
Baccino Osvaldo
When someone looks at the Monthly Indicator of Economic Activity in Argentina in order to examine the economic growth since 2003, immediately faces a serious inconsistency: the annual growth at high steady rate. Many people did not take account of this problem because they do not consider the interrelationships of the productive system.

The aim of this paper is to describe a method of correction of a fragment of the Monthly Economic Activity series to make the original indicator more usable particularly in exercises of projections and forecasting. The method relies on the spectral treatment of time series in order to locate the main distortions and to make a replacement of the identified components of the dynamic behaviour. This procedure allows modifying the original indicator temporarily until the construction of the index becomes revised.

A rapid glance at the original Index of the Monthly Economic Activity published by the INDEC (figure 1) is enough to realise that something strange has been happening with the series after the beginning of 2002.

The indicator shows a sharp modification in its evolution dividing the graph in two, thus presenting two different growth behaviours for the economy. The first type of conduct takes place since the beginning of the series up to the end of 2001. The second type of evolution starts since 2002 onwards.

According to this indicator the economy has attained a path of high and steady growth at unprecedented rates when they are measured annually. On the other hand, the oscillations around trend do not seem to change at all with respect to the past. There is a pattern of annual scheme which reproduces itself along the entire period depicted in the graph. That pattern can be identified between relative minimum values of the index, which usually correspond to the months of January and/or February of each year.

So far, at first sight the economic activity indicator seemed to undergo changes in the trend component without affecting much the monthly seasonality. The oscillations remained quite unchanged but there is a tremendous impulse of growth that generates steady rates along time.

Such a kind of growth is usually known as “balanced growth” in the economic literature. That means an economy expanding at a uniform rate throughout all sectors of production. On the contrary, if the rhythm of growth is not uniform, the bottlenecks created would make the economy to expand in the long term at the minimum rate. In other words, the original steady rate cannot be maintained in the long run and the rate of growth must go down.

Nevertheless, a “balanced expansion” does not seem to be applicable to the Argentine economy in the period under analysis. Some variables like unemployment, reproductive investment, incomes, etc. do not seem to describe conditions of steady growth.

For example, within the Monthly Estimator of Economic Activity the Manufacturing sector is represented by the Monthly Industrial Indicator (EMI according to the INDEC). These data are periodically published for a set of branches of production.
Fig. 1

The yearly rates of variation of industrial activity appear in the Appendix 1. By the way, they show the heterogeneous performance, which is very difficult to reconcile with the case of “steady growth” at very high rates.

The data shown in these tables describe a behaviour that is incompatible with a high and invariable rate of growth for the whole economy. According to the heterogeneous rates of expansion a steady rate for the whole economy is unsustainable. Therefore, it cannot persist in the long run.

This is obviously an inconsistency in the original series. In the author’s view, this particular evolution of the index creates many doubts about the reliability of the monthly indicator of economic activity since there are no grounds to justify “balanced growth” as follows from the industrial activity indicator (EMI) among other variables.

Finally, the present paper aims to establish a procedure of correction of a segment of the original series of economic activity in order to remove certain inconsistencies. At first sight, the doubts centre on the trend rather then in the seasonal scheme. Perhaps, if one replaces that trend by another more adequate, the activity series might be likely to become more reasonable and closer to reality.

However, the simple observation of a seemingly distorted trend is not sufficient to describe reality because there may be many other factors that affect other components of the time series and they obscure the relevant characteristics. Therefore the phenomenon becomes unobservable at first sight. That is the reason why the spectral
analysis becomes a necessary instrument to identify the kind of distortion existing in the time series.

**The spectral density of a time series**

The spectral density function measures the part of variance accounted by each frequency. Usually many important periodicities cannot be directly observed from the time series. As it was mentioned above, there are components, which hide certain periodic movements. For example, one important element that prevents this detection at first sight is white noise. The latter will have no peaks in the spectral density function. White noise has variance in all frequencies. In other words, the shape of the periodogram becomes a straight line for white noise alone.

The main analytical instrument used in this paper is the spectrum as an estimate of the spectral density function. The manipulations of the data previous and after to the periodogram computation together with the procedure to smooth the periodograms are analogous to the ones applied in O.E.Baccino(2011). This was done to make comparable results independent from computation procedures.

The spectral density functions were calculated from tapered data to reduce the leakage of power of certain frequencies other than integer multiples of a fundamental frequency. The tapering applied here consists of reducing the ends of the series by means of a split cosine-bell in a percentage of 10%. When estimating the periodograms the original series were padded with zeros to extend the sample up to 256 observations. The padding was done to reduce the space between frequencies and obtain a better graphical representation of the spectrum.

The definition of periodogram is described by the equation (1). There, $P_{xx}(f)$ is the value of the periodogram at $f$, $f$ is the frequency measured as cycles per unit of time, $x_t$ is the de-trended indicator of economic activity, $T$ is the number of observations within the sample and $t$ is the time variable $t$. In this case, $f$ denotes the series of overtones or harmonics of a fundamental frequency.

$$P(f) = \frac{1}{2\pi T} \left[ \sum_{t=0}^{T-1} x_t \cos 2\pi ft \right]^2 + \left[ \sum_{t=0}^{T-1} x_t \sin 2\pi ft \right]^2$$  \hspace{1cm} (1)

The periodogram still has some defects that must be corrected by adequate smoothing. In this sense, a spectrum of variable $x_t$ was obtained by a smoothing-filter of five components known as a modified Daniell’s window.

In this paper, the calculations were speeded up by computing periodograms and cross periodograms by a fast Fourier transform such as,

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1 The weights of the split-cosine data window arise from

$$w_p(x) = \begin{cases} 
\frac{1}{2} \{ 1 - \cos 2\pi x/0.10 \}, & 0 \leq x < 0.10/2, \\
1, & 0.10/2 \leq x < 1 - 0.10/2, \\
\frac{1}{2} \{ 1 - \cos 2\pi (1-x)/0.10 \}, & 1 - 0.10/2 \leq x \leq 1,
\end{cases}$$

\[ d_x(f) = \frac{1}{2\pi T} \sum_{i=0}^{T-1} x_i e^{-2\pi i f} \]  

(2)

In the following way

\[ P_{xx}(f) = 2\pi T d_x(f) \overline{d_x(f)} \]  

(3)

where the barred expression denotes a complex conjugate. Finally, the periodogram was smoothed into the spectrum by applying a modified Daniell’s window of five five weights are defined as follows:

\[ w_j = \frac{1}{2(m-1)} \quad \text{for} \quad i = 1 \quad \text{and} \quad i = m \]

\[ w_j = \frac{1}{(m-1)} \quad \text{i otherwise} \]

with \( m = 5 \).

The smoothing of the periodogram with a modified Daniell’s window is described as:

\[ SD_{xx} = \frac{1}{m-1} \left\{ \frac{1}{2} P_{xx}(f-f_2) + \sum_{j=-1}^{1} P_{xx}(f-f_j) + \frac{1}{2} P_{xx}(f+f_3) \right\} \]  

(4)

Each ordinate of the spectrum is a moving average of the periodogram ordinates in the neighbourhood.\(^2\)

The idea of doing the same treatment like in last year paper is to compare results without introducing modifications emerging from the specific differences in the procedure of smoothing.

**Two different behaviours within the total sample**

The first step of the study is to detect whether the structure of periodicities in the period to be corrected differs from that existing in the previous segment of the total sample and what kind of anomalies are connected with the inconsistencies already mentioned.

Therefore, the spectrum of the monthly indicator of economic activity must be compared in the two segments of the time series described above. The total sample (Jan93-Sep11) of figure 1 has two noteworthy segments. One refers to Jan93-Dec02 and has 120 observations (subsample 1), while the other subsample includes data from Jan03-Sep11 with 105 observations (subsample 2).\(^3\)

\(^2\) Bloomfield, Peter, (2000), *op. cit*, p.157..

\(^3\) The year 2002 was included in subsample 1 because it included ups and downs and cannot be considered a year of full recovery. The recovery seems clearer a year after.
The examination starts in the domain of time. The de-trended series of each subsample show the following characteristics:

<table>
<thead>
<tr>
<th>Variable and sample</th>
<th>Obs.</th>
<th>Mean</th>
<th>Variance</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eco. Act. S1</td>
<td>120</td>
<td>1.92E-08</td>
<td>113.68</td>
<td>-30.7</td>
<td>20.14</td>
</tr>
<tr>
<td>Eco. Act. S2</td>
<td>105</td>
<td>-1.46E-07</td>
<td>92.75</td>
<td>-27.73</td>
<td>26.73</td>
</tr>
</tbody>
</table>

Both subsamples have different number of observations and subsample 1 has a bigger variance than subsample 2. The range of variation of the examined variable is almost alike in both subsamples. On the other hand, the pattern of monthly fluctuation within each year (figure 2) repeats itself along time in both cases and keeps a quite similar behaviour.

On this respect, these characteristics may be in part influenced by some procedures of construction of the indicator. At this point it is interesting to take into account some procedures applied by official statistics board in the construction of the indicator.

The National Board of Statistics (INDEC) periodically publishes the monthly index of economic activity and the quarterly indicator of GDP. Both types of information are reconciled by a definite procedure. This institution explains the procedures it uses to conciliate the monthly index of economic activity and the quarterly GDP.4

Later on, Patricia Botargues and Juan Manuel Pacheco wrote a paper with a revision of the methodology of disaggregation and they present several alternative ways explored in the literature. The authors arrive to the conclusion that the choice of the best technique to carry data to monthly periodicity should not differ much from the variation of value added indicator.\(^5\)

Generally, the methods of conciliations introduce some linear and/or non-linear relationships that work as filters. Thus, the Monthly Economic Activity Indicator published by the INDEC eliminates some information by following the procedures of conciliation. In addition, the Laspeyres formulation introduces a further problem. Relative changes in the weight of components are directly ruled off. Therefore, the series obtained may lack some variety of periodic components. The shapes of periodograms seem to reflect a few clear cycles. This is an alternative method to searching a direct improvement in the quality of collecting monthly and quarterly economic activity data.

The conciliation mechanisms are present because of the limitations of the monthly data surveyed for the construction of the index. This may be widely justifiable, but it restricts the meaning of the monthly indicator. Botargues and Pacheco - in their revision - warn that the choice of a particular method should require a clear definition about the use of the economic activity indicator.

For the INDEC, the monthly indicator should only reflect a non-seasonally adjusted indicator, a seasonally adjusted series and a trend and that is enough.

This aim can be accepted but one must be aware that the non-seasonally adjusted indicator already provides some filtered information because of the condition of reconciling the monthly evolution with the quarterly performance of GDP. Thenceforth, the spectral analysis will work with the limited information existing in the series. This is the cost of solving the lack of accuracy in the collection of the monthly data with a conciliation of that data with the quarterly GDP.

Once clarified this point one should go on with the analysis of the subsamples.

At first sight, the deviations from a linear trend in each subsample look alike between subsamples, as seen in figure 2, while the difference seems to emerge from the respective linear trends. Nevertheless, the spectral examinations will detect more subtle changes that cannot be observed at a simple glance.

conciliation with the quarterly series of GDP by the application of the method of Boot, Feibes y Lisman in certain cases and the method of Fernandez for cases in which there exists monthly data.

\(^5\) The monthly disaggregation of quarterly GDP, based on the monthly activity indicator consists in estimating a monthly series that minimizes the distortion with the index of economic activity subject to some conditions. The conditions are such that make the coincidence between the mean of three months being equal to the quarterly GDP index. See, Botargues, Patricia y Pacheco, Juan M. (2004) “Revisión de la metodología de conciliación temporal del estimador mensual de actividad económica con el producto interno bruto”, Dirección Nacional de Cuentas Nacionales del INDEC (it is available on the web).
The spectrum of each subsample is computed with the de-trended data. The de-trending method filters some components at certain frequencies while retains others. For instance, linear de-trending filters some high frequencies and the opposite happens with de-trending by differencing. The present procedure of correction deliberately uses linear de-trending in order to avoid losing information at low frequencies, since there is evidence at first sight that there exists considerable divergence in trend between the two subsamples.

Apparently, the spectra of the two subsamples do not look quite similar as can be seen in the figure 3. There are changes in the distribution of densities for the most important cycles of similar lengths. This means that some basic aspects of the spectral density are not coincident. Therefore, this implies that some part of the structure of oscillations does not repeat itself in both subsamples. This means that there may be some modifications in the dynamics of the economy.

By the way, both subsamples have six relevant peaks in density (Table 1 and figure 3), but they show some particular features that reflects differences in economic behaviour.

In the area of slow frequency, the most outstanding peaks of both subsamples take place at different frequency. In the first section of subsample 1 the highest peak occurs at frequency 0.01172. That implies a cycle of 85-month duration. In the case of subsample 2 the highest peak corresponds to a frequency 0.16797 (cycle length ≈ 6 months). The six relevant peaks for each sub-sample involve some cycles of unequal lengths and some others coincident but with some differences in rank according to density.

<table>
<thead>
<tr>
<th>Frequency cycles/month</th>
<th>Subsample 1 density</th>
<th>Subsample 2 density</th>
<th>Frequency cycles/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01172</td>
<td>104.4</td>
<td>56.2</td>
<td>0.16797</td>
</tr>
<tr>
<td>0.16016</td>
<td>17.9</td>
<td>39.8</td>
<td>0.08594</td>
</tr>
<tr>
<td>0.08203</td>
<td>18.5</td>
<td>19.2</td>
<td>0.25000</td>
</tr>
<tr>
<td>0.25000</td>
<td>14.5</td>
<td>14.4</td>
<td>0.01953</td>
</tr>
<tr>
<td>0.33594</td>
<td>5.8</td>
<td>9.2</td>
<td>0.33594</td>
</tr>
<tr>
<td>0.41797</td>
<td>3.6</td>
<td>8.0</td>
<td>0.41797</td>
</tr>
</tbody>
</table>

Here, there are only two cases where the local maximum location is coincident between subsamples at the same frequency. These are the two last peaks in the table.

On the other hand, though both spectra show some low frequency oscillations, the subsample 2 registers a smaller share of total variance in frequencies below 0.05 than in the subsample 1.

Figure 3 shows clearly the differences between the spectra computed in both subsamples.

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To assess the significance of the differences in spectrum, figure 4 presents the spectrum in subsample 1 with a confidence interval of 95%. The band is defined between the extreme dotted functions (blue). In the same graph the spectrum of subsample 2 is inserted. At very low frequencies most of the density mass of the subsample 2 spectrum is out of the 95% interval of subsample 1.
This leads to the rejection of the hypothesis that there is no significant difference between spectrum of subsample 2 and spectrum of subsample 1 in that range of frequency. For higher frequencies, the spectrum of subsample 2 is located inside the interval. So, one can conclude that there are no significant differences between spectra in that region of frequencies.

Excepting the cycle of 4.3 years (frequency = 0.01953), all remaining cycles in subsample 2 correspond to seasonal oscillations. The long-term cyclical components reflect an almost complete change of dynamic behaviour. The interesting difference between both subsamples, apart from trends, is that long term cycles have lost weight in subsample 2. The long-term adjustment of markets was weakened and most of the dynamics is now centred in the short run.

In fact, this change of behaviour may respond to the maintenance of persistent disequilibria by deliberate action of economic policies, such as use of subsidies to prevent modifications in prices and quantities. This lengthens extremely the movements around equilibrium and most decisions apply to the short period. That is why the spectrum stresses the fast frequency movements. In the subsample 1, the long term cycle representing a peak in the spectrum lasts 7.1 years while in subsample the relative peak correspond to a cycle lasting 4.3 years. The remaining important peaks correspond to cycles of length of one year and less. With the exception of the cycle of 4.3 years of duration, the rest are seasonal oscillations.

The comparison showed that subsample 2 reflects some change in economic behaviour that is impossible to detect with the naked eye. Actually, there seems to have a process of postponing the clearance of markets without time definition. The problem is that such delay considerably increases the costs of the adjustment. The instability of such an action may lead to severe impacts on the economy when the economic policy runs out of steam and the economic forces restores equilibrium on their own.

From the characteristics observed so far, it follows that it is reasonable to think that the main distortion, which produce the inconsistency in growth obeys to the trend existing in the original series. In addition, the loss of importance of long term oscillations expresses some serious alteration in the processes of market clearance. The structure of oscillations remains very similar in both subsamples at seasonal levels.

This should call the attention on part of the responsible of economic policy because it may have severe negative impacts on the economy in the future when the postponing of adjustment is unsustainable. This result supports the diagnosis of persistent disequilibrium of O.E.Baccino (2005).

**The construction of a new trend for subsample 2**

One way to improve the existing indicator of economic activity is to replace the trend component in a stretch of time based on a variable associated with the indicator in the long term. The solution looks trivial, but the justification and the analysis of distortions are not.

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7 For an explanation of such policies that maintain disequilibrium in the long run for certain markets, see O. E.Baccino (2005), “A Case of a Persistent Disequilibrium Policy: Argentina since 2002”, Asociación Argentina de Economía Política. Later, new restrictions were applied such as price control, obstacles to external trade (both exports and imports), foreign exchange controls, etc.
(a) The choice of a specific variable to measure the trend

So the first step is to identify a variable closely related to economic activity specifically in the long term whose trend is associated with the trend of activity.

At first glance, it seems important that this variable should be deeply related to the production process. Another condition should be that this variable can be measured in physical units and its construction does not derive from information of national accounts.

After a search for possible substitutes of trend, the choice fell on the consumption of electricity and natural gas. The point is that both can be measured in physical terms and they should be connected with the economic activity in the long term. This long run relationship should derive from the fact that both are important inputs in general production.

The selection of a variable with a long run trend that could be used to replace the existing trend in the original series for the span of time of subsample 2 requires strong association with economic activity in the long term. Once again the spectral analysis will be useful to decide what substitute fits better the objective.

The series of economic activity, consumption of electricity (Gwh) and consumption of natural gas (millions of cubic meters) for the total samples, that is Jan1993-Sep2011, are compared to detect their behaviour in the long term. A spectrum is computed for each variable (measured as indexes with Jan 1993 = 100) to compare the behaviour at different frequencies (figure 5).
The three spectra are coincident in the distribution of density at frequency 0.0039 implying a cycle with duration of 21.3 years. However, the following important peak of economic activity has a length of approximately 1 year at a frequency 0.0859. It is noticeable that the density is greater than other peaks in the spectrum of gas. For this variable the most important periodicity, correspond to this frequency.

On the other hand, the consumption of electricity does not have a relevant cycle of one year of duration. The only case in low frequency for electricity is the cycle of 21 years while the rest of peaks correspond to oscillation of less than a year.

These characteristics imply that electricity exhibits better similarity with economic activity almost exclusively in areas of high frequency (seasonal oscillations).

On the contrary, the consumption of gas seems more biased towards long-duration oscillations. On these grounds, the gas variable seems a better choice to build a substitute trend for economic activity. Moreover, it should be taken into account that trends are equivalent to oscillations of low frequency in the spectral density function. Then, a trend obtained from a gas series will replace the original on in subsample 2.

In other words, the reason for such a choice is that electricity seems to be mainly associated with the economic activity in the field of fast oscillations. There are many factors determining variations in the consumption of electrical power operating outside the productive sphere. The recurrent fluctuations are concentrated in cycles with lengths shorter than twelve months. The only cyclicity registered by the spectrum in low frequency has a length of 21 years!

This performance is surpassed by the consumption of gas that has its highest peak in the spectrum in the frequency at which electricity has no relevant cycle (f = 0.082031, or equivalently a cycle length of 12 months approximately.

The importance of having relevant low frequency components in the substitute variable similar to economic activity is essential for using its trend to correct the original economic activity series in the segment with problems. The series that provides its trend component should have common long-term oscillations with economic activity. This is quite different from having both series correlated in the time domain.

The bivariate analysis in the frequency domain, of the relationship between electricity and gas consumption with respect to economic activity represents one step further to appraise the interconnection of each variable with the indicator of economic activity alone, since it allows visualising the most convenient choice for correcting the economic activity series.

The main instrument in bivariate analysis used to compare the relationship with economic activity is the coherence function. The coherence function expresses a concept like the $R^2$ between two series, in this case the index of economic activity and a consumption of electricity or gas at each frequency. Furthermore, the function presents a different and independent $R^2$ at each frequency. In each point the value of the function corresponds to a correlation between two cycles of equal length. Figure 6 compares the obtained values of coherence for relations such as economic activity-electricity, and economic activity - gas.

The most noticeable differences occur in the area of low frequencies. The correlation economic activity-electricity shows many low values of coherence in that area, while the correlation eco. activity – gas presents higher values of coherence and introduces a highly correlated cycle of long duration which does not exist for electricity.
In the graph, the blue solid curve presents a wiggly shape, though the higher peaks alternate themselves along the whole range of frequencies. For frequencies lower than 0.15 there is only one big peak very near to f = 0. Outside the range there are peaks of high coherence from 0.15 to 0.5. The densities placed near zero frequency may express existence of leakage, and they must not be taken seriously.

On the other hand, the red dotted line shows a similar wiggly pattern from one end to the other. Several peaks denoting high coherence appears everywhere, even in the low frequency region. The coherence diagrams gives some more support to the fact that in the long term gas consumption might be better related to economic activity as far as oscillations are concerned.

This comparison confirms the adequacy of the choice of gas consumption trend as a valid alternative to modify the original trend in the segment to be corrected in the original series.

(b) The substitution of a new linear trend for the trend of economic activity

A linear trend in the time domain describes a cycle of infinite duration. If this trend is included in the raw data, the spectrum will have an intercept at frequency zero.

Firstly, an average continuous rate was computed for monthly economic activity, gas and electricity along the total sample that is from Jan1993 to Sep 2011. This was obtained by semilog regression of each variable with respect of time t (t = 1, 2, 3,...225).

The slopes of the regression lines such as ln xt = a + bt were:
For Electricity $\rightarrow b = 0.0036433$; Gas $\rightarrow b = 0.0026016$; and Economic Activity $\rightarrow b = 0.0025728$.

It is interesting to notice that the continuous rate of growth of gas consumption is very close to the rate of economic activity. This coincidence reasserts the relationship in the long term even when the distorted information is included in the sample. The following table presents similar regression slopes for each subsample.

When comparing these subsample results, it comes out clearly that there is acceleration in the growth of the three variables in subsample 2. This may be the effect of the economic recovery, but it is also noticeable that the difference in growth between gas and economic activity is great and it may show that the expansion in activity could be overstated.

The trend of gas as follows from the regression is measured in logarithms, so they can be transformed into its levels by applying antilogarithms for each time period. The slope of the regression line expresses a continuous rate of increase for variable $x_t$.

Now, the following paragraphs describe the computation of the substitute trend for the economic activity variable to be applied to the segment of the time series that is corrected.

$x_t$ denotes the original index of economic activity per month $t$. A semilog regression is computed with respect to month $t$ for the total sample ($t=1,2,3,...225$). For subsample 1 ($t = 1,2,..., 120$) and for subsample 2 ($t= 1,2,3,..., 105$).

### Table 2. Growth in Subsamples

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subsample 1 1993-02</th>
<th>Subsample 2 2003-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>0.0033669</td>
<td>0.0040659</td>
</tr>
<tr>
<td>Gas</td>
<td>0.0014347</td>
<td>0.0035489</td>
</tr>
<tr>
<td>Eco. Activity</td>
<td>0.0006949</td>
<td>0.0059363</td>
</tr>
</tbody>
</table>

$y_t = \ln x_t$

$\hat{y}_t = a + \beta t$, where $y_t$ is the logarithm of the observed value of the index $x_t$, and $\hat{y}_t$ is the fitted value of $y_t$.

$Z_t = e^{\hat{y}_t}$ for $t > 120$. $Z_t$ is the antilogarithm of the fitted value of $y_t$.

$Z_t^0 = \mu + \lambda t$ is a linear approximation of $Z_t$ for $t > 120$.

Let $\epsilon_t$ be the de-trended $x_t$ for the sample 2, from Jan 2003 to Sep 2011,

Then, define $x_t^c$ as the corrected segment of the original economic activity indicator and consists of the linear approximation of $Z_t$ plus de-trended $x_t$. 
Therefore, these new values replace the original ones in the mentioned range. (See Appendix 2).

The inclusion of the indicator of O.J. Ferreres was to compare the original and the new series with one index of private source.

The General Activity Index of Ferreres moved very close to the one of the INDEC until the second part of 2008. Then it is gradually moving away below the official index of economic activity.

The new series kept the rising trend but at a slower rhythm than the original monthly estimator. Now this evolution gets more compatible with the evolution of other variables. Particularly, the annual rates are not steady at all in the long term and they adopt an oscillatory variability that makes more sense. No “Chinese rates” appear any more in the new series. The level of growth rates went to more credible standards in connection with the performance of other areas of the economy.

\[ x_t^c = Z_t^0 + \varepsilon_t \quad \text{for } t > 120 \text{ (from Jan 2003 to Sep 2011)} \] (5)

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8 Orlando J.Ferreress & Asociados consulting firm provides its General Activity Index (IGA) in the Web and presents it as an unbiased estimate of monthly GDP. It also mentions that a set of 122 statistical series are periodically used to construct the monthly indicator of economic activity.
It is also interesting to observe what happens with the annual rates of growth of the three series considered from 2002 to 2010. The indicator of economic activity presented with quarterly periodicity is equivalent to the real index of GDP owing to the conciliations between both sources of data.

Table 3 presents the annual rates of growth of economic activity from 2002 up to 2011 of the three series shown in figure 7.

<table>
<thead>
<tr>
<th>Year</th>
<th>Indec</th>
<th>Newseries</th>
<th>O.Ferreres</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>-10.9</td>
<td>-10.9</td>
<td>-10.7</td>
</tr>
<tr>
<td>2003</td>
<td>8.8</td>
<td>5.8</td>
<td>8.7</td>
</tr>
<tr>
<td>2004</td>
<td>9.0</td>
<td>3.0</td>
<td>8.9</td>
</tr>
<tr>
<td>2005</td>
<td>9.2</td>
<td>3.9</td>
<td>8.9</td>
</tr>
<tr>
<td>2006</td>
<td>8.5</td>
<td>3.9</td>
<td>8.8</td>
</tr>
<tr>
<td>2007</td>
<td>8.6</td>
<td>4.7</td>
<td>8.8</td>
</tr>
<tr>
<td>2008</td>
<td>6.8</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>2009</td>
<td>0.8</td>
<td>-4.1</td>
<td>-4.1</td>
</tr>
<tr>
<td>2010</td>
<td>9.2</td>
<td>7.0</td>
<td>8.2</td>
</tr>
</tbody>
</table>

Now the corrected indicator shows a more reasonable behaviour. The annual rates were fluctuating and the steady growth at very high rates was removed. Now, there are not such traces of "balanced growth". The inconsistency of very high steady rate was eliminated.⁹

The recovery that took place since 2002 onwards still remains but at a more realistic rhythm if one takes into account the performance of employment, and other aggregates in the economy.

The original indicator described conditions of "balanced growth" at very high rates until 2007. Then, a slowing down took place but the rates were still maintained at very high levels. The O.J. Ferreres indicator shared this behaviour until 2008. However, later O.J.Ferreres index diminished its growth and got closer to the new series.

Unfortunately, O.J.Ferreres’s index also keeps for some years a steady growth like the INDEC indicator: Here the comments made about the INDEC’s original series apply to Ferreres’s. Perhaps, the current practice of treating growth in aggregate terms made many economists to overlook the requirements of steady growth and they preferred to consider it as fast growth with inequality as it was stated several times in the media.

On the other hand, the inconsistent balanced growth prevailed in the figures since 2003. The original indicator of economic activity definitely has overstated the

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⁹ These rates are constructed from the monthly rates of the Indicator and they are coincident with the annual rates of GDP. These rates were often described as “Chinese rates”. These growth rates made many people to believe in an exceptional expansion taking place in Argentina, but they did not much to relate them with other macro-variables, which followed a different path. It is surprising that this situation did not generate important questions in economic analysts, even today.
economy's growth quite before 2007. The year 2007 was very important when the understatement of inflation by the INDEC became evident.

The phenomenon of the high steady growth rate calls the attention by two main aspects: (i) the ‘balanced growth’ condition; and (ii) the magnitude of the rates.

There are no clear reasons for the productive system to behave like that unless the figures include some operations which are not usually registered in the national accounts. The lack of steady growth at high rates is quite detectable if one looks at the sector behaviour in production, but the other alternative is very difficult to be ascertained without a profound search of the data quality.

**Testing the bivariate relationship of economic activity with employment with quarterly new series**

The analysis made in 2011 with quarterly series of GDP and Employment showed some peculiar characteristics for Argentina. Those were very different from analogous analysis made upon the US data. That study aimed at the relationship between aggregate output and a given index of employment. Now the new series replaces the old and new conclusions arise.

In this section, the analysis is re-made using the corrected series of economic activity. The results were compared to those of last year. This implies to express the data per quarter. In fact, the quarterly indicator expresses the GDP of Argentina. The series of employment is the same like the used in last year paper. The period was also alike.

The bivariate spectral analysis detects the relationship between GDP and employment in the frequency domain. The analysis starts from the cross spectrum and from it derives the following real functions:

i) Coherence function

\[ \kappa^2(f) = \frac{\text{co}^2(f) + q^2(f)}{S_{yy}(f)S_{xx}(f)} \]  

(6)

where \( \text{co} \) is the cospectrum and \( q \) is the quadrature spectrum as functions of the frequency

ii) Phase function

\[ \phi(f) = \tan^{-1}\left(\frac{q(f)}{\text{co}(f)}\right) \]  

(7)

In this work it is possible to detect the existence of anomalies in the official data, but the analysis cannot conclude about the real causes of those anomalies. The reasons might be voluntary alterations of the information, problems of defective statistical procedures, and so on. To reach conclusions about real causes of misinformation would require an audit of methods and processes of construction of the indicator. Meanwhile, it urges to locate the main distortions in the statistical series and see if the series can be improved by partial adjustments until the audit comes up.
The coherence function should be interpreted as the square of the correlation coefficient, and the phase function is used to find the lead-lag relationship between the series\textsuperscript{11}.

The following step is to evaluate the relationship between GDP & employment with the original GDP series and with the corrected version. Regarding the function of coherence (figure 8), the new series introduces some changes in particular for frequencies lower than 0.2. For some frequencies the new series has more correlation between both variables and in others the coherence is smaller.

In the region of higher frequencies the scene is quite analogous in terms of correlation between GDP & employment both for original and corrected indexes.

Something similar happens with the Phase function in figure 9. There some major differences introduced by the new series of economic activity that take place at frequencies below 0.2, but there are some similarities within the range 0.25–0.5 in the area of higher frequencies.

Firstly, the relevant change particularly takes place in the cases where employment leads economic activity.\textsuperscript{12} The lead of employments is longer than with the original


\textsuperscript{12} There is a particular modification in sign on the phase function occurred at a very low frequency such as 0.0039603. This modification at a very low frequency obeys to a change in sign in the corresponding element in the real part of the cross spectrum. These changes take place very near the axis and are very difficult to interpret due to several factors that may be
series. Presumably, some of the problems of construction in the series of occupation continue affecting the relationship with the new series. It is clear that the in the long term employment and activity are less synchronised. This is a peculiarity of the Argentine case and it was explained in O.E.Baccino 2011).

The increase in the lead of employment over GDP represents a relative reduction in $\phi$, or phase parameter of the cycle function of economic activity, at the corresponding frequency, with respect to the $\phi$ parameter of the cycle function of employment. This situation pushes down the ordinate in the new phase function with respect of the old.

Another feature that is worth noticing is that the phase function with the corrected series shows greater amplitude than the old phase in the range of low frequencies. This implies that at those points, the lags or leads become longer than the ones corresponding to the relationship between the original GDP series and employment. (2011).

Secondly, the new series brought about important negative ordinates at frequencies below 0.25. These changes pushed the mean downwards. Now it is clear that the combination of partial modifications in the trend of original data had its impact in the relationship between time series.

influencing the result. Several general alterations may produce results at the extremes of the series. For instance, different conditions of smoothing can produce different signs at the mentioned frequency. Therefore, this case was not essential owing to the proximity to the vertical axis.
The substitution of trend in the original series produced some improvements, particularly in the removal of inconsistencies, but those modifications are not sufficient to be a general approximation to reality. The present method stands on certain assumptions and it concentrates the improvements in certain region of the long-term behaviour.

Some general features of the Coherence and Phase in terms of mean and variance appears in table 4. Here, the USA exercise is included in the comparison of the bivariate analysis. The comparison with a bivariate spectral analysis performed upon similar variables in the USA, with the same treatment as far as tapering, padding and smoothing are concerned, gives an experience with information that does not offer doubts.

<table>
<thead>
<tr>
<th></th>
<th>New Emae</th>
<th>Original Emae</th>
<th>USA</th>
</tr>
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<td></td>
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<td>Phase</td>
<td>coherence</td>
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<td>Mean</td>
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<td>0.0451</td>
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<tr>
<td>Variance</td>
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<td></td>
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At this level, the values look very similar among cases. However, the US example shows a higher coherence on the average. However, the phase values are quite different between USA and Argentina. The differences mainly arise from the disparity of mean values for the Phase function. The Argentine cases have a mean very close to zero and relatively higher variances.

In particular, the most outstanding feature of the new phase (figure 9) is the shrinkage of the region of leads of employment on economic activity at very low frequencies. As frequency rises, the behaviour of the new phase function becomes very similar to the obtained with the original series.

A series of leads of employment over economic activity in the region of low frequencies allows comparing their lengths for the three alternative computations in Table 5. Within the table, the green area shows the shrinkage of the region mentioned above, and the features of the US case.

The Argentine computations receive influences from the difficulties introduced in the construction of the employment data. Therefore, in a separate test, with the original sample of 70 observations, without tapering and padding, some cycles computed by regression for each Argentine alternative showed the negative impact on $\phi$ in the economic activity cycle based on the new series.

Each cycle is usually defined in terms of length, amplitude and phase. The estimate with the corrected series produced a smaller phase. On the other hand, the phase of the corresponding cycle in employment was not changed by definition, and it is the same in any calculation. Since the phase of the case with the corrected data has a smaller phase, this implies a lengthening of the lead of employment over GDP as it follows from the table.
### Table 5. Leads(+) & lags(-) of Employment over GDP

<table>
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<tr>
<th>Frequency</th>
<th>GDP = New series lead/lag year</th>
<th>GDP = Old series lead/lag year</th>
<th>USA lead/lag year</th>
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<td>23.45 5.9</td>
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<td>0.0078125 28.00 7.0</td>
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</table>


The value of lead or lag follows from \( t = -\Phi(f)/(2\pi f) \). When \( t > 0 \), employment leads economic activity and the converse occurs when \( t < 0 \). If \( t = 0 \), both variables have the same phase and move synchronously. The interpretation of the sign depends on the way of doing the calculations.\(^{13}\)

The new series does not improve the relationship in terms of shortening the lead of employment over economic activity and therefore, the employment itself should be corrected\(^{14}\). The US relationship implies a considerable short lead and a better synchrony.

The next step is to compare the Spectrum of quarterly economic activity (GDP) between the corrected series and the original one. Both estimates are presented in the figures 10.a and 10.b respectively. These functions are shown within an interval of confidence of 95%. The spectra are measured in logarithms in order to avoid problems of scale in the graphs. This is due to that the limits of the interval are proportional to the Spectrum function.

Both spectra are quite the same except for very slight differences in the range of frequencies denoted between 0.05 and 0.2 approximately.\(^{15}\) Besides, this comparison

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\(^{13}\) In the case of coherence any way of doing the calculations arrives at the same result. This is not the case for the phase function. The interpretation given to +/- sign of the phase, depends on the way the cross spectrum is computed.

\(^{14}\) The problems of measurement of employment were already commented in O.E. Baccino (2011).

\(^{15}\) The graph 10.b should correspond to the figure 2.4 in p.6 of O.E.Baccino (2011). However, the author realised that a mistake took place in the computation of the equivalent degrees of
refers to the quarterly series of economic activity that implies filtering further high frequency oscillations.

The bivariate analysis of economic activity and employment maintains and enhanced some difficulties produced by the Argentine data. The correction of economic activity is not enough. It is required the revision of the employment data because the log term relationships cannot be properly interpreted.

It is likely that a greater problem may be threatening the consistency of national accounts as a system. The problem of registered and non registered data may become more important as time goes by. In the beginning of the period under analysis, there were situations in which growth in production coexisted with lack of current investment and high levels of consumption, and many other problems of this kind.

freedom with the result that the interval limits were miscalculated. For example, \( c_T \) should be 1.05511. Then, after correcting the following computations, one arrives at \( \nu = 2.2961 \), (equivalent degrees of freedom), and the inequality (5) becomes \( 0.287 \ S(f) \leq S(f) \leq 26.3 \ S(f) \) where the bold letter symbols are estimates.
This type of difficulties cannot be solved with the methods employed here alone, since it produces strange results that are difficult to interpret. The actual solution requires an examination of the system of data collection and how to deal with unrecorded data.

**The Spectrum of the Corrected Monthly Indicator**

The new series of the indicator of economic activity includes a corrected set of data as a result of the replacement of a partial segment of trend. The latter was estimated on the basis of the long run trend in gas consumption. The original and corrected segments of the economic activity indicator are shown in appendix 2.

The spectrum of the new series is coincident with the spectrum of the original data except in the area below the curve at very low frequency. Obviously, the substitution of partial segments of linear trends necessarily operates as the introduction of additional filters that modify the structure of oscillations in the very low range of frequencies.

This can be seen in figure 8. The bigger differences between spectra occur below frequency 0.043. The lower frequency the difference grows bigger. At the highest peak, the old spectrum is 4.2 times the new spectrum while the proportion declines to 1.56 at frequency 0.043. Above the limit of 0.043 the differences are very small and they change their sign almost alternatively.

These changes are responsible of the elimination of steady growth that was characteristic of the original series.

![Fig. 11](image_url)

Finally it is interesting to estimate confidence intervals for the new spectrum.

The influence of tapering, padding and smoothing upon the variance is determined by:

\[
c_T = \frac{U_2}{U_2^2} = 1.05511132 \quad \text{(tapering)}
\]

where \( U_2 = \frac{1}{T} \sum u_t^2 \) and \( U_4 = \frac{1}{T} \sum u_t^4 \) with a data window \( \{u_t: 0 \leq t \leq T\} \).

\[
c_P = \frac{T^*}{T} = \frac{256}{225} = 1.13777778 \quad \text{(padding)}
\]

\[
g^2 = c_T \, c_P \, \sum g_u^2 = 0.26260548 \quad \text{(smoothing)}
\]
\[ \nu = 2 / r^2 = 2 / 0.26260548 = 7.61598716 \text{ (equivalent degrees of freedom)} \]

The 95% confidence interval of the spectrum is determined as follows,

\[ \frac{7.616}{16.954513} \hat{s}(f) \leq s(f) \leq \frac{7.616}{1.9876635} \hat{s}(f) \]

The distribution is a chi2 function that generates asymmetric interval limits. For instance,

\[ \chi^2_{\nu}(0.975) = 16.954513 \text{ and } \chi^2_{\nu}(0.025) = 1.9876635. \]

The dotted lines define the 95% confidence interval of the spectrum obtained from corrected data (figure 9).

The asymmetry of interval limits with respect to the estimated spectrum emerges from the asymmetry of the \( \chi^2 \) function as can be noted from the inequality above.

The monthly indicator of economic activity from period 2003 onwards looked very suspicious since it showed conditions of steady growth at very high rates. This kind of expansion is very inconsistent for Argentina. In that part of the series, the activity evolved around a rising linear trend very steep. In fact, since 2003 there was a long period of recovery in the economy, mainly supported by very favourable external prices for export products, but with a very difficult situation for investment and lack of foreign financial assistance. The long period of recovery actually exists but it is far from conditions for steady growth.
No doubt, such long-term growth has been overstated and this seems untenable if one looks at other variables of the economy. This is clear if one considers the heterogeneous expansion of different branches of production, the structure of relative prices, and the continuous disequilibrium forced by economic policy through measures of control, taxation and trade restraints.

A trend usually reflects the direction of the economy in the long run because of population growth, changes in technology, modernisation of institutions and methods of production, etc. However, the conditions of operation of the economy being unable to attract foreign capital, with a strange system of domestic incentives, which are increasingly supported by subsidies, are creating further imbalances along time and setting new obstacles to growth.

Therefore, in this paper, it was implemented a substitution of the original trend by a new one estimated on the basis of the consumption of gas variable, which renders a series more credible. The removal of the inconsistency shows a recovery at variable lower rates at more reasonable levels.

The need of the substitution is that the original trend between 2003 and 2011, could not be explained by economic reasons, There was no reason whatsoever that could push up the average economic activity in the magnitude depicted by the original series.

There are other constraints operating in the monthly indicator published by the INDEC, which also limited the reach of the spectral analysis. The conciliation between the monthly data and the quarterly GDP imposes certain filters to the unadjusted data thus reducing the amount of information about periodicities.

By the way, in this analysis it is impossible to conclude whether the wrong trend arises either from the monthly data or from the quarterly data of the GDP or from both sources. INDEC believes that GDP is more accurate than the monthly indicator. This may be so, but the high levels of trend in the original series may derive also from a defective process of constructing the GDP series. That is why, there is an urgent need to make a thorough audit of the method of construction of both types of indicators.

In Argentina, for many years, the economic aggregates have undergone important changes in the composition in real terms and in relative prices. Perhaps, the macro aggregates will improve if transformed in real terms by means of chained indexes like it happens in the USA.

The application of the spectral analysis has proved to be helpful in identifying aspects, which cannot be seen at first sight. The distortions mainly took place in the region of low frequency, or in other words, with oscillations of long duration. These seem less likely to happen by limitation in the collection of data. They could be the outcome of overstating activities at sector level. In a previous article, the author examined the composition of GDP and threw some light on the matter.

The spectrum of economic activity changes from subsample 1 to subsample 2. This outcome appears as a loss of weight of long-term cyclicities. The loss of importance of long-term oscillations expresses some serious alteration in the processes of market clearance. In economic terms, some long run fluctuations have disappeared because the economy may be undergoing a process of persistent disequilibrium. Control devices, though unable to be maintained indefinitely in the future, postponed the disequilibrium through time.
As it was mentioned in previous papers already quoted, the spectral analysis allows identifying the problems but it cannot determine the reasons of the distortions. The latter may arise from different causes, and the identification of them should emerge from a thorough audit of the index construction. So far, there was some official reluctance to do it, but in so far as the information problems increase, the quality of data and statistical procedures will have to be revised in a deep and efficient manner. Otherwise, the statistics becomes useless.

References


* Orlando J Ferreres & Asociados S.A: – CENTRO DE ESTUDIOS ECONOMICOS
## Appendix 1: Annual rates of Change of Industrial Activity according to the INDEC

### % Annual Rates of Change of Industrial Activity (EMI)

<table>
<thead>
<tr>
<th>Periodo</th>
<th>EMI</th>
<th>Alimentos y bebidas</th>
<th>Productos del Tabaco</th>
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### % Annual Rates of Change of Industrial Activity (EMI)

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(1) Present paper

(2) INDEC