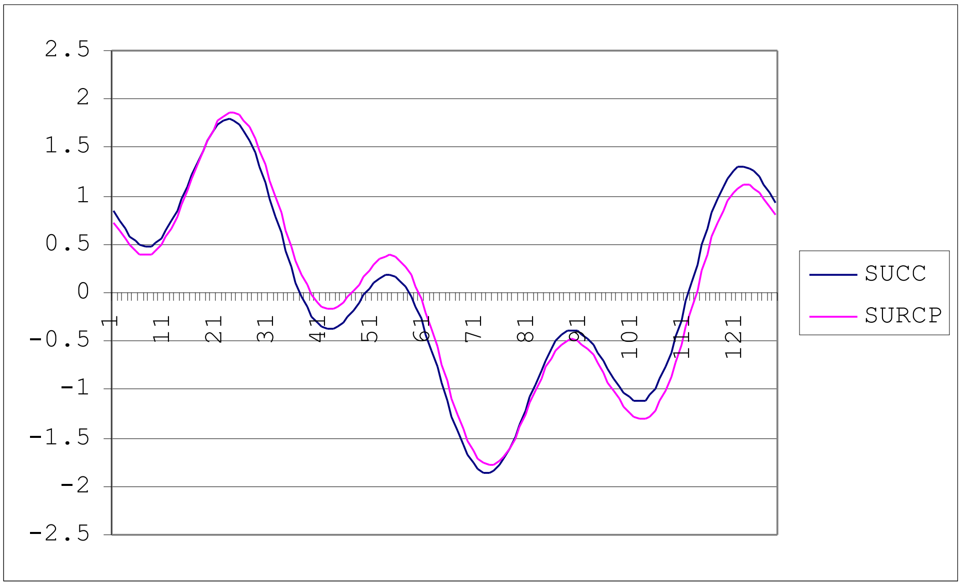
The third case is the monetary conditions curve C, for which theoretical cycles of 128 and 32 months are used.

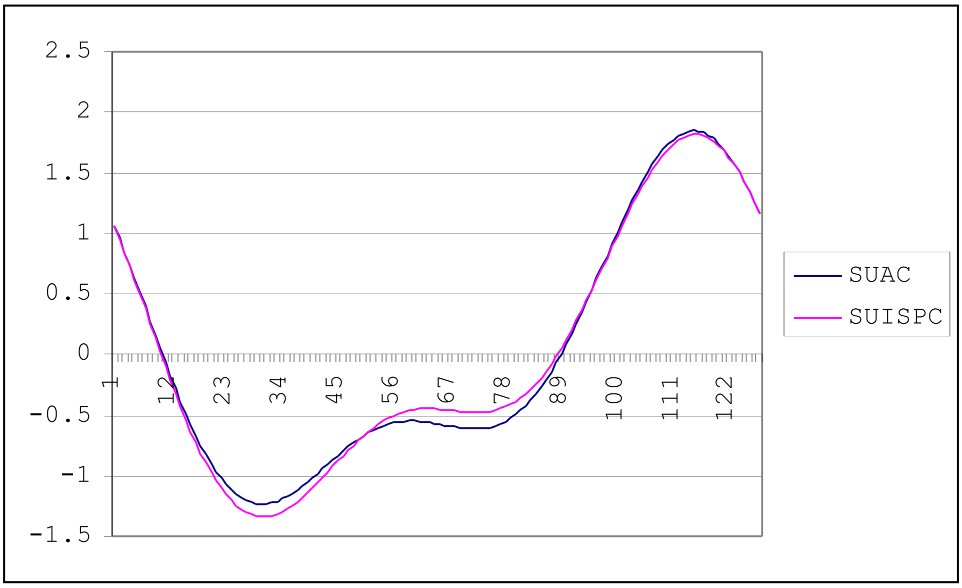


As with curve B, the initial adjustment is good and the theoretical movement announces a fall prior to event, in this case from February 1929. However, it does not predict the decline in monetary conditions that would occur.

Consequently, the prediction would be true for curve A, but not for the curves B and C.

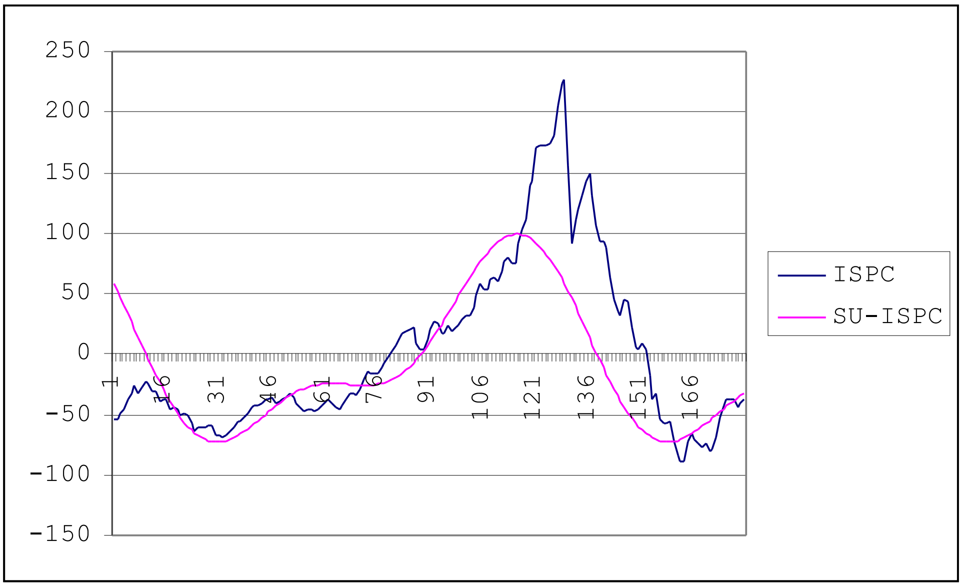
The Harvard curves do however closely reflect the movements of the series from which they originate. This fact is confirmed in the two cases in question. Firstly, the monetary conditions curve C and the interest rate RCP series are broken down into two relevant theoretical cycles of the same frequency, meaning that they alone account for 85% of the observable variation. The differences between both series refer to the relative importance of other fluctuations whose impact on the total variance is small. The joint evolution of the sum of the two relevant theoretical cycles (SUCC and SURCP) of both series is observed graphically in standard values. Secondly, the A and ISP series also contain equivalent regular theoretical movements, as observed in the evolution of the addition of the two theoretical cycles that may be considered significant (SUAC and SUISPC). The differences between both are centred around the contribution to the variance of medium and long period fluctuations.





Therefore, it is necessary to conclude with Álvarez et al. (2006), firstly, that aggregation is not the source of the observed regularity. Also, that “la agregación en barómetros, como la curva C, no añade nada a la consideración de las curvas individuales como los tipos de interés” [the aggregation in barometers, such as curve C, does not add anything to the consideration of the individual curves such as interest rates] (p.5).

Finally, bearing in mind the data from January 1919 to December 1933, and making the prediction in September 1929, the harmonic analysis of the industrial companies' shares prices series could have allowed for the prediction of both the sharp fall in prices (which began nine months after the prediction), and the upward recovery (four months later).



5. CONCLUSIONS.

The application of the harmonic analysis to the Harvard A, B, and C curves in August 1929 would not have allowed for the prediction of the economic Depression that was approaching, but it would have allowed for the forecasting of the collapse in speculation. In effect, in the case of speculation Curve A, the analysis announced a sharp fall, which, indeed occurred to the extent predicted. On the other hand, the theoretical cycles of curves B and C predicted a small and temporary decrease compared to the actual fall that was sharp and much more intense. In this sense, this paper does not fully confirm the thesis of Domínguez et al. (1988), in that the HES, using a procedure whose validity they had previously denied, but which was well-known at the time, could indeed have predicted the dramatic fall in stock market prices.

Likewise, in the case of the Harvard barometers, this paper confirms the thesis of Álvarez et al. (2006) according to which aggregation does not create regularities. However it is doubtful whether there is any use in aggregating from already aggregated indices.

6. BIBLIOGRAPHY.

ALCAIDE INCHAUSTI, A. and ÁLVAREZ VÁZQUEZ, N. J. (1992), *Econometría. Modelos Deterministas y Estocásticos. Teoría*, Madrid, Ramón Areces.

ÁLVAREZ VÁZQUEZ, N. J., MATILLA GARCÍA, M., PÉREZ PASCUAL, P.A., and RODRÍGUEZ RUÍZ, J. (2006), "Una Revisión de los Barómetros de Harvard," *Rect@*, Minutes_14-1-32.

BERRIDGE, W. A., PERSONS, W. M. and SILBERLING, N. J. (1922), "An Index of British Conditions, 1903-1914", *The Review of Economic Statistics*, Vol. 4, No. 2, pp. 157-175.

BULLOCK, C. J., PERSONS, W. M. and CRUM, W.L. (1927), "The Construction and Interpretation of the Harvard Index of Business Conditions", *The Review of Economic Statistics and Supplements*. Vol. 9, No. 2, pp. 74-92.

BURNS, E. M. (1929), "Statistics and Economic Forecasting", *Journal of the American Statistical Association,* Vol. 24, No. 166, pp. 152-163.

CARMICHAEL, F. L. (1928), "The Arc Tangent in Trend Determination", *Journal of the American Statistical Association*, Vol. 23, No. 163, pp. 253-262.

COMMONS, J. R., MCCRACKEN, H. L. and ZEUCH, W. S. (1922), "Secular Trends and Business Cycles: A Classification of Theories", *The Review of Economic Statistics*, Vol. 4, No. 4, pp. 244-263.

COPELAND, M. T. (1915), "Statistical Indices of Business Conditions", The Quarterly Journal of Economics, Vol. 29, No. 3, pp. 522-562.

CRUM, W. L. (1922), "The Determination of Secular Trend", *Journal of the American Statistical Association,* Vol. 18, No. 138, pp. 210-215.

CRUM, W. L. (1923), "Cycles of Rates on Commercial Paper", *The Review of Economic Statistics and Supplements*, Vol. 5, pp. 17-27.

CRUM, W. L. (1924), "The Pre War Indexes of General Business Conditions", *The Review of Economic Statistics*, Vol. 6, No. 1, pp. 16-21.

CRUM, W. L. (1925), "Progressive Variation in Seasonality", *Journal of the American Statistical Association,* Vol. 20, No. 149, pp. 48-64.

DAY, E. E. (1928), "The Role of Statistics in Business Forecasting", *Journal of the American Statistical Association,* Vol. 23, No. 161, pp. 1-9.

DOMÍNGUEZ, K.M., FAIR, R.C. and SHAPIRO, M.D. (1988), "Forecasting the Depression: Harvard versus Yale," *The American Economic Review*, Vol. 78, No. 4, pp. 595-612.

FAVERO, G. (2007), "Weather Forecast or Rain-Dance?. On Inter-War Business Barometers", Department of Economics, Ca' Foscari University of Venice, Working Paper 14/wp/2007.

FISHER, R.A. (1929), "Tests of Significance in Harmonic Analysis", *Proceedings of the Royal Society of London*, Series A, Vol. 125, pp. 54-59.

GREENSTEIN, B. (1935), "Periodogram Analysis with Special Application to Business Failures in the United States, 1867-1932", *Econometrica*, Vol. 3, No. 2, pp. 170-198.

HART, A. G. (1937), "Failure and Fulfilment of Expectations in Business Fluctuations", Review of Economic Statistics, Vol. 19, No. 2, pp. 69-78.

HAUTCOEUR, P.-C. (2006), "Why and how to measure stock market fluctuations?. The early history of stock market indices, with special reference to the French case", Paris-Jourdan Sciences Economiques, Working Paper 2006-10.

JONES, J. H. (1928), "Business Forecasting", *Economic Journal*, Vol. 38, No. 1, pp. 414-25.

KITCHIN, J. (1923), "Cycles and Trends in Economic Factors", *The Review of* Economic Statistics, Vol. 5, No. 1, pp. 10-16.

KLUG, A., LANDON-LANE, J. S. and WHITE, E. N. (2005), "How could everyone have been so wrong?. Forecasting the Great Depression with the railroads", *Explorations in Economic History*, Vol. 42, No. 1, pp. 27-55.

MILLER, H. E. (1924), "Earlier theories of Crises and Cycles in the United States", *The Quarterly Journal Economics*, Vol. 38, No. 2, pp. 294-329.

MILLS, F. C. (1926), "An Hypothesis Concerning the Duration of Business Cycles", Journal of the American Statistical Association, Vol. 21, No. 156, pp. 447-453.

MITCHELL, W. C. (1910), "The Rationality of Economic Activity", Journal of *Political Economy*, Vol. 18, No. 3, pp. 197-216.

MITCHELL, W. C. (1923), "Business Cycles", in Committee of the President's Conference on Unemployment and NBER (eds.), *Business Cycles and Unemployment*, pp. 7-20.

MOORE, H. L. (1914), *Economic Cycles: Their Law and Cause*, New York, The MacMillan Company.

MOORE, H. L. (1921), "Generating Cycles of Products and Prices", *The Quarterly Journal Economics*, Vol. 35, No. 2, pp. 215-239.

PERSONS, W. M. (1922a), *Interpretation of the General Index of Business Conditions*, Harvard Economic Service, Cambridge, Massachusetts.

PERSONS, W. M. (1922b), *Measuring and Forecasting General Business Conditions*, Boston, American Institute of Finance.

PERSONS, W. M. (1926), "Theories of Business Fluctuations", *Quarterly Journal of Economics*, Vol. 41, No. 1, pp. 94-128.

PERSONS, W. M. (1927), "An Index of General Conditions, 1875-1913", *The Review of Economic Statistics*, Vol. 9, No. 1, pp. 20-29.

PERSONS, W. M. (1928), “Pigou, Industrial Fluctuations”, *Quarterly Journal of Economics*, Vol. 42, No. 4, pp. 669-677.

PERSONS, W. M. (1930), “The Recession of 1929-1930 in the United States”, *Bulletin de l'Institut International de Statistique*, Vol. 25, No. 3, pp. 479-489.

RITSCHL, A. and STRAUMANN, T. (2009), “Business cycles and economic policy, 1914 – 1945: A survey,” London School of Economics, Economic History Department Working Paper 115/09.

ROOS, C. F. (1955), “Survey of Economic Forecasting Techniques: A Survey Article”, *Econometrica*, Vol. 23, No. 4, pp 363-395.

RÖTHELI, T.F. (2006), “Business Forecasting and the Development of Business Cycle Theory”, History of Political Economy, Vol. 39, No. 3, pp. 481-510.

SCHUSTER, A. (1906), “On the Periodicities of Sunspots”, *Philosophical Transactions of the Royal Society of London*, Series A, CCVI.

SILBERLING, N. J. (1923), “British Prices and Business Cycles”, *The Review of Economic Statistics*, V, Supplement No. 2, pp. 223-247.

SMITH, B. B. (1931), “A Forecasting Index for Business”, *Journal of the American Statistical Association*, Vol. 26, No. 174, pp. 115-127.

SLICHTER, S. H. (1937), “The Period 1919-1936 in the United States: Its Significance For Business-Cycle Theory”, *Review of Economic Statistics*, Vol. 19, No. 1, pp. 6-9.

WRIGHT, P. G. (1915), “Moore´s Economic Cycles (a review)”, *The Quarterly Journal of Economics*, Vol. 29, No. 3, pp. 631-641.