

A periodization of the business cycles in the Brazilian economy, 1856-1985*

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The paper presents some coherence analyses to show that Brazilian economic time series are reasonably correlated in business cycle frequencies. It also gives a business cycle periodization for the period 1856-1985, which recognizes three types of cycles: Kitchin, Juglar and Kuznets cycles. In addition, the paper contrasts the cycles found with cycles previously identified in the literature.

1. Introduction; 2. Coherence analysis of some economic time series; 3. An index to identify the Brazilian Business Cycles; 4. Major types of Business Cycles; 5. Spectral identification of the cycles; 6. Periodization of the Brazilian Business Cycles; 7. Comparing our cycles periodization with previous cycles identifications in the literature; 8. Conclusion.

1. Introduction

As in other countries cyclical fluctuations are also present in the Brazilian economy. This idea has not been challenged in the literature on Brazilian long-term growth, but most of these cycles have been attributed to occasional shocks. Many of these are external shocks, such as the fall in coffee prices at the end of last century and the beginning of this one, or oil shocks, as those in the seventies. There are also some shocks generated internally, however, as the Paraguayan War and the Proclamation of the Republic (Contador & Haddad, 1975) in the last century, and inflation and political disruptions in the sixties. These ideas are in line with those presented by Blanchard and Watson (1986) for the United States, when they argue that there is possibly no such things as

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business cycles which can be identified with an intrinsic tendency to periodical fluctuations in the economy. In looking at the Brazilian literature, one is sometimes led to think that the Brazilian economy would not present business cycles were it not for exogenous shocks which force income growth fluctuations. All those fluctuations in income growth are attributed to some shocks that are perfectly identifiable in most of the cases and are not a consequence of the intrinsic development of the country, but are rather fortuitous.¹

In this paper, I started from the largely accepted idea that business cycles are a consequence of the accumulation of small shocks in a dynamic system. No further attempt to test statistically these two alternative hypotheses will be made. I shall simply use what is more widely accepted in theory, disregarding what is implicit in studies of the Brazilian history. Therefore, I shall only present a tentative periodization of cyclical fluctuations, without attempting to associate each cycle to particular phenomena, which could be interpreted as shocks responsible for the specific fluctuation. Nevertheless, after the presentation of a cyclical periodization, the relation of the cycles found with suggestions from the literature on the Brazilian economy will be studied. In this case, some cycles will be linked to periods when particular phenomena occurred, such as the so called Encilhamento and the oil shock. A causal relation will not be identified, although they are common in the literature.

The concept of business cycles does not refer only to fluctuations in domestic product or income. It also recognizes the existence of common fluctuations in many economic variables. The fluctuations in themselves are regarded as having different amplitudes and frequencies, making the identification of cycles difficult (Sargent, 1978, ch. 11; Zarnowitz & Moore, 1986; Zarnowitz, 1985). As a first approach to show the existence of business cycles and the existence of common fluctuations of many economic variables, coherence functions for these variables will be estimated. Of course, only a restricted set of variables will be used. The criteria to choose them will be relevance and availability. Two periods will be taken in this first step: from 1856 to 1939 and 1920 to 1985. The main reason for this cut is data availability.

The Brazilian domestic product is only available after 1920. As this is the most important variable for business cycles, it will be used as a parameter in the second period. Hence, all estimated coherence functions will be of other variables with respect to GDP. Since this series is not available for the first period and only few available series for this period are relevant, all possible

¹ Villela & Suzigan (1973), Suzigan (1986), Baer (1989) and Leff (1982) are examples of historical presentations of the Brazilian economy in which this particular feature of the fluctuations are present, while Contador (1977) is an important exception.

coherence functions will be estimated. Section 2 of this paper brings the analysis of these coherence functions.

It is usually accepted that series with quarterly or monthly frequencies are necessary for a cyclical periodization (Zarnowitz & Moore, 1986). Since there are cycles which are very short, sometimes of around two years, the need for high frequencies data is obvious. Sometimes qualitative information is used to help a cyclical periodization, as was done by Burns & Mitchell (1946) for the United States. Unfortunately, only yearly data is available for long Brazilian time series. So, yearly data is used in estimations here.

Distinct time series behave differently in time. Therefore, if one tries to identify the cycles based on any one of them separately, distinct cycles periodization will be obtained. Since the concept of business cycles is mainly related to movements in real GDP, this is the most reasonable series to be selected. Another option, which could more appropriately reflect the idea of co-movements in time series, is to obtain a series which is a linear combination of a set of other relevant series. The periodization of the cycles could be based on the behavior of this created series.

A principal component analysis is a method which could create this series. Using this method one can obtain the linear combination which could maximize the explanation of the movements in all series included. This maximum variance apprehension by the first principal component shows the common movement of all the series. The use of this series to identify business cycles is intuitively appealing, since cyclical fluctuations are present in this co-movement of all the series. A principal component analysis is used in section 3 to create a series which enables the identification of the cycles of the Brazilian economy. This analysis is divided in three periods, but contrary to the coherence analysis of section 2, no intersection will be allowed. Periods cover 1856-88, 1889-1920 and 1921-85, respectively. Data availability again was the driving force for this split.

Section 4 presents the major types of business cycles identified in the literature, emphasizing some of their major features. In section 5, the spectrum of the series created in section 3 is presented and some simple tests for the concentration of variance on the frequencies associated with the types of business cycles discussed in section 4 are shown. The presentation of the periodization of the business cycles of the Brazilian economy is on section 6, and some comparisons with alternative cycles identifications found in the literature are made in section 7. Section 8 brings the main conclusions. A more detailed description of the data and their sources is in the appendix.

2. Coherence analysis of some economic time series

A coherence function can be interpreted as the square of the correlation coefficient at the particular frequency.² The interest of using it instead of a coefficient of correlation is that it can show the differences of correlation at distinct frequencies. Since business cycles are usually associated with specific frequencies, one should expect that those variables which present a cyclical behavior might have a high correlation at these frequencies. This section aims to show that this is the case for some relevant economic variables, for which there was data availability. It also shows that the series which will be used in the principal component analysis of the next section are correlated in the relevant frequencies for business cycles determination.

The analysis in this section divided the period 1856-1985 in two parts, namely from 1856 to 1920 and from 1921 to 1985. The series used for the first period were exports, capital goods imports for the industry, total imports and real money supply (M1). Imports were divided in two parts only to strengthen the evidence on the correlation of time series in the frequencies associated with business cycles. This procedure was changed in the next section, however, to avoid overweight of imports in the principal component analysis, since capital imports and total imports are highly correlated. All possible coherences were estimated for this period. The four variables used gave six estimated coherence functions. For the second period the variables used were real GDP, real industrial output, real agricultural output, real money supply (M1), real exports, real imports and central government taxes. These seven variables would give 21 coherence functions, if all possibilities were estimated. In this case, only the coherences of the variables with real GDP were estimated. Natural logarithms and first differences were taken of all the variables before estimations. These aimed at achieving stationarity. No loss of information will be incurred because of the elimination of the zero frequency, as a consequence of this transformation, since the zero frequency is not relevant for the analysis of business cycles.

The estimated coherence functions were not reported to avoid the excess of unnecessary material. Tables 1 and 2 present the average of the estimated coherences for specific frequency ranges. From the analysis of these tables one can see that the correlations at the frequency range reported are reasonable, showing that there is some common movement of these series. Another important result is that when the high frequency corresponding to periodicity less than three years are excluded, the estimated correlation increases for all pairs.

In table 1, where more frequencies are available because longer series were used, one can see that, in general, when the frequency range was restricted such

² See Granger & Newbold (1986, p. 60).

that the periodicity of the cycles contained in this range approximate more closely the range accepted as relevant for business cycles (3-21 years in table 1), the estimated average coherences show high values. This attests to the

Table 1
Average for specified ranges of estimated coherences for some Brazilian economic time series, 1856-1939

Frequency range	K&X	K&M1	K&M	X&M1	X&M	M&M1
2 - 42	0.422270	0.562317	0.640681	0.479907	0.638562	0.579686
3 - 42	0.531599	0.591675	0.793286	0.493083	0.698480	0.659502
4 - 42	0.522997	0.650468	0.822094	0.430868	0.666025	0.689416
5 - 42	0.583815	0.707125	0.843523	0.383646	0.657698	0.717119
3 - 28	0.538677	0.602511	0.803157	0.499658	0.716243	0.672739
4 - 28	0.532230	0.668390	0.837118	0.436591	0.688625	0.709104
5 - 28	0.600689	0.735495	0.865453	0.388039	0.687775	0.745817
3 - 21	0.534288	0.602380	0.801161	0.508964	0.721730	0.670666
4 - 21	0.525776	0.671868	0.836233	0.446012	0.694711	0.708246
5 - 21	0.597020	0.745472	0.866407	0.397349	0.696136	0.747453
3 - 16	0.527437	0.597266	0.795966	0.511406	0.725798	0.663738
4 - 16	0.515603	0.668737	0.830962	0.445757	0.698865	0.700675
5 - 16	0.588545	0.747170	0.861454	0.392931	0.702140	0.739995

Note: In this table K is imports of capital goods to the industry. X and M are exports and imports, respectively. M1 represents the real money supply. A window with width equal to seven years was used. Frequencies were transformed to calendar time, with year as the unit. Estimations were made using Rats.

validity of the hypothesis that the series are reasonably correlated in the business cycle frequency range.

The tendency of economic time series to be closely related in low frequencies can also be seen in these tables. Most of the peaks in the presented averages have five years as higher frequency. An interesting fact, however, is that the lower frequencies were generally excluded. Most of the coherence peaks at frequency ranges around 5-28, 5-21 or 5-16. The high presence of these two last ranges in the peaks indicates the importance of business cycles frequencies

Table 2
Average for specified ranges of estimated coherences for some Brazilian economic time series, 1920-85

Frequency range	Y & A	Y & I	Y & X	Y & M	Y & M1	Y & T
2 - 32.50	0.4104	0.4643	0.4690	0.5018	0.6136	0.6017
3 - 32.50	0.4321	0.4806	0.4868	0.4945	0.7556	0.7419
4 - 32.50	0.4237	0.5679	0.5927	0.5368	0.7621	0.7475
4 - 16.25	0.4139	0.5665	0.5954	0.5570	0.7444	0.7285
5 - 16.25	0.4592	0.6683	0.6297	0.6264	0.8074	0.7941
3 - 16.25	0.4259	0.4699	0.4769	0.5045	0.7420	0.7275
5 - 21.67	0.4613	0.6635	0.6294	0.6073	0.8166	0.8040

Note: In addition to the variables already defined for table 1, A, I and T were included in this table representing agricultural product, industrial product and central government taxes, respectively. A window with width equal to 7 years was used. Frequencies were transformed to calendar time, with year as the unit. Estimations were made using Rats.

to co-movements of Brazilian time series, especially of frequencies associated with Juglar and Kuznets or Building Cycles (see section 4 for these definitions).

The higher correlation of economic time series at lower frequencies is easily seen in table 2. By fixing the lower frequency bound at 32.5 or at 16.25 and moving the higher frequency bound towards lower frequencies (from 3 to 4, for example), most of the averages increase. The reasonability of correlations at frequency ranges associated with business cycles is also clearly indicated by the coherences in this table. In what concerns the business cycles frequencies, it can be noted that the highest averages of the estimated coherences presented in table 2 are for the range 5-21.67, which is in the last row of the table.

3. An index to identify the Brazilian Business Cycles

As already said, it is normally accepted that a periodization of business cycles should be based on data with a frequency higher than yearly. If possible, monthly or at least quarterly data should be used. However, these frequencies of data are not available for most relevant Brazilian time series for sufficiently long periods. Therefore, I have to use yearly data, although by doing this I am not trying to challenge the commonly accepted frequency requirements. A more accurate periodization could be achieved with an extensive use of

qualitative information, possible to be obtained from publications of the period covered and other historical sources. This is beyond the scope of this research, however.

The method adopted for cyclical periodization was to gather data on relevant variables for the period of interest, to make a principal component analysis of this time series and to make a visual determination of the business cycles. The period covered extends from 1856 to 1985 and was divided in three parts because of data availability: 1856-88, 1889-1920 and 1921-85. The series used for the first period were exports, imports and real money supply (M1).³ For the second period, Central Government taxes were added to the three of the first period. The third period included GDP, domestic agricultural product, domestic industrial product, exports, imports, real money supply (M1), and Central Government taxes.

First difference of natural logarithms of all the series were used in the principal component analysis. The reason for this transformation is to simulate the rate of growth and to eliminate the zero frequency in the spectra of these series. Business cycles are associated with frequencies higher than the zero one (which determines the trend of the series) and lower than those associated with one year or less nuisances. This second set of frequencies which are left out of business cycles analysis could not be eliminated from the series by filter methods because of the periodicity of the data available.

A principal component analysis, with the retention of only the first principal component, might reduce the presence of these very short run nuisances, if the hypothesis that the economic variables used are more related among themselves in frequencies associated with business cycles is correct. As was seen in the previous coherence analysis, this seems to be the case with the chosen series. This elimination of unwanted high frequency nuisances is another justification for the use of the principal component technique.⁴

After logarithm extraction and differentiation, means were extracted from all series and the remained values were divided by the sample standard deviations of the series. These transformations were used to avoid the inclusion of spurious weights, which could distort the results. Given these transformations, all series entered with the same weight in the principal component analysis. One could argue that a higher weight for GDP is desirable, since it is the main and most important variable used to identify business cycles. This device was not used because of the lack of criteria to determine which weight should be chosen. Fortunately, the importance of this variable for business cycles periodization was also introduced by the results of the principal compo-

³ Data sources and descriptions are in the appendix.

⁴ For a technical exposition of the principal component analysis technique and its features, see Kendall & Stuart (1976, ch. 43) and Anderson (1958, ch. 11).

ment analysis, without any need for artificial imposition. From all variables used for the period 1921-85, GDP is the one which was most correlated with the first principal component, as can be seen in table 3.

Table 3
Coefficient of determination (R²) for univariate regressions ($Y = \delta_0 + \delta_1 X$)

Independent variable	Coefficient of determination	Independent variable	Coefficient of determination
GDP	0.78	Imports	0.36
Agricultural product	0.09	Money supply	0.22
Industrial product	0.65	Central government taxes	0.35
Exports	0.27		

Since the three series used for the first period are also available for the third period, I estimated the first principal component of these three series for the last period, 1921-85, and compared with the first principal component used as index for business cycles in this period. This comparison was based on regression estimations, where the index based on three variables was used as regressor. A coefficient of determination of 0.5845 was obtained. This is not high and can indicate that the two cycle indexes can differ. One should note, however, that the further back one goes in the Brazilian history, the greatest the importance of movements in exports and imports will be for the oscillations in economic variables. Therefore, this coefficient of determination might actually be underestimating the relation of the index used in the third period with the one used in the first period, if both were calculated to the first period. Another important result was the high estimated Durbin-Watson statistics for this regression, 1.72, which indicates that no first order autocorrelation was left in the remaining errors after the projection of one index on the other. This indicates that deviations of one index from the other were not systematic, suggesting that no serially correlated movement of one index was left out of the other. This, of course, is a desirable property. A similar test was developed for the index of the second period, with four variables involved, where the index for the third period, with seven variables, was again taken as the benchmark. A coefficient of determination equal to 0.67 and a Durbin-Watson statistics equal to 1.79 were obtained in this case. This shows that the index for the second period performed better than the one for the first period.

Data available made possible some overlapping periods before every change of index. These periods were used to normalize the series, imposing the same variability for all of them. The variability chosen as standard was the one of the index for the third period, as it came out from the principal component analysis with the already described transformations of the original data. The procedure to achieve this can be described in the following steps:

1. A constant was extracted from each entry of the index for the second period. This constant was calculated to force the averages of the overlapping period of the second and third indexes to be the same. The overlapping period extends from 1921 to 1939.

2. The series resulting from the first step was divided by another constant which should equalize the standard deviations of the indexes for the second and third periods, in the overlapping period.

3. A similar procedure to that defined in steps one and two was applied to normalize the index for the first period. In this case the standard used was the normalized second period and the overlapping period used was 1889-1939. Figure 2 shows the resulting series, when all the indexes are put together, after normalization. It should be noted that the absolute values of the fluctuations are meaningless in this index. Relative deviations from the average might represent the relative intensity of economic fluctuations.

4. Major types of Business Cycles

Before presenting a business cycle periodization for the Brazilian economy, it is useful to describe the main types of economic fluctuations recognized in the literature, with some of their characteristics:

1. *Kondratieff long waves*. Kondratieff found some empirical evidence which could suggest the existence of cycles with periodicity between forty and sixty years. Originally, he developed no consistent theoretical support for this idea, although he offered some tentative explanation. The own periodicity of the fluctuations make it difficult to develop precise empirical tests for this hypothesis. There was a recent revival of the Kondratieff hypothesis in the light of new evidence after the Second World War and of new empirical methods to test its existence. Recent works which support this hypothesis are Mandel (1975) and Solomou (1987).

2. *Kuznets long waves*. Simon Kuznets found empirical evidence that there were fluctuations in many economic variables which lasted around twenty years. Considerable empirical support for this hypothesis was found. Recently yet additional new empirical material supporting this hypothesis has been provided. Examples of these studies are Solomou (1987), and Catao (1989), with the last one applying the idea and empirical methods to the

Brazilian case. It has been found that the initial method applied by Kuznets, however, indicated the existence of cycles due to inappropriate filter procedures (Howrey, 1968, and Sargent, 1978, p. 248-51).

3. *Building Cycles*. There are some arguments which support the existence of cycles with periodization between fifteen and twenty years. These cycles correspond to the building periodicity of capital equipment in the industries. Once built, equipments work for an interval of time before they are worn out and therefore replaced by other new equipments. If the replacement time is similar for many industries, and if there is enough idle capacity for an increase in total production, instead of simply reducing consumption at that time, waves will be introduced in the economy. Similar argument was already used to justify business cycles of smaller periodicity, as Marx (1967), who used it to justify cycles of frequency around ten years.

4. *Juglar or Major Cycles*. These are cycles with periodicity between six and eleven years. In terms of frequency, these would correspond more to Marx's suggested cycles. Certainly, these are among the most popular cycles when economists refer to this phenomenon. They are called Juglar cycles because they were first discovered by Juglar in 1862.⁵ The initial idea proposed was that there were cycles with average frequency of nine to ten years. Afterwards, the possible range for this frequency was extended for the period suggested above.

5. *Kitchin or Minor Cycles*. First identified by Joseph Kitchin, these cycles have a periodicity of two to four years. Their recessions tend to be mild, representing only a slight slowdown in economic growth, when they do not coincide with recessions associated to other cycles.

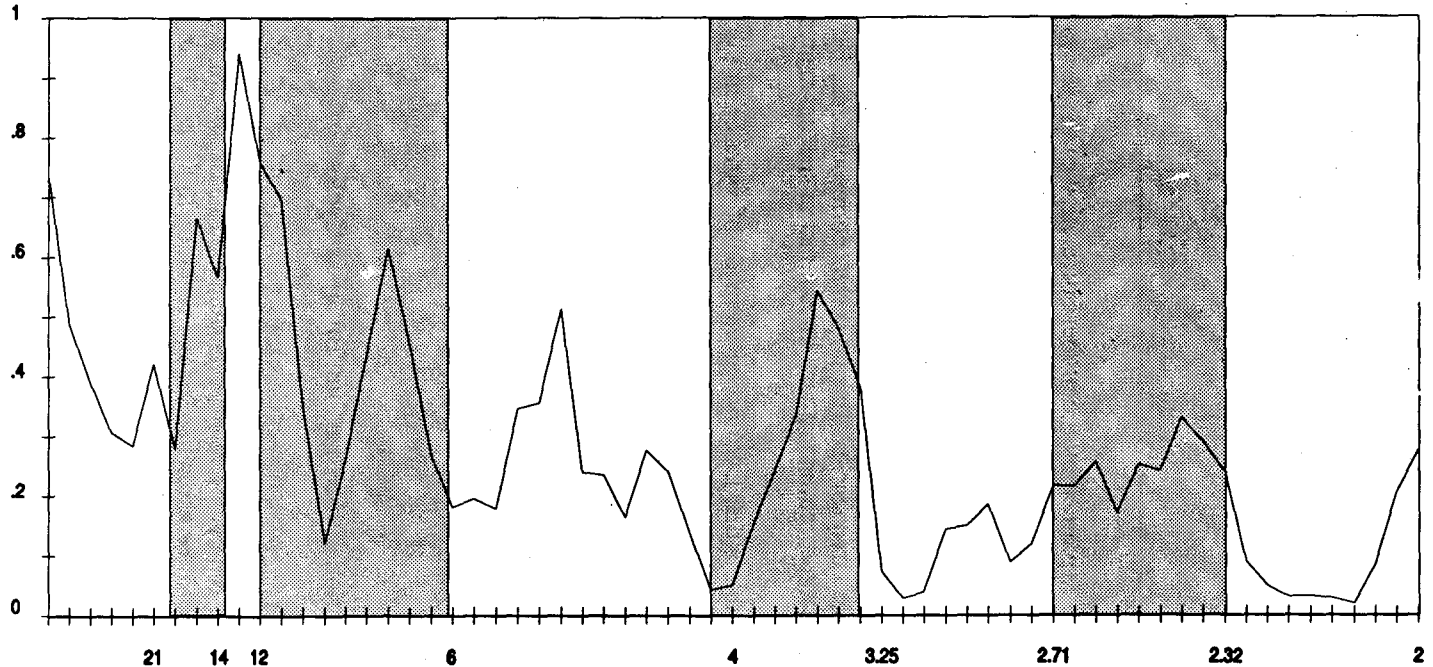
5. Spectral identification of the cycles

In this study, only three types of cycles were identified: Kitchin or Minor Cycles, Juglar or Major Cycles, and Kuznets or Building Cycles. The identification of Kondratieff cycles is very difficult because of its long duration.

A first general conclusion that can be obtained from an estimated spectrum of the index created in section 3 is that there is a concentration of spectral density in the low frequencies. Figure 1 presents this spectrum, which was estimated using a flat window with width of three. A taper was used, which affected the 10 entries of the series at each extreme. The rate of the sum of the density within the lowest 32 frequencies to the density within the 32 highest frequencies is 2.035. This shows the concentration mentioned. This concentration of density in the lowest

⁵ See Schumpeter (1954, p. 1.123-4).

Figure 1
Spectrum of the estimated index to identify the business cycles



Note: a flat window with width equal to 3 and a taper affecting the 10 extreme entries of the series was used. The areas shaded represent the types of cycles identified in the text. The area for the kitchen cycles were split in two areas which have high concentration of mass of the spectrum.

Table 4
Share of the density of the cyclical frequencies on total
density of their half of the spectrum

Frequency range	Share	Frequency range	Share
14.4 - 21.6	1.27	3.25 - 4	1.54
7 - 12	1.22	2.71 - 2.32	1.35

frequency is explained by the higher correlation of the series used in the principal component analysis in the low frequencies, as showed in section 2.

The peaks in the spectrum that are nearer the frequencies associated to the cycles mentioned above (with exception of the Kondratieff cycles) are shaded in figure 1. As may be seen, the existing peaks do not fall exactly within the bandwidth of the cycles, although there is some concentration of spectral density in these frequencies. This no perfect correspondence between cycles and peaks in the spectrum is a well known fact in spectral analysis (Sargent, 1978, ch. 11).

The hypothesis that there is concentration of variance in the frequencies associated with the business cycles is tested using a simple statistics presented in table 4. This statistics consists of a simple ratio of the average density in those frequencies to the average density at the half of the spectrum in which that particular cyclical frequency range falls. If there is concentration of variance on the cyclical frequency, these ratios must be greater than one. Table 4 shows that all calculated ratios are greater than one, as expected. Therefore, the hypothesis that there is concentration of variance in the frequencies associated with the three types of business cycles identified below has support from the spectrum of the cycle index.

6. Periodization of the Brazilian Business Cycles

All cycles identified in this research will be presented from trough to trough. For the short-run cycles, any decrease in the rate of growth, which appear as a decrease of the estimated index in relation to the previous period, was normally identified as a trough and consequently as the end for a short-run cycle. This method is of some reliability, because the first principal component should have downturn when there is a tendency in some of the series which is strong enough to overcome counter-tendencies in other series.

Simple random or isolated movements in the series will not be reflected in the first principal component.

6.1 Kitchin or Minor Cycles

Table 5 and figure 2 show the identified Kitchin or minor cycles for the Brazilian economy. Table 5 also brings their duration. In the identification of the period, the two extremes were included. For determining the length of the cycle, only one extreme was included. The average periodicity of these fluctuations is 3.31 years (approximately three years and four months). The maximum period length identified was five years. Only one cycle had this length, which lies outside the usually accepted range of the Kitchin Cycles. All remaining cycles are in the usually accepted range. The minimum period length was two years. Thirty nine cycles were identified in table 5.

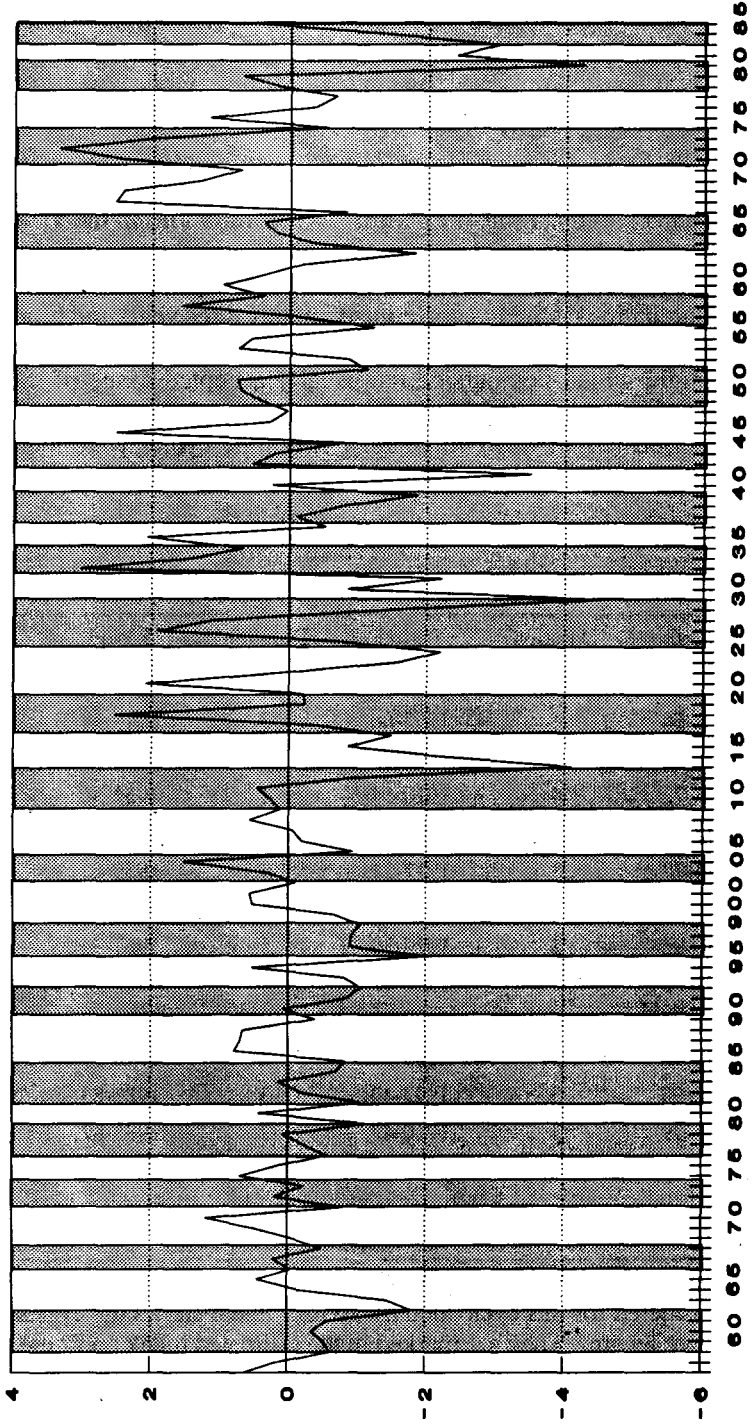
Table 5
Short run business cycles of the Brazilian economy, 1858-1987

Period	Duration	Period	Duration	Period	Duration
1858-62	4	1899-03	4	1942-45	3
1862-66	4	1903-06	3	1945-48	3
1866-68	2	1906-10	4	1948-52	4
1868-72	4	1910-14	4	1952-56	4
1872-74	2	1914-17	3	1956-59	3
1874-77	3	1917-21	4	1959-63	4
1877-80	3	1921-25	4	1963-67	4
1880-82	2	1925-30	5	1967-71	4
1882-86	4	1930-32	2	1971-75	4
1886-90	4	1932-35	3	1975-78	3
1890-93	3	1935-37	2	1978-81	3
1893-96	3	1937-40	3	1981-83	2
1896-99	3	1940-42	2	1983-87	4

6.2 Juglar or Major Cycles

These cycles are also identified from trough to trough. Minor fluctuations were not considered for this cycle identification. Table 6 shows the cycles and their respective lengths. They are marked in the estimated index on figure 3. Again, the two extremes were included in the period identification, although only one

Figure 2
Cycle index for the Brazilian economy with Kitchin cycles identified



was considered to determine the length of the cycle. Fourteen cycles of this type were identified. Only one of them is shorter and two more. Two more are longer than the postulated length. The average period length of the cycles was 9.07, which corresponds approximately to nine years and one month.

Table 6
Juglar Cycles of the Brazilian economy, 1862-1989

Period	Duration	Period	Duration	Period	Duration
1862-72	10	1906-14	8	1952-63	11
1872-80	8	1914-25	11	1963-75	12
1880-86	6	1925-30	5	1975-81	6
1886-96	10	1930-42	12	1981-89	8
1896-06	10	1942-52	10	average	9.07

6.3 Kuznetz or Building Cycles

As in other cases, these cycles are also identified from trough to trough. Seven cycles of this type were identified, covering the period from 1862 to 1981. An average of 17 years in each cycle was obtained. As can be seen in table 7, only one cycle departs strongly from the expected periodicity. Apart from this particular cycle, it is impressive how close to each other the period length of the cycles identified are. Figure 4 brings the identified cycles marked in the estimated cycle identifying index.

7. Comparing our cycles periodization with previous cycles identifications in the literature

There is only one cyclical periodization available for the Brazilian economy for such a long period as the one used above. It was made by Contador (1977) and cover the period 1861-1976. It is also possible to find references to some particular cycles or at least to crises and booms in the Brazilian economy. In addition to the comparison of the cycles periodization just presented with the one given by Contador (1977), an interesting exercise will be to compare some of the references to particular cycles with our results. A first fact that should be noticed is that when cycles are identified in the literature, no differentiation between the three types of cycles as presented above is made.

Figure 3
Cycle index for the Brazilian economy with Juglar cycles identified

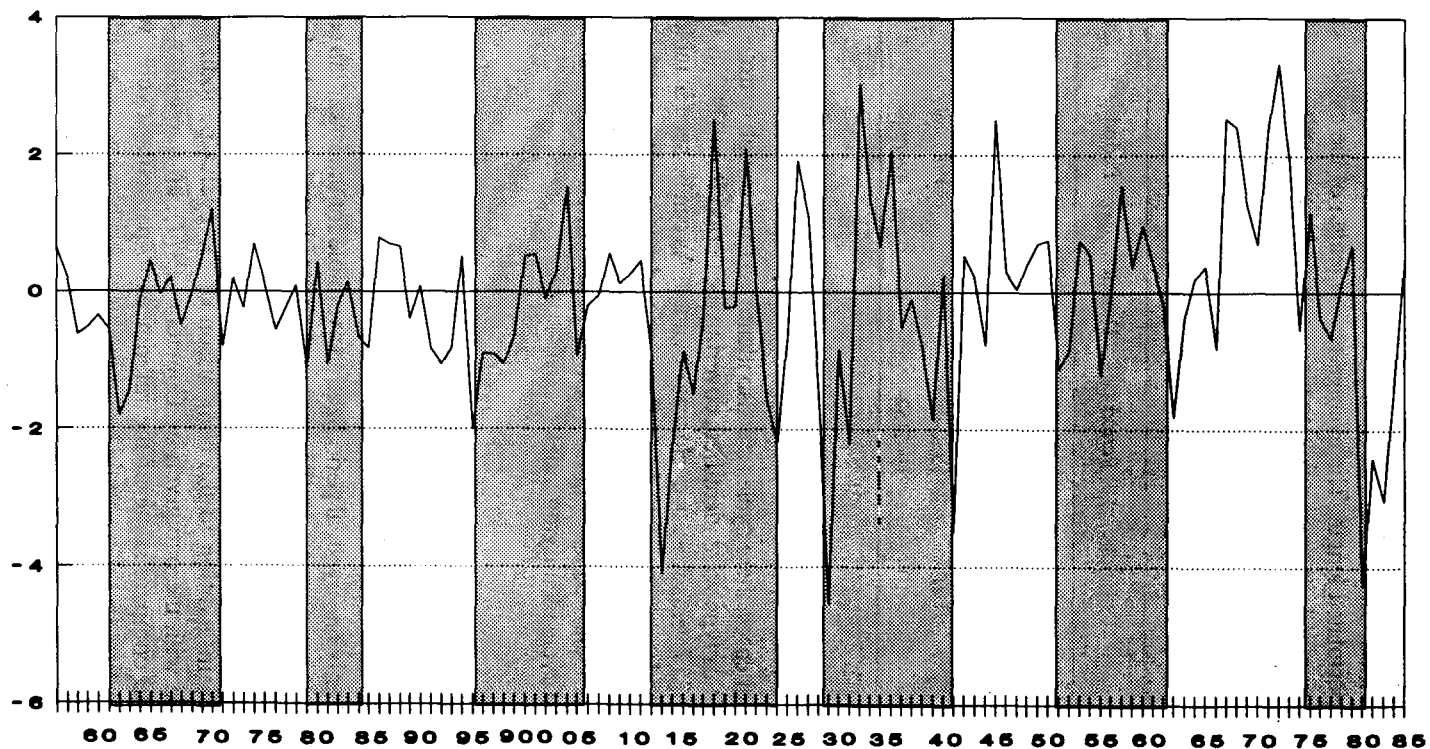


Figure 4
Cycle Index for the Brazilian economy with Kuznetz cycles identified

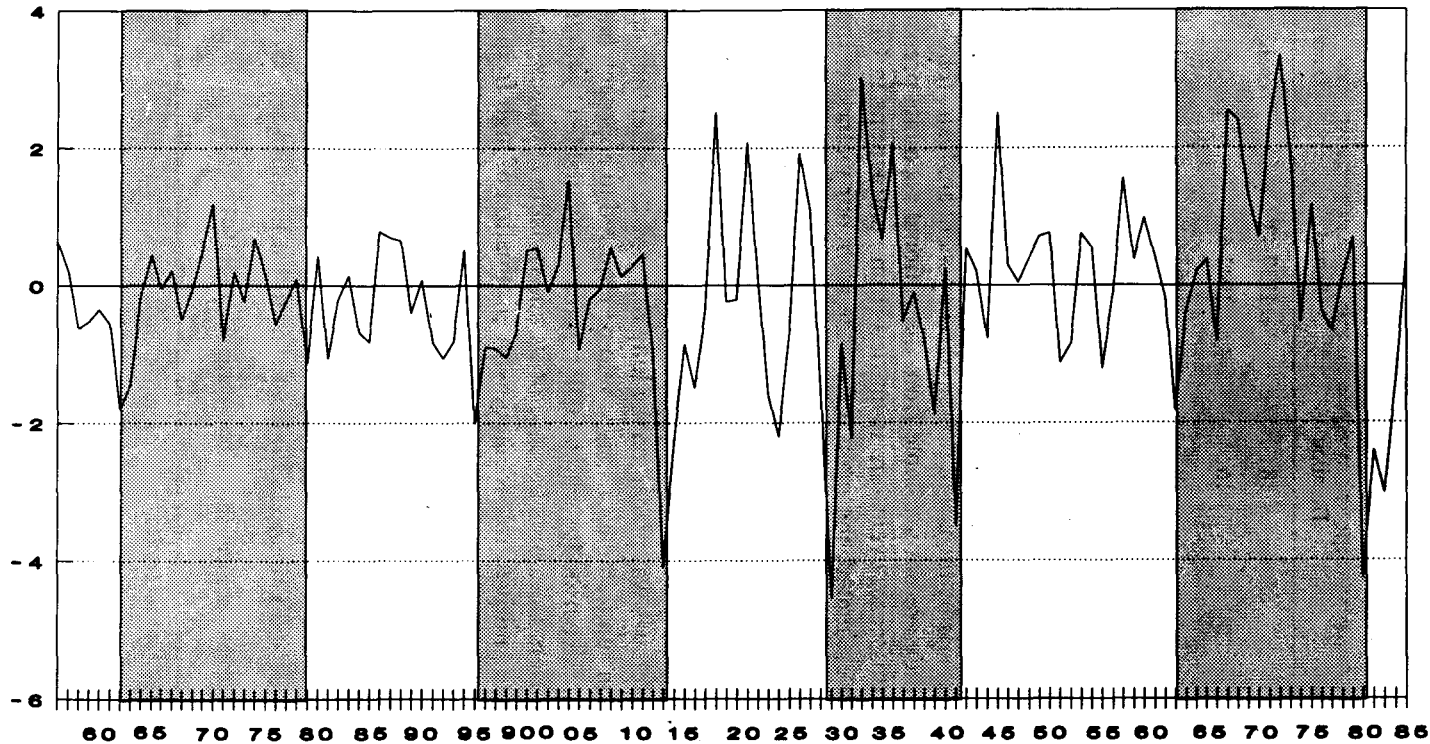


Table 7
Kuznetz of Building Cycles of the Brazilian economy

Period	Duration	Period	Duration
1862-80	18	1930-42	12
1880-96	16	1942-63	21
1896-1914	18	1963-81	18
1914-30	16	average	17

Contador (1977), in particular, does not distinguish the three types of cycles and only identified very long cycles. He made three cycles periodization, which are shown in table 8. The first is based on estimates of real GDP, made by the use of principal component analysis, for the years in which they are not available from the national accounts prepared by FGV.⁶ In this case, cycles are identified from contractions in GDP. For the period estimated, the main difference from our method is the form the series enter the principal component analysis and the radical interpretation of the slumps, which are only recognized when there is a fall in GDP, which requires that its growth rate becomes negative. While we used the series in first difference of their natural logarithms, he used them in level in the principal component analysis.⁷ Therefore, in his case special emphasis was placed on the long run growth, rather than on short and medium run fluctuations, as would be required to approach business cycles.⁸ In the period for which GDP figures are available (1947-76), his method differs from ours because of its uni-variable approach, in opposition to the multivariable method, with elimination of high frequencies, used in this paper.

Another method used was to identify the cycles through deviations of the constructed series for GDP from a long run trend. Nelson & Kang (1981 and 1983) have shown that the use of time trend to detrend time series which have a stochastic trend could produce spurious periodicity. Recent studies by Barros (1990, ch. 3) and Cribari (1990) have shown that Brazilian real GDP has a

⁶ The GDP data from Fundação Getulio Vargas starts in 1947.

⁷ His estimates of GDP through principal component analysis was made in a previous study by Contador & Haddad (1975).

⁸ I have been using the idea that economic time series have a large concentration of their spectra in the low frequencies and particularly in the zero frequency, as argued by Granger (1966).

stochastic trend. Therefore, this second method used by Contador is not appropriated for a cycle periodization.

In a third method he used, the growth rate of the constructed series was used to identify the business cycles. There are two important differences from this method to the one used in this paper. First, his principal component analysis gave much emphasis to the zero frequency of the series, because of their importance in macroeconomic time series dynamics.⁹ The growth rate of the series was only obtained after its estimation through principal component analysis. Secondly, after 1947 his method is based only on one variable which is the estimates of real GDP made by FGV, rather than on several variables, as was done in this paper.

Another difference from the method used in this paper and those used by Contador, which applies to all his procedures to identify the cycles, is that I identified three different types of cycles, while he only indicated a few cycles, not actually expressing any concern with their distinction or classification. Nevertheless, some troughs indicated by Contador are also in our periodization. From his cycles identified in growth rate, as presented in table 8, one can see that only two troughs are not also presented in table 5. Furthermore, his cycles (with all three methods) are normally defined for periods which would encompass one or two of the Juglar Cycles presented in table 6 and are very close to the Building Cycles shown in table 7, although the limiting dates are slightly different in many cases.

Contador & Haddad (1975) identify some crises and cycles, which could be compared to those of section 6. They argue that the Brazilian income decreased during the Paraguay War (1865-67). According to our estimates a slump can be found in 1866, but this crisis is contained in a period of expansion of a longer Juglar Cycle. They argue that the Brazilian economy also presented a crisis in the period 1879-82, when there was a world recession and a strong drought in part of Brazil. In accordance with our estimates, this is a very unstable period in the Brazilian economy. The period of the drought, 1877-80, really represented a crisis, or at least a slow growth period, with crises in 1877 and 1880. But in 1881 there was a recovery, which was reverted in 1882. For the whole period of 1877-82, a very low growth rate was certainly observed. If our cycle index was taken as a growth rate index, the average growth rate for this period would be -0.4094 , compared to an average of -0.2746 for the data on last century (1856-99).¹⁰

⁹ See Granger (1966).

¹⁰ One should note that previous standardizations on the construction of the cycle index made the absolute values completely meaningless. Only the relative values are relevant. Therefore, the negative values of the average index does not involve any judgment of Brazilian economic performance in these periods.

In addition to the crisis already mentioned, Contador & Haddad (1975) also identify some cycles. Particularly, they point the periods 1893-98, 1910-14, and 1928-32 as cycles in the Brazilian economy. The first one is associated with the political and economic instability, which was consequence of the slavery abolition (1888), the Republic proclamation (1889) and the domestic conflicts which followed. On the economic front, the banking law which allowed private banks to print high powered money (1888), the boom and following crisis in the Brazilian capital market (1889-92) and the high inflation of the period are pointed out as the main causes of the crisis which followed this period. The five-year cycle of 1893-98 indicated by Contador & Haddad appear in our periodization as the end of a Juglar Cycle and beginning of another one. The year of 1893 is a bottom of a Kitchin Cycle. After that year there was some recovery, which led to a peak in 1895, but this peak is reversed in 1896 to a more profound trough than the one in 1893, which is actually a bottom of a Juglar Cycle. After this year the recovery starts, although another trough of a Kitchin Cycle can be detected in 1899, when the cycle of Contador & Haddad ends.

Table 8
Contador's cycles to the Brazilian economy, 1861-1976

Real GDP		Deviation from trend		Growth rate	
Period	Duration	Period	Duration	Period	Duration
-1868	8	-1868	8	-1867	7
1868-84	16	1868-84	16	1867-82	15
1884-98	14	1884-98	14	1882-97	15
1898-1915	17	1898-1916	18	1897-1914	17
1915-32	17	1916-32	16	1914-30	16
1932-42	10	1932-44	12	1930-40	10
1942-	34	1944-63	9	1940-63	23
		1953-56	3	1963-76	13
		1956-67	11		
		1967-76	9		

Note: This table was constructed using indications by Contador (1977, p. 225-8) of the troughs. Therefore, the cycles indicated in the table conforms to our definition from trough to trough.

By using the cycle definition from trough to trough, it can be said that Contador & Haddad had taken two Kitchin Cycles and put them together as only one cycle. This procedure is not incorrect when one wants to find a Juglar Cycle, but the simple addition is misleading. One needs to consider the whole movement in the neighboring years. From the period which goes from 1891 to 1905, which were two peaks in the Brazilian economy, 1896 is the bottom. Therefore, rather than taking 1893 or 1899 as the trough of a Juglar Cycle, 1896 should be chosen.

The period which preceded this cycle presented by Contador & Haddad is a very controversial one. Some say that the boom in the capital market which followed the banking reform and republic proclamation was completely artificial and did not have any relevant positive consequence on industry (Versiani & Versiani, 1977, and Leff, 1982). Suzigan (1986, p. 46-8), Stein (1979, p. 97-9) and Fishlow (1972, p. 12-3), on the other hand, argue that the boom in the capital market which preceded the phenomena called *Encilhamento* (1892) was not completely artificial and had some positive effect on industry. The evidence found by Suzigan seem to be conclusive in the case of industry. According to our estimates, after the peak in 1887, the economy started to slow down. This process would end in a crisis in 1890. A small recovery in 1891 could not be sustained and a three years crisis followed. This means that two years after the *Encilhamento* the economy was still in recession, indicating that, in general, the *Encilhamento* was not a good period for the Brazilian economy, although there was some positive effects to the industry. The particular year of 1896, which is the end of a Juglar Cycle in our estimates, contained a period of decline in international coffee prices and strong readjustment policies, which could justify the crisis, especially as it is known that it was the end of a period of unbalances in government finances.¹¹

The second cycle identified by Contador & Haddad extends from 1910 to 1914. Our estimates point towards a crisis in 1910, and another one in 1914. This period, therefore, corresponds to a cycle. It should be noticed, however, that this is a Kitchin Cycle. The year 1910 corresponds to the beginning of a depression of a Juglar Cycle which had started in 1906 and ended in 1914.

The third cycle identified by Contador & Haddad goes from 1928 to 1932. It would be a four year cycle. It is known, however, that the Brazilian economy reached its lower growth rate in this period of the Great Depression in 1930, as our estimates show. The trough of 1932, therefore, is smoother and can be seen as a small reverse of the process of recovery. Instead of choosing 1928 as the peak of their cycle, 1927 would have been more adequate, since it is known that in 1928 the Brazilian economy already showed the first signs of decline. These movements are shown in our index.

¹¹ See Villela & Suzigan (1973, p. 35).

In the period Contador & Haddad identify these cycles, Villela & Suzigan (1973) identify other crises and booms. Their concern is not much with cycles, but rather with general movements in the Brazilian economy. In particular, their emphasis is on sectorial performances, structural changes and governmental policies. Their period of analysis is 1889-1945. A first result worth noting, not mentioned in previous comments, is their recognition of the end of a recession in 1903, with the beginning of an expansion. This is seen in our index as the bottom which divides two Kitchin Cycles. They classify the period between 1903 and 1913 as a period of expansion in the Brazilian economy, and recognize that 1913 and 1914 were years of recession. Our estimates suggest a split of this period in one and a half Juglar Cycles or three Kitchin Cycles. The depression in 1914 is a widely known phenomenon, and is recognized as such by Villela & Suzigan (1973, p. 42). This crisis coincided also with an international recession and the beginning of the First World War. They failed, however, to give emphasis to the crisis of 1906, which was presented only as a period of disturbances in the coffee sector of the economy, characterizing the first Brazilian intervention in the coffee market.

The crisis of 1920/21 was not pointed out as an important crisis of the Brazilian economy by Villela & Suzigan, although they identify the crisis of the coffee sector in this period. In our estimates, it corresponds to the end of a Kitchin Cycle. The more far-reaching recession of 1924-26, which is a landmark to disjoin two Juglar Cycles in this study, was identified by Villela & Suzigan (p. 45). This recession is attributed to mismanagement of government policies, mainly monetary policies.

Apart from the recession at the end of the 1920's and the beginning of the 1930's, which is a well known phenomenon in the Brazilian and world economies, Villela & Suzigan recognized a low period of growth during the Second World War (p. 219-20). This can be clearly seen in figures 2 to 4. A more detailed analysis showed that 1942 could be considered the year of an important recession in the Brazilian economy, which corresponded to the end of a Juglar and a Kuznets cycles.

Fritsch (1990) also presented some cycles for the early 1900's. Since his analysis begins in 1900, this year was used as a starting date for a long cycle which extended until 1913. Nevertheless, he recognizes that 1900 is not a year of deep recession and that the previous important recession in the Brazilian economy was in the second half of the previous decade. Therefore, the initial data of 1896 for the Kuznets cycle which covers the period he identifies is in line with his arguments. Although he presents the cycle as extending up until 1913, he recognizes that 1914 is a year of recession (p. 37 and 42), legitimating the use of this year as the other extreme of the cycle.

Fritsch (1990) considers the period 1900-13 as one of a long cycle, but recognizes that there were special events in 1906 which made that year

particular. In this year, after a period of restrictive policies, the government promoted a monetary reform of paramount importance to the expansive period afterwards (p. 38). In this way, a division of the long cycle in 1906 is hinted, although it is not explicitly specified. In addition to the references to 1906, Fritsch also draws particular attention to an important expansive period between 1908 and 1913 (p. 38-9). This period, if the crises before and after are included, would give a Juglar Cycle as the one identified in section 6.

Fritsch (1990) also identified a slowdown of the Brazilian economy in 1921, with growth resuming in the following years (p. 46-50). In our estimations, this slowdown corresponds to a crisis which split two Kitchin Cycles. Fritsch also identified a recession in 1925, aggravated by restrictive policies (p. 55-6). In the periodization developed above, this recession was a watershed of two Juglar Cycles.

Serra (1982) defined some cycles for the Brazilian economy for the post Second World War period. Serra's cycles refer to the industrialization process, but the dynamics of the Brazilian economy in this period was already mainly determined by the domestic industrial behavior. Therefore, these cycles also affected the rest of the economy, as is clear in Serra's arguments. He identified three cycles and a four-year crisis. The first cycle extends from 1947 to 1962. According to our estimations, 1947 represents a year of crisis of a Kitchin Cycle. This is not a year of importance for any Juglar or Building Cycle, neither as a peak or a trough. The other limit used, 1962, is the last year before a trough which will mark the end of one of each type of cycle identified in section 6. It closely approximates an important period for the Brazilian economy. Serra should have picked two other alternative years to define the beginning of his cycle, namely 1942 or 1952. Had he chosen 1942, he would have identified a Building Cycle, which actually is more related to the type of structural change that he identified in the Brazilian economy at that time. If the year chosen had been 1952, a Juglar Cycle would be identified.

After the first cycle Serra identifies a four-year crisis, which lasted from 1963 to 1967. In our estimates, this corresponds exactly to a Kitchin Cycle. It is a widely accepted idea that this was a period of stagnation of the Brazilian economy between two booms, the Kubistchek era (1956-60) and the Brazilian Miracle (1967-73). Our estimates, however, showed that this period presents a typical cyclical behavior and if it is considered as a cycle, the period length will also be typical of a Kitchin Cycle. Therefore, the definition made in this study seems more appropriate. This is not to say this period was not one of slow growth. On the contrary, as in the other crisis which marks the end of a Building Cycle, a slow growth can be identified in the surrounding years. For the trough of 1963, this slow growth period was stronger in the years immediately following the crisis. The stagnation of these years (1963-67) is a typical phenomenon, rather than an abnormal situation.

Following the four-year crisis, Serra identifies another cycle, which extends from 1967 to 1973. This is the so called Brazilian Miracle. The year 1973 is well known as a peak year in the Brazilian economy. Brazil, then, reached one of the highest rates of economic growth of its history, as far as reported. In 1974 the economy had a slowdown, which would reach its lowest level only in 1975, as recognized by the cycle periodizations presented above. Therefore, Serra's second cycle corresponds to part of a Kitchin Cycle only, since he started in a recession and ended in a peak. Defining cycles from bottom to bottom, as I am doing, will necessarily lead to the periodization presented here, rather than Serra's.

The third cycle identified by Serra extends from 1973 to 1980. The 1980 cut was probably chosen on the basis of data availability at the time he wrote his paper, rather than as a meaningful cut. All these years will not be put together by a periodization from bottom to bottom, as the one developed in this paper. In adopting a bottom to bottom cycle specification, a Juglar Cycle corresponding to Serra's third cycle can be found. The end period should be 1981, however, not 1980. In 1981 not only a Juglar but also a Building Cycle ended. As in other cases, a stagnating period followed this end of a Building Cycle. This is the well known first half of the 1980's in the Brazilian economy.

Finally, a few remarks on two specific troughs previously identified are in order. They are the troughs of 1952 and 1975, which correspond to years in which real GDP did not perform badly. In 1952, GDP actually had a higher rate of growth than in the two adjacent years. Nevertheless, there were restrictive policies in the economy¹² and other economic indicators, such as the industrial production, real imports and exports and government income,¹³ pointed to the existence of a recession. In 1975 the Brazilian economy had just experienced a period of tremendous growth, as the name "Brazilian miracle" suggests. In 1973, the oil shock hit the economy in a time it lacked the necessary structure to absorb it. The high control of the economy the government had and the enthusiasm among authorities with the miracle made the government avoid to face the reality that depressive adjustment would be necessary. In 1975, there was no chance of avoiding these adjustments and the rate of growth fell to levels below the one of the preceding expansionary period, although it was still high.¹⁴

¹² See Vianna (1990, p. 128-30).

¹³ Obviously the restrictive policies made the real money supply also indicate that there was a trough.

¹⁴ See Carneiro (1990, p. 299-310).

8. Conclusion

The essential message that should be retained from this paper is that the Brazilian economy, as other capitalist economies, evolves in time with business cycles. The economic time series used in this paper showed to have a reasonable correlation at the business cycles frequencies, supporting the hypothesis that there are cyclical movements in the Brazilian economy at the standard frequencies found for other capitalist economies and that the main macroeconomic aggregates fluctuates jointly in these frequencies. Three periodizations of the cycles in the Brazilian economy according to the most important types of business cycles identified in the literature shown to be reasonable. Therefore, similar regularities, such as those found by Schumpeter (1939) and Burns and Mitchell (1946) for the USA, can also be found for the Brazilian economy. The study of the Brazilian economy which considers fluctuations to be an intrinsic phenomenon of the dynamics of the economy proved meaningful.

Appendix

Data sources and description

The main problem with the data used in this paper is the price deflator for series before 1944, when the price index of Fundação Getulio Vargas (FGV) was first published. Two price indexes are frequently used in the literature. The first, developed by Lobo et alii (1971), is a price for the cost of living in Rio de Janeiro, and is used to deflate series in domestic prices, such as money supply or Central Government income. The British wholesale price index is normally used to deflate those series in foreign currencies, such as exports and imports. Some variances occur when British wholesale prices are combined with US wholesale prices as a deflator in foreign currencies. Other domestic price deflators are available for series in domestic currency in this century, such as that which was created by the Serviço de Estatística Econômica e Financeira do Tesouro Nacional (SEEF), published in Instituto Brasileiro de Geografia e Estatística - IBGE (1941), the one estimated by Haddad (1974) and the one calculated by Onody (1960). An alternative method to deflate all the series is to use the exchange rate to transform all the foreign prices into domestic prices. In this case, one could use the prices of imports as the price index. The logic underlining this procedure is that the Brazilian economy was highly dependent on foreign supplies of many goods. Therefore, many domestic prices were linked to import prices. When the chosen bundle of domestic consumption

changed, this would immediately be reflected in the price of imports, since a different composition of goods would be imported.

A combination of Haddad's & Lobo's (base 1919) prices indexes was used to deflate money supply. A combination of British and American price indexes was used to deflate exports. As a test of these deflators, a regression was run with exports as explanatory variable and money supply as endogenous variable. Both variables were used in first difference of their natural logarithms. This procedure avoided the presence of spurious relation of the series and shows the relation in addition to the one in the trend. It is a standard result in economics that income is positively correlated with these two variables. This relation extends itself beyond the relation in the trends. Business cycle movements of income are usually positively correlated with these two series. Therefore, a minimum requirement in accepting a price deflator combination is that money supply and exports are positively correlated. The combination used for this regression, however, did not pass this test. A negative correlation was obtained. Furthermore, a very low coefficient of determination ($R^2=0.00024$) was also obtained. For theoretical reasons, then, I rejected the aforementioned combination of price deflators as adequate to the Brazilian data.

A similar test to the index based on domestic import prices was made. In this case, a positive coefficient and a coefficient of determination equal to 0.18 were obtained. For comparison, a similar regression was run with data for the period 1920-85. As expected, a positive coefficient and a coefficient of determination equal to 0.002 were obtained. Therefore, the coefficient of determination for the previous period is very satisfactory. It is probably higher than the one for the latter regression, because at that time the relation between income and exports was stronger. When this price index was used, most of the coherences presented in table 1, which are for the period in which this price deflator was used, increased. This also supports the superiority of this price deflator over the alternative used. Therefore, this price index was used to deflate the series between 1856 and 1939 for coherence analysis and between 1856 and 1920 to build the cycle index. After these periods, Haddad's price GDP deflator, together with the domestic availability price index of FGV, was used to deflate the series. Price of imports and exports for this period were already obtained in Brazilian monetary units of the time. More details on the source and description of all the series used in this paper are given below.

1. Exports (1855-1913): the index of quantum and price developed by Gonçalves (1981) was used. It was obtained from IBGE (1987, p. 551-2). They were multiplied by each other, converted to the Brazilian monetary unit using the exchange rate given by Suzigan (1986, p. 379-83) and deflated by the domestic import prices.

2. Exports (1913-85): data presented by IBGE (1987, p. 524-5) were used. The series on Brazilian monetary units were chosen. These series were deflated

by the price index, based on domestic import prices up to 1939 in coherence estimates, and up to 1920 in cycle index estimates. For coherences to the second period (starting in 1920), as well as cycle index after 1920, a combination of Haddad's GDP deflator and FGV's domestic availability price index was used.

3. Imports: Gonçalves quantum index was used for the period 1855-1939, for the coherence analysis and for the period 1856-1920 for the cycle index. Again, this was obtained from IBGE (1987, p. 551-2). For the rest of the period, data from IBGE (1987, p. 524-5) were used. The same deflators as those for exports were used.

4. Price index (1855-1921): the price index which was tested as an alternative to export prices was the consumer price index in Rio de Janeiro presented by Lobo et alii (1971), for the period 1855 to 1907. The weight of 1919 was chosen. The global implicit price deflator presented by Haddad (1974) was used for the period 1908-39. This index was extracted from IBGE (1987). As was seen, this deflator was rejected for domestic series, when used together with American and British wholesale price indexes for series in foreign currencies.

5. Domestic import price index: Gonçalves' import price index was used for the period 1855-1913. This was transformed to the Brazilian monetary unit through the exchange rate and ad valorem tariff rate, both supplied by Suzigan (1986). For the period 1914-39, another import series, already in Brazilian monetary unit, supplied by IBGE (1987, p. 524-5), was used. Gonçalves' import quantum index was used to obtain the prices from this series.

6. A combination of Haddad's implicit GDP deflator and FGV's domestic availability price index was used as the price index after 1920, when adequate. Both series were obtained from IBGE (1987).

7. Money supply: M1 for the end of the second quarter was used. For the period 1855-1945, the series estimated by Pelaez & Suzigan (1976) was used. The data from the remaining period come from Banco Central do Brasil, Boletim Mensal. Both series were extracted from IBGE (1987).

8. Capital good imports for the industry (1856-1939): extracted from Suzigan (1986). They are deflated by a wholesale price index for Great Britain, presented in Mitchell (1975, p. 737-41).

9. Real GDP (1920-85): it was obtained from Zerkowski & Veloso (1982) for the period 1920-80. For the period 1980-85 the source was IBGE (1987, p. 120). The data for this last period was deflated by the FGV's domestic availability price index.

10. Real Agricultural Output (1920-85): the same as real GDP.

11. Real Industrial Output (1920-85): the same as real GDP.

12. Central Government taxes (1889-1985): obtained from IBGE (1987, p. 570-1). These data were deflated by the price indexes described above. The one used for this series was the same used for exports.

Resumo

Uma análise de componentes principais é utilizada para construir um índice apropriado para periodizar os ciclos da economia brasileira no período 1856-1985. Três tipos de ciclos, com três frequências distintas, são identificados: os de Kitchin, os de Juglar e os de Kuznets. Adicionalmente, foram usados métodos espectrais para se mostrar que as séries econômicas no Brasil são correlacionadas nas frequências associadas com os ciclos econômicos, e que há uma concentração de variância do índice gerado nas frequências associadas com os ciclos econômicos. O artigo também contrasta a periodização sugerida com ciclos previamente identificados na literatura.

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