COMPUTING TURNING POINT MONTHLY PROBABILITY OF THE ARGENTINE ECONOMY ACCORDING TO THE LEADING INDEX. 1973-2000

JUAN MARIO JORRAT
ANA MARÍA CERRO

Abstract

Two indicators of the Argentinean economic cycle prove to be useful for economic forecasts, the leading and coincident indexes. The former points out the level of economic activity monthly. The latter anticipates the future direction of the economy.
The purpose of this paper is to estimate the monthly peak and trough probabilities, in the business and growth cycles using the Neftci's sequential probability recursion. We first determine the probability density function that best adjusts to the observed frequency of the monthly leading index rate of change. The results obtained by the probabilities are evaluated in each case.

Resumen

Dos indicadores del ciclo económico argentino resultaron de utilidad para las predicciones económicas: el índice coincidente y el índice líder. El primero señala el nivel de actividad económica mensual. El segundo anticipa la dirección futura de la economía.
El propósito de este trabajo es estimar las probabilidades mensuales de picos y valles, tanto en el ciclo básico como de crecimiento, utilizando las probabilidades secuenciales recursivas de Neftci. Se determina primero la función de densidad de probabilidad que mejor ajusta la frecuencia observada de la tasa de cambio del índice líder mensual. Los resultados obtenidos por las probabilidades se evalúan en cada caso.

JEL Classification: *E32,C63*

Keywords: *Economic cycles, Argentina, leading index*

□ Universidad Nacional de Tucumán, Instituto de Economía Aplicada, Fundación Banco Empresario de Tucumán. E-mail: jjorrat@herrera.unt.edu.ar
□ Universidad Nacional de Tucumán. E-mail: acerro@herrera.unt.edu.ar

1. Motivation

Two indicators of the Argentinean economic cycle prove to be useful for economic forecasts: the leading and coincident indexes.

The methodology used in the construction of these indexes is quite similar to the one developed by The National Bureau of Economic Research (NBER), the Center for International Business Cycle Research of Columbia University (CIBCR), and The Conference Board (TCB) for US.

The coincident index points out the level of economic activity monthly. It is a broader definition than the GDP concept. This index includes variables related to the Industrial Production Index, Total Real Imports, Building Industry Activity Level, Total Real Wages Paid by the Manufacturing Industry and Gross Collection of the Value Added Tax, besides the GDP.

The turning points, peaks (local maximum) and troughs (local minimum), of the coincident index define the recessions and expansions of the economy in the business cycle analysis. In the growth cycle analysis, the turning points are determined by the deviations from the long run trend. Decelerations and accelerations of the economy are the growth cycle phases.

The leading index anticipates the future direction of the economy. It summarizes the information related to expected profits and orders of new capital goods. The leading indicators are:

1. Real Value of Buenos Aires Stock Market Index;
2. Real Money Supply;
3. The Number of Appeals to be Declared Bankrupt;
4. Relative Price of Services to the CPI;
5. Monthly Average Hours per Worker Index in the Manufacturing Industry;
6. Labor Average Productivity in Manufacturing Industry;
7. Ratio of Manufacturing Prices to Unit Labor Cost;
8. Building Permits.

The leading index has its turning points, peaks and troughs, in advance of the coincident index. The leading indicator predicts the coincident index turning points in an average of five-month advance with 92% of accuracy, Jorrat (1996 and 1998).

While the coincident index depicts the present condition of the economy related to the business cycle, the leading index points out the future direction. Both indexes show where the economy is and where it is going.

One of the proposed rules to determine the proximity of an economic turning point take into account the sign and magnitude of the changes in both indexes produced in the last three months. They also compare the change rates with the GDP long run annual growth rate. Nevertheless, they do not allow us to figure out the occurrence probability of a turning point in the current month.

The purpose of this paper is to estimate the monthly probability of peaks and troughs, in the business cycle as well as in the growth cycle. We first determine the probability density function that best adjusts to the observed frequency data of the leading index. The results obtained by the probabilities are evaluated in each case.

2. Theoretical Framework

The theoretical analysis is based on the models proposed by Neftci (1982), and Diebold and Rudebusch (1989). The leading index is frequently used as predictor of business cycle peaks and troughs. As the leading index signals happen before the coincident index turning points, they are used to anticipate the turning points in the economy.

The behavior of the economy changes in the expansions and contractions. The leading index has a probability distribution function that switches at turning points. We are interested in recognizing the date at which this change in the probability density takes place, so that it helps in the prediction of turning points in the economic business and growth cycles.

The observations on X_t (the leading index), will be used to predict the moment in which the change in regime takes place (turning points). In this way we can obtain a prediction rule that yields early warnings while minimizes false signals.

We suppose that there are two stochastic processes: X_t and Y_t where Y_t represents the observation of the coincident index. The latter index has two probability distribution functions of expansion and of recession regimes of the business cycle (acceleration and decelerations of the growth cycle). A turning point is defined as the precise moment in which the change in the coincident index probability distribution takes place. The aim of the forecast is to predict the turning points in Y_t in an optimal way. The switch in the probability distribution of Y_t also happens in the distribution of X_t but in advance of the change in Y_t, so, knowing the distribution of X_t helps us to predict the turning points in Y_t.

Let Z_x be the integer number that represents the first period after a turning point, precisely a peak in the leading index, and F^u and F^d the probability distribution of recoveries and contractions of X_t respectively, we have:

(1)
$$\begin{aligned} X_t &\sim F^u(x_t), \quad for \quad 1 \le t \le Z_x \\ X_t &\sim F^d(x_t), \quad for \quad Z_x \le t \end{aligned}$$

At time t the forecaster has to decide whether to signal a turning point or not. By doing so he takes into account the value of the probability of the corresponding month. The forecaster must have in mind that whether a turning point is incorrectly signaled or not signaled at all, a mistake is committed (false alarms and/or missed calls). The aim of building an optimal rule is to give early signals minimizing the number of false signals.

After observing X_t, the probability of signaling a peak can be decomposed by the Baye's formula:

(2)
$$P_t = P(Z_x \le t / x_t) = \frac{P(x_t / Z_x \le t)\,.\,P(Z_x \le t)}{P(x_t)}$$

Where $P_t = P(Z_x \le t / x_t)$ is the posterior probability of a turning point given the information of the leading index available at the moment t.

The posterior probability seen in expression (2) can be expressed in a convenient recursive formula, which in case of a peak is given by:

$$(3)\quad P_t = \frac{(P_{t-1} + \Gamma_t^u (1-P_{t-1}))\quad f^d(x_t / x_{t-1})}{(P_{t-1} + \Gamma_t^u (1-P_{t-1}))\quad f^d(x_t / x_{t-1}) \;+\; (1-P_{t-1})\quad f^u(x_t / x_{t-1})\quad (1-\Gamma_t^u)}$$

Where $\Gamma_t^u = P(Z_x = t / Z_x \geq t)$ is the probability of a peak in the period t given that it did not happen before. The last observation probability density is $f^u(x_t / x_{t-1})$ in recovery regime, while $f^d(x_t / x_{t-1})$ is in a contraction state, both under the condition of previous observations of x_{t-1}.

If the sequential probability recursion (SPR) exceeds a critical predetermined value, a peak is signaled in X_t, the leading index, at the moment $t = Z_x$. Therefore it can be associated with an imminent turning point in the coincident index Y_t.

3. Sequential Probability Recursion Evaluation

We use a variety of techniques to evaluate the probability forecasts following the paper by Diebold and Rudebusch (1989). The evaluation of turning point predictions, based on the leading index, uses accuracy and calibration as attributes.

Accuracy refers to the predicted probability (P_t) closeness, on average to observed realization (R_t), as measured by a zero-one dummy variable. To measure accuracy we use Brier's Quadratic Probability Score (1989), which is analog to the Mean Squared Error:

$$(4)\qquad QPS = \frac{1}{T}\sum 2\,(P_t - R_t)^2$$

QPS ranges from 0 to 2; 0 corresponds to perfect accuracy.

The logarithm of the probability score (LPS) is another accuracy-scoring rule also considered:

$$(5)\qquad LPS = -\frac{1}{T}\sum\left[(1-R_t)\ln(1-P_t) + R_t\ln(P_t)\right]$$

The LPS ranges from 0 to infinity; 0 corresponds to perfect accuracy. The difference between QPS and LPS is the implicit loss function; the former is quadratic and latter is logarithmic. Another difference between those scorings is that larger mistakes are less taken into account by the LPS.

Calibration refers to the closeness of forecast probabilities to observed relative frequencies. It is measured by the global squared bias:

$$(6)\qquad GSB = 2\,(\bar{P} - \bar{R})$$

The GSB ranges from 0 to 2; 0 corresponds to the case in which the average probability forecast equals the average realization.

4. Empirical Analysis

The following steps are used to analyze Argentinean data:

a) Turning points of the leading index are determined by the NBER methodology according to Bry and Boschan (1975). In classical analysis, we set contraction and recovery periods, while in the growth analysis (deviations from trend), deceleration and acceleration are specified.
The time span, January 1973 to June 2000 (1973.01-2000.06), is classified in leading index contraction and recovery months according to the classical analysis; and in decelerations and accelerations considering the growth analysis.

b) Different leading index rates of growth are classified in two different states: contractions and recoveries, in the classical analysis; and decelerations and accelerations in the growth study.
Statistical analysis is performed for each state. Two different density functions (normal and Laplace distributions) are adjusted to the corresponding histogram. A goodness of fit test is carried out to determine which function adjusts better in both stages.
We decide the use of a particular change rate according to previous results.

c) We calculate the Sequential Probability Recursion (SPR) on each state of the business cycle (or growth cycle) based on the previously estimated density function of the selected change rate.
We establish the critical value of SPR equal to 0.90.
We set the initial value of a trough SPR (expansion probability) to zero at the beginning of a business cycle recession. Immediately afterwards the sequential probability recursion is applied until it reaches the critical value. When this happens a trough signal is detected. The same procedure is applied at the beginning of a business cycle expansion. Both analyses are also carried out for the growth cycle.

d) Finally, we evaluate the performance of the SPR, based on the Quadratic Probability Score (QPS) and in the Global Squared Bias (GSB).

4.1. Leading index turning point determination

Leading index turning point determinations are carried out according to the methodology of the NBER and using the Bry and Boschan's computing program (1971), to both business and growth cycles.

Business and growth cycle dates and leading index turning points are exposed in Charts 1 and 2. There are more growth cycles than business cycles (Chart 1). The number of leading index turning points in growth analysis is greater than in the classical study. The same conclusions are reached by all the empirical studies.

CHART 1
ARGENTINEAN BUSINESS AND GROWTH CYCLE DATES,
COINCIDENT INDEX PEAKS AND TROUGHS, 1973-2000

Business Cycle		Growth Cycle	
Trough	Peak	Trough	Peak
	1974.12	1973.07	1974.12
1976.05	1977.07	1976.05	1977.07
1978.03	1980.08	1978.03	1980.08
1982.06	1984.06	1982.06	1984.06
1985.08	1987.07	1985.08	1987.07
1990.02		1990.02	1992.04
		1992.12	
	1994.12		1994.05
1995.08	1998.06	1995.08	1998.06
1999.07	1999.12		

Source: Jorrat (2000).

CHART 2
ARGENTINEAN LEADING INDEX TURNING POINTS,
CLASSICAL AND GROWTH ANALYSES, 1973-2000

Classical Analysis		Growth Analysis	
Trough	Peak	Trough	Peak
	1974.12		1974.07
1975.08	1977.03	1975.08	1977.03
1978.01	1980.04	1978.01	1979.06
1981.09	1982.08	1981.09	1982.08
1983.07	1984.03	1983.07	1984.03
1985.05	1986.05	1985.06	1986.01
1987.12		1988.04	1989.10
		1990.04	1992.03
	1994.11	1992.11	1994.01
1995.06	1998.05	1995.07	1997.10
1998.12	2000.02	1998.12	2000.02

Source: Jorrat (2000).

4.2. Probability distribution of several leading index change rates

All the series used to build the coincident and leading indexes are seasonally adjusted. Consequently both indexes are series without seasonal movements. Therefore we can compare one month with the previous one.

Three monthly change rates are used in this stage. The first one is the TCM, which lacks the seasonal component. It can be thought as composed of monthly changes in the trend, in the cycle and in the irregular components. It is defined by:

$$TCM = \left(\frac{x_t}{x_{t-1}} - 1 \right) 100 \tag{7}$$

The second change rate is the TCIA, which compares each month with the corresponding one of the previous year:

$$TCIA = \left(\frac{x_t}{x_{t-12}} - 1 \right) 100 \tag{8}$$

The third one is the TCSA, suggested by Moore and Zarnowitz (1982), that relates the current month to the previous year average. The TCSA is expressed as a compound annual rate:

$$TCSA = \left(\left(\frac{x_t}{\sum_{j=1}^{j=12} x_{t-j}} \right)^{12/6.5} - 1 \right) 100 \tag{9}$$

Where the exponent to calculate the compound rate is 12/6.5; 12 is the length of the year and 6.5 is the distance between the current month and the previous year average.

The leading index change rates are classified into contractions or recoveries. The location and variability measures of the three defined change rates can be seen from Chart 3.

Normal and Laplace densities are fitted. The former is a well-known distribution and is not presented here. The latter is the following one:

$$f(x) = \frac{1}{2\beta} e^{-\frac{|x-\alpha|}{\beta}}, \text{ for } \beta > 0 \text{ and } -\infty < x < \infty \tag{10}$$

see Johnson (1970).

CHART 3

LEADING INDEX DESCRIPTIVE STATISTICS OF THE MONTHLY, ANNUAL, AND SMOOTH ANNUAL CHANGE RATES; MONTHLY OBSERVATIONS, PERIOD 1973.01-2000.07

Change Rate	Statistics	Classical Analysis		Growth Analysis	
		Contractions	Recoveries	Decelerations	Accelerations
Monthly Change Rate	Observations	95	233	156	172
	Minimum	–9.2	–5.9	–9.2	–5.6
	Maximum	2.6	4.9	3.3	4.9
	Mediam	–0.7	0.6	–0.4	0.8
	Mean	–0.9	0.6	–0.5	0.9
	Median Dev.	1.1	1.0	1.1	1.1
	Std. Deviation	1.5	1.5	1.5	1.5
Annual Change Rate	Observations	95	233	156	172
	Minimum	–13.6	–12.9	–13.6	–12.9
	Maximum	18.3	22.4	22.4	20.6
	Median	–1.1	4.3	0.7	3.8
	Mean	–1.2	4.1	1.1	3.9
	Median Dev.	4.6	5.2	5.0	5.6
	Std. Deviation	6.3	6.6	6.6	7.0
Smoothed Annual Change Rate	Observations	95	233	156	172
	Minimum	–19.6	–17.8	–19.6	–17.8
	Maximum	10.7	25.6	18.5	25.6
	Median	–2.6	4.8	–0.4	5.7
	Mean	–3.5	5.1	–1.0	5.8
	Median Dev.	4.8	5.4	5.2	5.7
	Std. Deviation	6.0	7.1	6.6	7.4

Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

The maximum likelihood estimators for the Laplace distribution are:

$$\hat{\alpha} = \textit{Sample Median} \qquad (11)$$

and

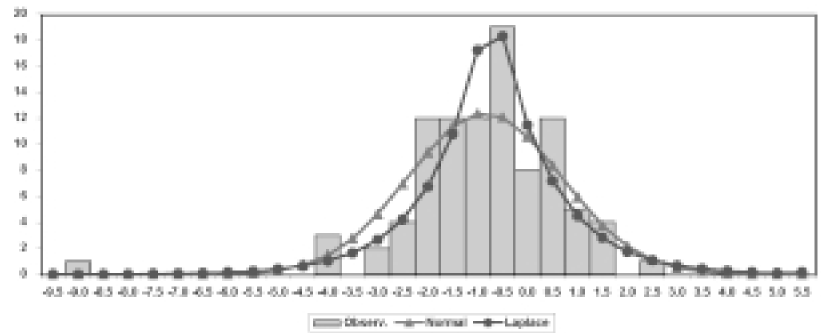
$$\hat{\beta} = \frac{1}{T}\sum \left| x - \textit{Sample Median} \right| \qquad (12)$$

Normal and Laplace densities are fitted using the maximum likelihood estimators of the previously defined rates. The frequency distribution and the fitted densities of the monthly change rate (TCM) are presented in Graphs 1 and 2.

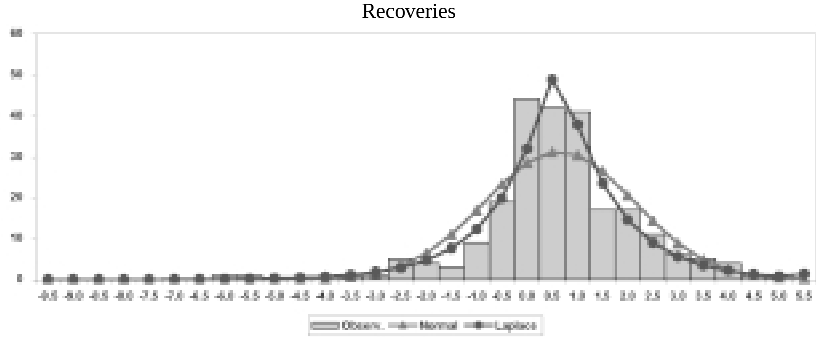
GRAPH 1

LEADING INDEX MONTHLY CHANGE RATE FREQUENCY DISTRIBUTION AND FITTED NORMAL AND LAPLACE DENSITIES; CLASSICAL ANALYSIS; ARGENTINA, 1973.01-2000.07

Contractions



Recoveries



Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

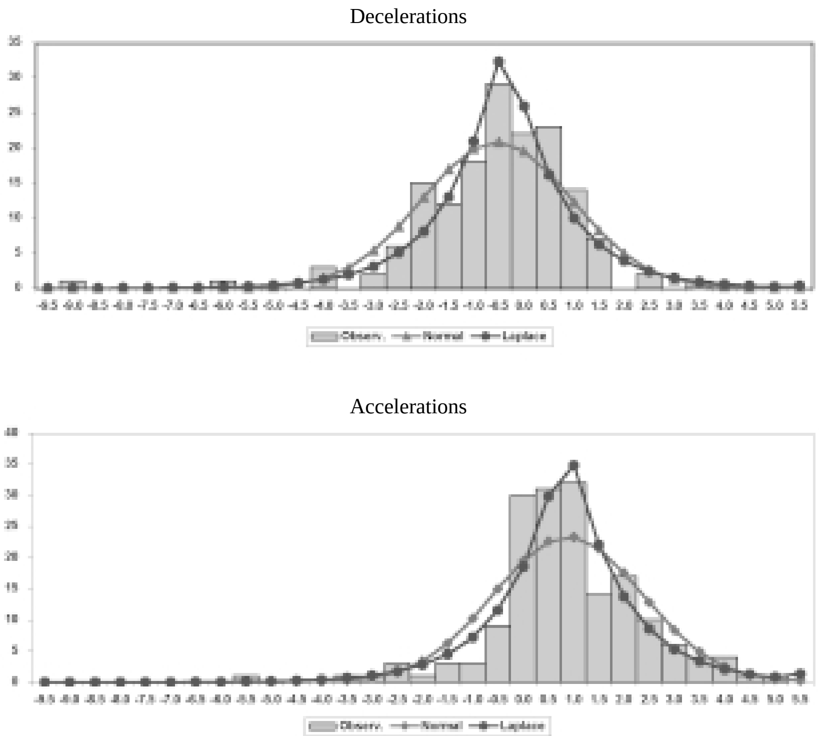
The goodness of fit test results in the classical analysis is presented in Chart 4. When the monthly change rate (TCM) is used, the Laplace distribution adjusts better than the normal in contraction and recovery stages. In the case of the annual change rate (TCIA) both distributions adjust only to one regime. While in the smoothed annual change rate (TCSA) the normal density, which is broadly used in the related literature, performs better.

The results in the growth study are seen in Chart 5. The conclusions drawn from the monthly and smoothed annual change rates (TCM and TCSA) are similar to the previous ones. But, in the case of the annual change rate (TCIA) none density adjusts to both states.

According to these results we arrive to two main conclusions: On the one hand, the monthly change rate (TCM) is chosen out of the three rates; and on the other hand, Laplace distribution fits the TCM observations better.

GRAPH 2

LEADING INDEX MONTHLY CHANGE RATE FREQUENCY DISTRIBUTION AND FITTED NORMAL AND LAPLACE DENSITIES; GROWTH ANALYSIS; ARGENTINA, 1973.01-2000.07



Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

It is interesting to point out that TCIA, which is often used to avoid seasonal adjustment, turns out with the weakest result. It is distributed as Laplace in contractions, and as normal in recoveries and accelerations, but it does not have a defined density in deceleration states.

TCSA is distributed in all cases as normal. This rate is used to predict turning points by means of a three consecutive monthly decline rule. A similar study of the TCSA is going to be developed in the near future.

CHART 4

GOODNESS OF FIT TEST OF THE LEADING INDEX CHANGE RATE FREQUENCY DISTRIBUTION; CLASSICAL ANALYSIS; ARGENTINA, 1973.01-2000.07

Rate of Change	Distri-bution	Contraction of the Leading Index			Recovery of the Leading Index		
		Chi Squared	Degrees of Freedom	Right Tail Prob. (%)	Chi Squared	Degrees of Freedom	Right Tail Prob. (%)
Monthly Change Rate	Laplace	11.2	8	19.1%	12.5	10	25.4%
	Normal	11.1	8	19.6%	32.4	10	0.0%
Annual Change Rate	Laplace	8.6	8	38.1%	28.1	12	0.5%
	Normal	17.7	8	2.4%	17.5	12	13.2%
Smoothed Annual Change Rate	Laplace	16.1	7	2.4%	23.1	15	8.1%
	Normal	7.2	7	41.0%	18.6	15	23.5%

Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

CHART 5

GOODNESS OF FIT TEST OF THE LEADING INDEX CHANGE RATE FREQUENCY DISTRIBUTION; GROWTH ANALYSIS; ARGENTINA, 1973.01-2000.07

Rate of Change	Distri-bution	Decelerations of the Leading Index			Acceleration of the Leading Index		
		Chi Squared	Degrees of Freedom	Right Tail Prob. (%)	Chi Squared	Degrees of Freedom	Right Tail Prob. (%)
Monthly Change Rate	Laplace	18.7	12	9.6%	15.1	11	17.8%
	Normal	17.2	12	14.0%	26.0	11	0.6%
Annual Change Rate	Laplace	19.1	10	4.0%	20.6	10	2.4%
	Normal	18.7	10	4.4%	9.7	10	46.5%
Smoothed Annual Change Rate	Laplace	16.8	10	7.9%	14.5	10	15.0%
	Normal	5.6	10	84.8%	11.3	10	33.1%

Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

4.3. Computing the sequential probability recursion

When the stage of having the parameters estimated is reached, the only missing information is Γ_t^u and Γ_t^d according to the formula of the sequential probability recursion. The unknown probabilities are the transition probabilities. Γ_t^d is the probability of a trough in *t* given that the recession has not finished yet. The probability of a peak in *t* is Γ_t^u granted that the expansion continues. Neftci (1982) estimates these probabilities. Diebold and Rudebusch (1999) demonstrate that these are independent of the phase length for US data. This means that a long expansion is not more likely to end than a short one. Consequently we use time invariant transition probabilities in the same way as Phillips et al (1996) do in Mexico. We estimate them as the ratio of the corresponding turning point number to the cumulative length of the matching regimes.

Changes in the transition probability shift upward or downward the whole estimated SPR. This process is known as calibration. The final values chosen are 3 times the original estimations.

We calculate the monthly probability of a turning point in the business cycle expansion (a peak that ends the expansion), taking into account the sign and the magnitude of the leading index TCM. This analysis is not only applied to the business cycle but also to the growth cycle.

According to the SPR, an economy peak signal happens when the monthly peak probability is greater than the critical value. We are in presence of a false signal each time the SPR intercepts from below the critical probability line and a turning point does not take place.

Graphs 3 and 4 depict the peak and trough SPR in the business cycle. The gray area in economic graphs represents recessions and decelerations of the business and growth cycles. The critical selected probability is presented as a horizontal line. In Graph 3 the presence of false signals is noticed. Some of them are due to the leading index sensitivity to weak growth periods, e.g. 1992. In Graph 4 there are no false signals but lags are noticed.

Graphs 5 and 6 show the peak and trough SPR in the growth cycle.

The quantitative analysis can be seen in Chart 6. The following conclusions are drawn from that analysis:

1. Peak probability of the economic and growth cycles produces false signals. Trough SPR does not bring them about.

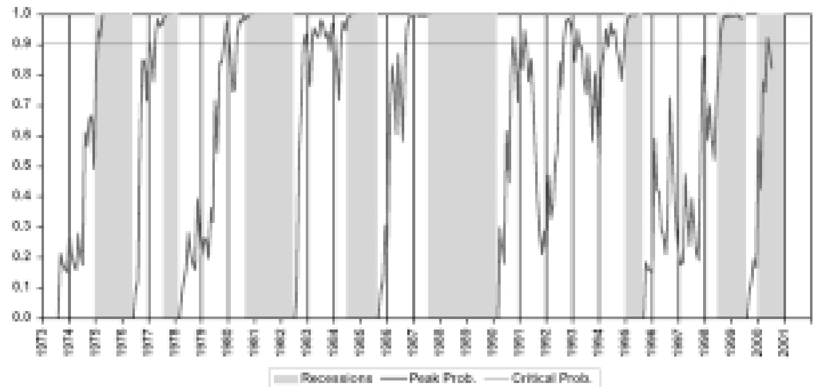
2. In the economic cycle, trough signals occur in a greater monthly average anticipation than peak signals. Quite the opposite happens in the growth cycle.

3. Troughs are easier to predict than peaks in the economic cycle.

4. A great deal of deviation is seen in the leading months.

GRAPH 3
PEAK PROBABILITY IN THE BUSINESS CYCLE;
ARGENTINA; MONTHLY OBSERVATIONS, 1973.01-2000.07

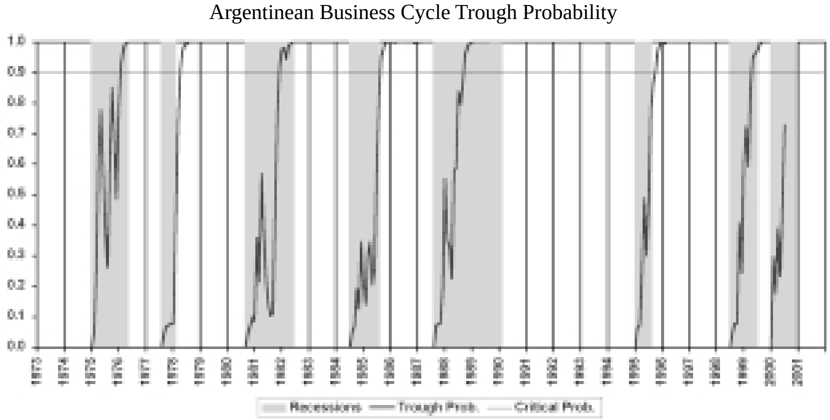
Argentinean Business Cycle Peak Probability



Source: Argentinean Business Cycle Research Project; Juan M. Jorrat, Chairperson; UNT & IEA-FBET.

GRAPH 4
TROUGH PROBABILITY IN THE BUSINESS CYCLE;
ARGENTINA; MONTHLY OBSERVATIONS, 1973.01-2000.07

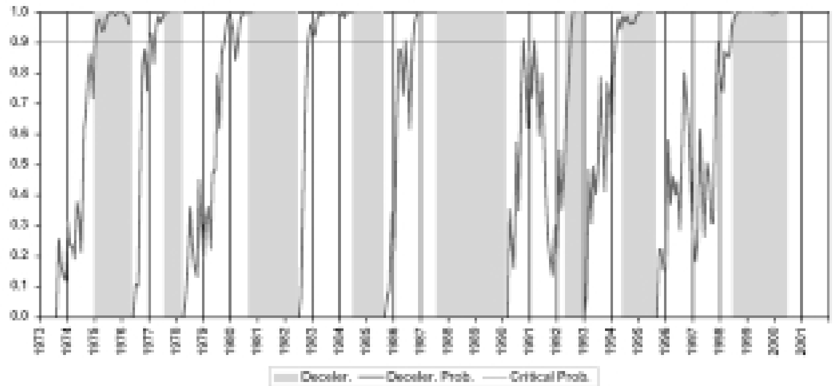
Argentinean Business Cycle Trough Probability



Source: Argentinean Business Cycle Research Project; Juan M. Jorrat, Chairperson; UNT & IEA-FBET.

GRAPH 5
PEAK PROBABILITY IN THE GROWTH CYCLE;
ARGENTINA; MONTHLY OBSERVATIONS, 1973.01-2000.07

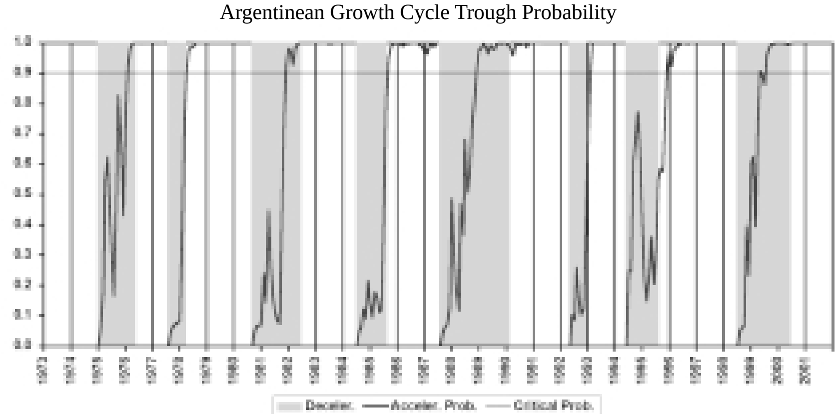
Argentinean Growth Cycle Peak Probability



Source: Argentinean Business Cycle Research Project; Juan M. Jorrat, Chairperson; UNT & IEA-FBET.

GRAPH 6
TROUGH PROBABILITY IN THE GROWTH CYCLE;
ARGENTINA; MONTHLY OBSERVATIONS, 1973.01-2000.07

Argentinean Growth Cycle Trough Probability



Source: Argentinean Business Cycle Research Project; Juan M. Jorrat, Chairperson; UNT & IEA-FBET.

CHART 6
SEQUENTIAL PROBABILITY RECURSION LEADING MONTHS AND FALSE SIGNAL NUMBERS; ARGENTINA; 1973.01-2000.07

Measures	Business Cycle			Growth Cycle		
	Peaks	Troughs	Both Turning Points	Peaks	Troughs	Both Turning Points
Median	0.5	2.0	2.0	2.0	–1.0	0.0
Average	1.0	3.1	2.0	3.9	0.4	2.3
St. Dev.	4.2	6.9	5.5	7.2	6.6	6.9
False Signal / Signal	10 / 8	0 / 7	10 / 15	4 / 8	0 / 7	4 / 15

Source: Argentinean Business Cycle Research Project; Juan M. Jorrat, Chairperson; UNT & IEA-FBET.

4.4. Sequential probability recursion performance evaluation

The SPR evaluation is carried out taking into account accuracy and calibration. Business and growth cycle results are exposed on Charts 7 and 8 respectively.

CHART 7
SEQUENTIAL PROBABILITY RECURSION EVALUATION MEASURES IN BUSINESS CYCLE TURNING POINTS; ARGENTINA, 1973.01-2000.07

Evaluating Measures	Forescasting Months (Horizon)								
	0	1	3	5	7	9	11	13	15
Peaks of the Business Cycle									
Quadratic Probability Score (QPS)	0.58	0.55	0.50	0.46	0.41	0.37	0.34	0.33	0.32
Log Probability Score (LPS)	0.95	0.89	0.79	0.86	0.77	0.69	0.64	0.63	0.75
Global Squared Bias	0.27	0.23	0.17	0.12	0.08	0.05	0.02	0.01	0.00
Troughs of the Business Cycle									
Quadratic Probability Score (QPS)	0.28	0.25	0.22	0.20	0.20	0.20	0.22	0.23	0.23
Log Probability Score (LPS)	0.70	0.62	0.50	0.43	0.54	0.64	0.64	0.77	0.88
Global Squared Bias	0.07	0.05	0.03	0.01	0.00	0.00	0.00	0.01	0.02

Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

CHART 8

SEQUENTIAL PROBABILITY RECURSION EVALUATION MEASURES IN GROWTH CYCLE TURNING POINTS; ARGENTINA, 1973.01-2000.07

Evaluating Measures	Forecasting Months (Horizon)								
	0	1	3	5	7	9	11	13	15
Peaks of the Business Cycle									
Quadratic Probability Score (QPS)	0.54	0.50	0.43	0.37	0.32	0.29	0.25	0.24	0.23
Log Probability Score (LPS)	1.05	0.95	0.78	0.67	0.56	0.47	0.40	0.37	0.48
Global Squared Bias	0.24	0.20	0.14	0.09	0.05	0.03	0.01	0.00	0.00
Troughs of the Business Cycle									
Quadratic Probability Score (QPS)	0.28	0.25	0.24	0.24	0.26	0.26	0.27	0.28	0.29
Log Probability Score (LPS)	0.54	0.48	0.42	0.40	0.40	0.67	0.68	0.68	0.97
Global Squared Bias	0.06	0.05	0.02	0.01	0.00	0.00	0.00	0.01	0.02

Source: Research Project Argentinean Business Cycle; Juan M. Jorrat Chairperson; UNT & IEA-FBET.

Chart 7 shows that trough predictions have fewer QPS, LPS and GSB than peak forecasts up to 11th horizon month, in the business cycle. The same phenomenon occurs up to 9th horizon month in the growth cycle (Chart 8).

The feature of note (for both expansions and contractions) is the GSB associated with a low forecasting horizon. The problem of false alarms and missed calls is illustrated by this scoring.

The difference between business and growth cycles is not significant. Growth cycle turning point predictions are carried out with fewer errors than those in the business cycle.

In contrast to Moore and Zarnowitz (1982) and Diebold and Rudebusch (1999), we arrive to the conclusion that troughs are easier to predict than peaks.

5. Concluding Remarks

This paper provides an analysis of the leading index forecasting capability using the Sequential Probability Recursion. Besides, we use all the information on the leading index change rate probabilistic behavior to evaluate the SPR.

Laplace distribution fits the data best. Fewer forecasting errors are found when this probability density is applied. Its use in countries without experience in business and growth cycle indicators is recommended. This is the case of Mexico and Argentina.

The SPR is a good complement to other forecasting techniques. One of them is the three consecutive month decline rule based on the smoothed annual change rate. Studying the smooth change rate we arrive to the conclusion that the normal density fits better the observed data. A possible future research topic among specialists is the application of SPR analysis to the leading index smooth change rate.

Acknowledgment

This study is being carried out within the framework of The Argentinean Business Cycle Research Program, which is partially financed by the Consejo de Investigaciones de la Universidad Nacional de Tucumán (26/F104) and by the Instituto de Economía Aplicada, Fundación Banco Empresario de Tucumán.

We wish to thank Juan Esteban Jorrat for useful assistance in the preparation of the final manuscript.

References

Brier, G. W. (1950). "Verification of forecasts expressed in terms of Probability, *Monthly Weather Review*, 75 (January): 1-3.

Bry, G. y Boschan, Charlotte (1971). "Cyclical Analysis of Time Series: Selected Procedures and Computer Programs". Technical Paper, Nº 20. *National Bureau of Economic Research*. New York: Columbia University Press.

Diebold, F. X. and Rudebusch G. D. (1999). "Chapter 15: Scoring the Leading Indicators". *Business Cycles, Duration, Dynamics and Forecasting*. Princeton University Press.

Johnson, Norman L. (1970). *Continous Univariate Distributions - 2*. New York: John Wiley & Sons.

Jorrat, Juan M., Jarma, Nora y Hortt, Claudia (1995). "Estudio y Predicción del Ciclo Económico en Argentina". *Carta Económica*. Buenos Aires: Miguel A. M. Broda y Asoc. S.R.L., diciembre de 1994/enero de 1995.

Jorrat, Juan M. (1996). "Ciclos Económicos y de Crecimiento de Argentina y Sistema de Indicadores Coincidente y Líder: Período Enero 1970-Julio 1996". *Kipukamayo*. N° 25, pp. 40-55. Tucumán: Colegio de Graduados en Ciencias Económicas (Octubre).

Jorrat, Juan M. (1998). "Coincident and Leading Indexes for Argentina: Growth Cycles and Forecast of Gross Domestic Product". *Workshop on regional Economic Models*. University of South Caroline (Junio).

Jorrat, Juan M. (1998). "Indicadores del Ciclo Económico de Argentina: Situación a Noviembre de 1998". *Revista del Instituto de Economía Aplicada* 1: 12-29. Tucumán, Fundación del Banco Empresario de Tucumán, (Diciembre).

Jorrat, Juan M. (2000). "Indicadores del Ciclo Económico de Argentina: Informe a Julio del 2000". Mimeo (Agosto).

Moore, G. (1983). *Business Cycle, Inflation and Forecasting.* 2ª ed. Cambridge, Mass.: Ballinger.

Moore, G. and Zarnowitz, V. (1982). "Sequential signals of recession and recovery". *Journal of Business* 55: 57-85 (Enero).

Neftci S. (1982). "Optimal Prediction of Cyclical Downturns". *Journal of Economic Dynamics and Control*, Vol. 4 Nº 3, pag. 225.

Neftci, S. (1984). "Are economic time series asymmetric over the business cycle?". *Journal of Political Economy* 92: 307-328 (Abril).

Phillips, K, Vargas, L. Y Zarnowitz, V. (1996). "New Tools for Analyzing The Mexican Economy: Indexes of Coincident and Leading Indicators". *Economic Review Federal Reserve Bank of Dallas*, Second Quarter.