CYCLES AND GROWTH IN THE CHILEAN ECONOMY: 1985-1996[†]

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ABSTRACT

Previous research done by the authors indicated that the monthly activity index of the Chilean economy (IMACEC) was best described as a trend stationary process with occasional shifts in levels. That statistical representation proved to be strongly better than rival models such us a difference-stationary process or trend stationary with occasional shifts in trend. Hence, for the 1985-96 period, the Chilean economy could be described as a following a "natural growth rate" with occasional shifts in levels. It followed then that in the neighborhood of those shifts, the economy experienced “booms” (growth rates exceeding 10% on a 12 month basis) or “recessions” (growth rates below 4%), depending on whether the discrete shift was positive or negative.

Within that framework, this paper addresses two questions: 1) how to determine whether a shift in economic activity has taken place in the recent past and 2) how to predict the probability of occurrence of a shift in the near future. In relation with the first question the paper develops a Bayesian decision rule to determine the existence of a break. With regard to the second question the paper proposes a logit model to account for a “recession” (negative shift). That probability is related to both monetary policy and the price of copper. Monetary policy is shown to contain relevant information to predict the future occurrence of a recession but is of no use whatsoever to explain the noise around the time series once the shift has occurred. When applied to this year, the model indicated a 42% chance of a negative break in the last quarter.

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1. INTRODUCTION

During the 11 year sample spanning the 1985-96 period, the Chilean economy grew at 7.4% per year. By any standard this has been an outstanding performance, either if we compare it with the previous record of Chile or with the growth rates exhibited by other western hemisphere countries. As with other fast-growing countries, growth has not proceeded in a smooth way. Thus, within the 1985-96 period we find years in which the economy has grown at 11.8% (1992) and, on the other side, years in which growth has slowed to 2.3% (1990). Therefore, and given this high volatility, the issue of disentangling the underlying growth trend from business cycles around that trend is far from trivial.

In a previous paper, Chumacero and Quiroz (1996) developed alternative statistical representations to separate growth from cycles. Using the monthly economic activity index (IMACEC) as their main subject of analysis, they found that this time series could be best described as a stationary random variable around a deterministic trend which exhibited occasional shifts in levels. That statistical representation proved to be strongly superior to rival ones, such as: 1) difference stationary random variable; 2) a stationary random variable around a deterministic trend with no shifts; 3) a stationary random variable around a deterministic trend with shits in both, level *and* trend.

The statistical representation for IMACEC then can be summarized by two equations. First, a "long-run" equation that describes the log of IMACEC at month t, y_t, as the sum of a trend component and several structural breaks in levels:

$$y_t = \alpha_0 + \sum_{i=1}^{4} \alpha_i D_{i,t} + \beta T_t + \varepsilon_t \qquad \textbf{(1)}$$

where D_{it} is a dummy variable taking the value of 1 for any t belonging to the subset I_i, i=1,..4, and zero otherwise, with I_1=[85:07,96:08]; I_2=[90:07,96:08]; I_3=[91:10,96:08]; I_4=[93:07,96:08].

Second, an equation that describes the month-by-month changes in y_t, Δy_t as an error correction equation depending on the residual ε_{t-1} of the previous equation:

$$\Delta y_t = \alpha_1 + \alpha_2 \Delta y_{t-1} + \alpha_3 \Delta y_{t-2} + \alpha_4 \Delta y_{t-8} + \alpha_5 \Delta y_{t-9} + \alpha_6 \Delta y_{t-15} + \alpha_7 \Delta y_{t-16} + \alpha_8 \Delta y_{t-24} + \alpha_9 \Delta y_{t-27} + \gamma \varepsilon_{t-1} + \eta_t \quad \textbf{(2)}$$

For the sake of completeness, Tables 1 and 2 show the parameter estimates of the two previous equations and Figures 1 and 2 show the fit of equations 1 and 2 respectively. More details can be found in Chumacero and Quiroz (1996).

Table 1
Long-Run Equation for IMACEC

	Parameter	**Standard Error**
α_0	4.5337	0.0172
α_1	-0.0655	0.0201
α_2	-0.0798	0.0159
α_3	0.0527	0.0150
α_4	-0.0552	0.0140
β	0.0067	0.0003
Adj. R^2=0.970 SER=0.042 DW=1.927 F=888.951		

Notes: The dependent variable is the (natural) log of IMACEC (1985:01-1996:08). Adj. R^2 = Adjusted R^2. SER = Standard Error of the Regression. DW = Durbin Watson. F = F Test.

Table 2
Short-Tun Equation for IMACEC

	Parameter	**Standard Error**
α_1	-0.029	0.003
α_2	-0.316	0.081
α_3	-0.176	0.061
α_4	-0.174	0.058
α_5	0.169	0.058
α_6	-0.182	0.071
α_7	-0.306	0.042
α_8	-0.194	0.055
α_9	-0.167	0.059
γ	-0.184	0.087
Adj. R^2=0.949 SER=0.013 DW=1.910 F=139.858		
Q_6=0.593 Q^2_6=0.999 LM=0.853 JB=0.849		
ARCH=0.132 Ramsey=0.210		

Notes: The dependent variable is the first difference of the log of IMACEC (1987:02-1996:08). Monthly dummy variables where included. Adj. R^2 = Adjusted R^2. SER = Standard Error of the Regression. DW = Durbin Watson. F = F Test. Q_6 = *P-value* of Box and Pierce's test for white noise. Q^2_6 = *P-value* of Box and Pierce's test for white noise of the squared residuals. LM = *P-value* of Breusch and Godfrey's test for innovations. JB = *P-value* of Jarque and Bera's test of normality. ARCH = *P-value* of Engle's ARCH test. Ramsey = *P-value* of Ramsey's test for misspecification.

Figure 1
Long-Run Fit: Trend and Breaks in IMACEC

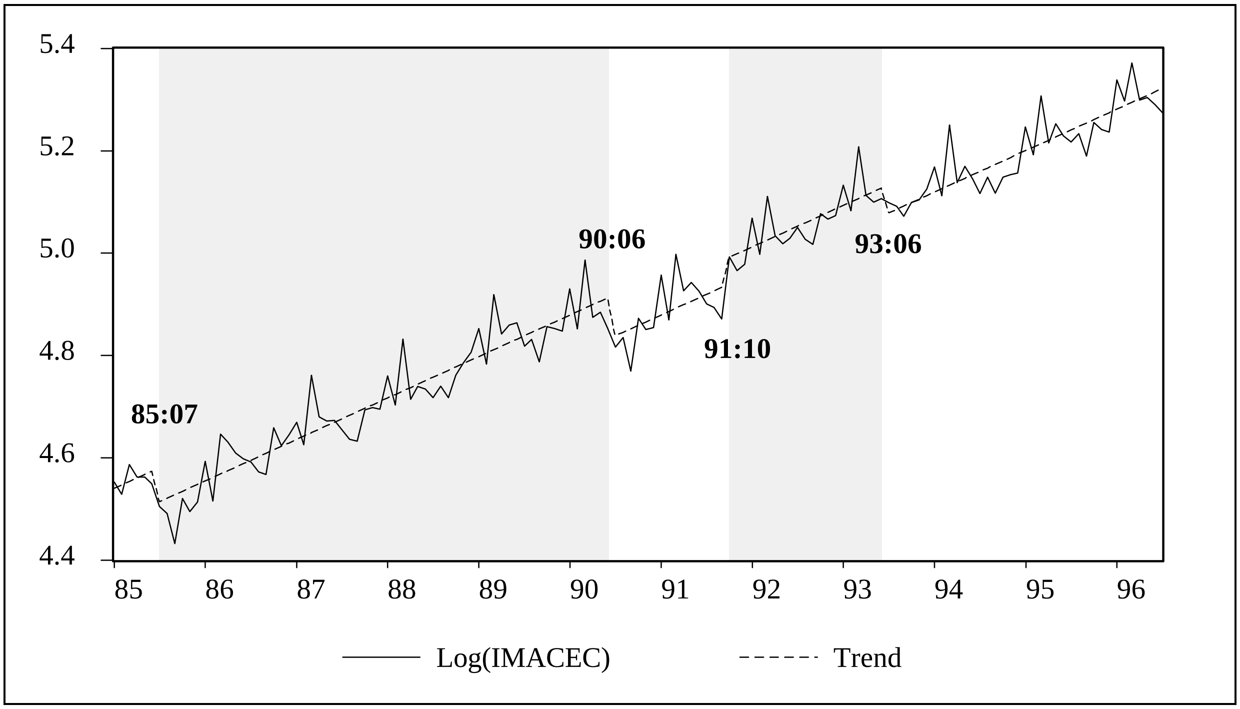
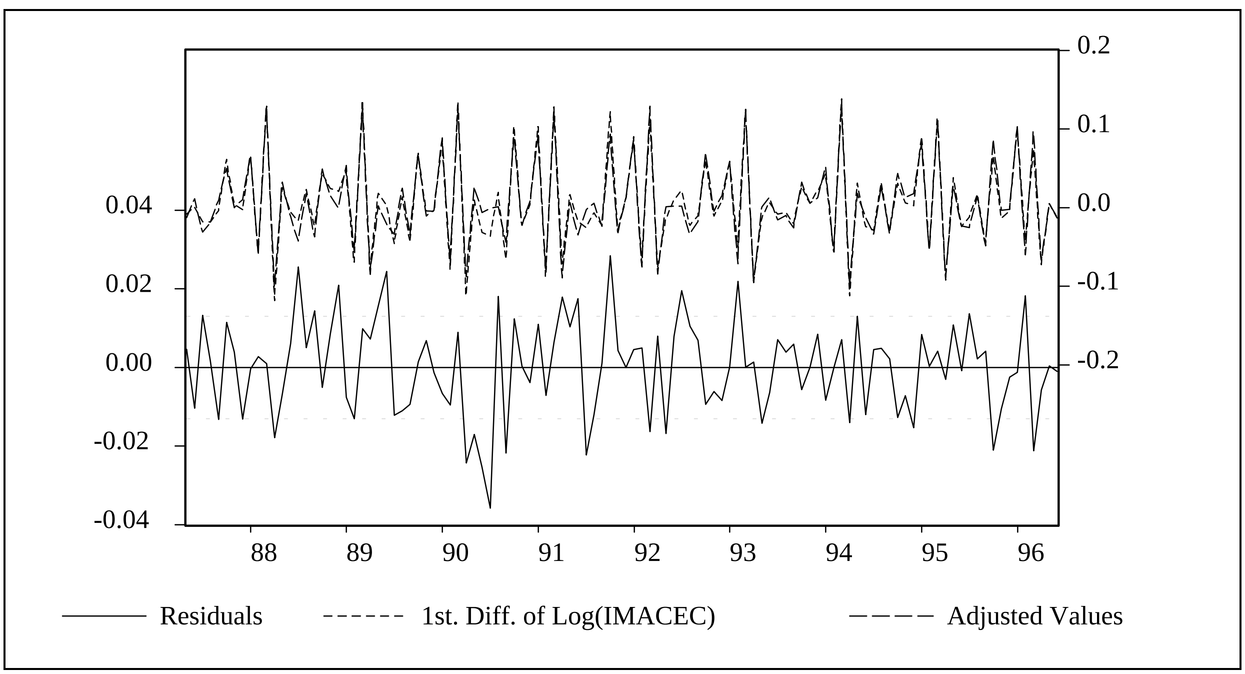


Figure 2
Short-Run Dynamics



The main corollary of this analysis was the notion of a "natural" growth rate, which corresponded to the growth rate of the underlying deterministic trend. The usefulness of that notion came from the fact that the statistical analysis did not find any trend break during the whole sample period, in spite of the fact that some structural macro variables did change a lot along the sample (e.g. the investment rate was 17.2% at the beginning of the sample an 27.4% by the end).

Another striking result of the analysis was the magnitude of the "natural" growth rate -- 8.34% per year for IMACEC and 8.1% for GDP --, well above what most observers, including the authors, thought to be the long-run growth trend of the economy. Finally, the analysis left untouched several questions, among them, what were the variables that could explain the shift levels and what could be the factors underlying the growth rate.

Within the aforementioned framework, this paper deals with the following two issues:

a) How can we determine whether a "shift" has happened in the recent past?

b) To what extent can the shifts that have been observed in the past be endogeneized as functions of real exogenous fundamental variables and policy interventions?

No doubt, the two questions bear an increasing order of importance but a decreasing order of tractability. For the same reason, they must be approached with an increasing order of a-priori restrictions. The first question is important from a purely forecasting perspective. Any econometrician using the model described above, and facing, say, a lower-than-average growth observation for the last available data, must be able to somehow discriminate whether the shock is just a noise around the short-run dynamic equation 2, or a break of the sort described by the dummy variables in equation 1. Fortunately, that question is easily tractable in terms of a signal-extraction problem which here we embed in a Bayesian decision rule, without adding too much a priori structure.

The second question is far more fundamental, and has to do with the difference between what we have termed here the "natural" growth rate of the economy, and the "potential" growth rate. From a purely empirical perspective, the "natural" growth rate is the rate at which the economy expands over time *in the absence of whatever causes the shifts in levels.* On the other hand, in this framework, we could define the "potential" growth rate of the economy as the growth rate at which the economy will be able to expand in the near future (1 to 2 years), *taking into account the exogenous restrictions and opportunities that may cause in the future a positive or negative shift.* In other words, the potential growth rate for the next x years could be defined as the expected growth rate for that period that comes out once the probability of a positive or negative shift is incorporated into the analysis. For example, if one found that a negative shift is likely to occur whenever the terms of trade of the economy fall below a certain level, then the potential growth rate of the economy for the next couple of years could be lower than the natural one if such a deterioration of the terms of trade is likely to happen in the near future. But the distinction between the natural and the potential growth rate becomes less trivial if some of the variables that causes the shifts in levels were related with policy interventions. In that case, there could be some room for arguing that the potential growth rate of the economy is, say, falling below the natural rate because of a given policy intervention that, perhaps, could be avoided.

In this paper we approach that issue by means of a logit model, where the dependent variable takes the value of 1 in the neighborhood of a negative break in the level and zero otherwise. The explanatory variables for this logit model are two: one related to a real international variable, namely the price of copper, and another related to a policy intervention, namely, the 90 days interest rate in the inflationary adjustable bonds of the Central Bank (PRBC). Within that framework then we try to discriminate to what extent the breaks are "God given" and/or induced by the interventions of the monetary authorities.

The remaining two sections approach the previous two questions in the same order.

2. DETERMINING WHETHER A BREAK HAS TAKEN PLACE

In Chumacero and Quiroz (1996) we addressed the issue of detecting breaks in the levels of the series by means of sequential F tests. While this methodology is useful for detecting breaks ex-post, (with all the sample information available), it louses its practical appeal when the problem becomes to detect the possibility of a break that may have occurred only few months ago.

The algorithm proposed in this section belongs to the class of optimal decision rules frequently advocated in the Bayesian literature (Berger, 1985) and is as follows:

a) From the model described in **(1)** and **(2)** above we construct a series that takes the values zero or one depending on whether there is statistical evidence in favor of a break in levels, that is all the dates in which the null of no break is rejected with a 5% confidence level. Denote it by B_t. It is important to mention that the dummy variables "assigned" the specific date of occurrence of the break to the particular month that favored the hypothesis the most. However, with standard significance levels there is a region of months for which the presence of a break can not be rejected. Recall that all these breaks were detected sequentially but using information of the complete sample.

b) Assume that the econometrician has information up to T_0+m and wants to know whether a break has occurred at date T_0. Let $D_{T_0,t}$ be an indicator function defined as:

$$D_{T_0,t} = \begin{cases} 0 & t < T_0 \\ 1 & t \geq T_0 \end{cases} \quad \textbf{(3)}$$

For every period we run the following regression:

$$y_t = \alpha_0 + \sum_{i=1}^{j} \alpha_i D_{i,t} + \beta t + \gamma D_{T_0,t} + \varepsilon_t \quad \textbf{(4)}$$

where j is the number of breaks in levels not rejected until period T_0-1. Obtain the p-values associated with the t-test for γ with information available until T_0+m. We repeat this procedure for every period. Thus for every period t that the sample allows we record m p-values associated with the null of now break. Collect the last m-1 p-values associated with the tests obtained with sample sizes t+2,...,t+3 on a Tx(m-1) matrix P (where T is the total number of observations).

c) Denote by P_t the column number "t" of the matrix P. For a given vector ((m-1)x1) of weights ϕ and an associated critical value $\kappa \in [0, 1]$ construct the following variable:

$$E_t = \begin{cases} 1 \text{ if } \phi' P_t < \kappa \\ 0 \text{ otherwise} \end{cases} \quad \textbf{(5)}$$

This variable assigns a value of 1 to the periods in which a break can not be rejected and zero otherwise. The weights tell us how much importance should we give to the p-values found with t+2,...,$t+m$ observations.

d) Let N_I be the fraction of times in which a type I error is committed (that is when $B_t<E_t$) and N_{II} be the fraction of times in which a type II error is committed (that is when $B_t>E_t$). Define a "0-K_i" loss function as suggested by Berger (1985). Then the Bayesian risk function can be represented as:

$$R(K_I, K_{II}, \phi, \kappa) = K_I N_I + K_{II} N_{II} \quad \textbf{(6)}$$

This function can then be numerically optimized by finding the optimal values the weights ϕ, the critical value κ, the number of lags m, and if desired the values of K_i.

We used genetic algorithms to numerically minimize **(6)** and obtained the values associated with the weights and critical values described in **(5)** for given values of K_i (that were normalized so that they add up to one).

Although it is conventional to put a heavier penalty on making a Type I error, one can imagine circumstances in which the econometrician would rather want to have a lower Type II error instead. A low Type I error will produce a set of long-run forecasts which will depart from the natural growth rate only when very high shocks take place (so that it would be difficult not to reject the null that no break has occurred). On the other hand, a low Type II error will generate long-run forecasts that very often will depart from the natural growth rate. So, on one extreme the risk is to miss breaks when actually they did occur, while on the other, the risk is to interpret (wrongly) a noise by a signal.

Using K_I=0.9 one finds that κ=0.025, m=3, and ϕ=(0.24,0.76)'. Applying the above procedure up to August of 1996 one finds that the hypothesis that no break has occurred cannot be reject, in spite of the fact that average 12 month growth rate of the last three observations amounts to 5.94% (information available up to August of this year). These results remain even when we set K_I=0.8.

One shortcoming of this test is that it needs information 3 months ahead to be able to determine if a break occurred. The following section develops a methodology that is complementary to this one and may provide useful guidelines for assessing the probability of occurrence of breaks.

3. ENDOGENEIZING THE SHIFTS

Given that in our sample period we observed three episodes of "recessions" and only one of "booms" (Figure 1) we did not have enough information to obtain reliable estimates of the sources of a "boom". Thus we focused only on the determinants of "recessions".

Given the discrete nature of a "recession" in our statistic representation, we approach the problem of endogeneizing the recession by means of a logit model.

Say that a break occurred "around" period t and denote it by T_t^a. We can then construct a dummy variable that takes the value of 1 in the neighborhood of this break and zero otherwise. Given that for each of these breaks there is a region where the presence of breaks can not be rejected, operationally we set the value of the this variable as:

$$d_t = \begin{cases} 1 \text{ if } t-2 \leq T_t^a \leq t+2 \\ 0 \text{ otherwise} \end{cases} \quad \textbf{(7)}$$

We conjecture that a recession can be the consequence of real fundamental exogenous shocks and/or domestic policy interventions. More specifically we conjecture that the probability of a recession may be related with:

a) the price of copper (US$/lb.)

b) the 90 days inflationary adjustable interest rate of the Central Banks bonds (PRBC).

Of course, a logit model is silent with regard to the specific propagation mechanisms that may lay behind each of these variables. For example, a low price of copper may signal economic agents a whole away of mechanisms, including future tightness of fiscal and monetary policies, that may prompt a recession.

Thus, the model to be estimated is:

$$\Pr\left(d_t = 1 \middle| c_t, r_t\right) = \frac{e^{\alpha+\beta c_{t-3}+\gamma r_{t-4}}}{1+e^{\alpha+\beta c_{t-3}+\gamma r_{t-4}}} \quad \textbf{(8)}$$

Where c_t is the price of copper at time t and r_t is the 90 days PRBC interest rate at time t. The results of the estimation are displayed in Table 3.

Table 3
Results of the Logit Model

	Parameter	**Standard Error**
α	-9.870	2.633
β	-0.061	0.020
γ	204.397	49.402
Mean in the whole sample	Mean when *d*=1	Mean when *d*=0
c 101.737	*c* 91.354	*c* 103.024
r 0.058	*r* 0.076	*r* 0.056
Log-Likelihood = -24.613	Observations with *d*=1: 15	Observations with *d*=0: 121
Notes: The dependent variable is *d*. The independent variables are the copper price and PRBC (1985:01-1996:08).		

We highlight the following conclusions from the estimation:

a) First, and as could be expected, both the 90 days PRBC and the price of copper do play an important role in terms of predicting the probability of a recession. Both variables are very significant and, very important, they are not contemporaneous to the recession episodes, because they enter in the model with a 3 and 4 month period lag. Given the way we defined the dependent variable this dynamic structure implies a 5 to 6 month period lag with respect to the “exact” date of a recession (the date that maximizes the probability of occurrence).

b) Consistently with the above results, the mean level of the 90 days PRBC during recessive breaks is 7.6%, which compare with a 5.8% average for the whole sample. Similarly, while the average copper price for the whole sample is 1.01 US$/lb., the mean level during recession breaks is 0.91 US$/lb.

c) Although not reported in the table, the PRBC variable does not play any role whatsoever in explaining the short run cycles around a given trend level (residuals of **(2)**). Thus, the impact of monetary policy is restricted to medium run shifts, with no short run influence.

Several implications stem out from these results. First, although the copper price and the 90 days PRBC interest rate do not influence the long run *natural growth rate* of the economy, they do have an effect in terms of constraining the potential growth rate in the medium term (1 to 2 years). The natural question that emerges then is what could be the rationale for setting, from time to time, abnormally high real interest rates. Two hypothesis can be conjectured:

Hypothesis A: The Central Bank firmly believes that the natural growth rate of the economy is far below our 8.1%. Then, whenever the economy sets around an 8% growth rate for some time, the Central Bank proceeds with monetary tightening. Eventually, the tightening becomes strong enough that a recession occurs and, during the transitions phase growth slows down to 4% - 5%. Then monetary policy is relaxed and the whole cycle starts again.

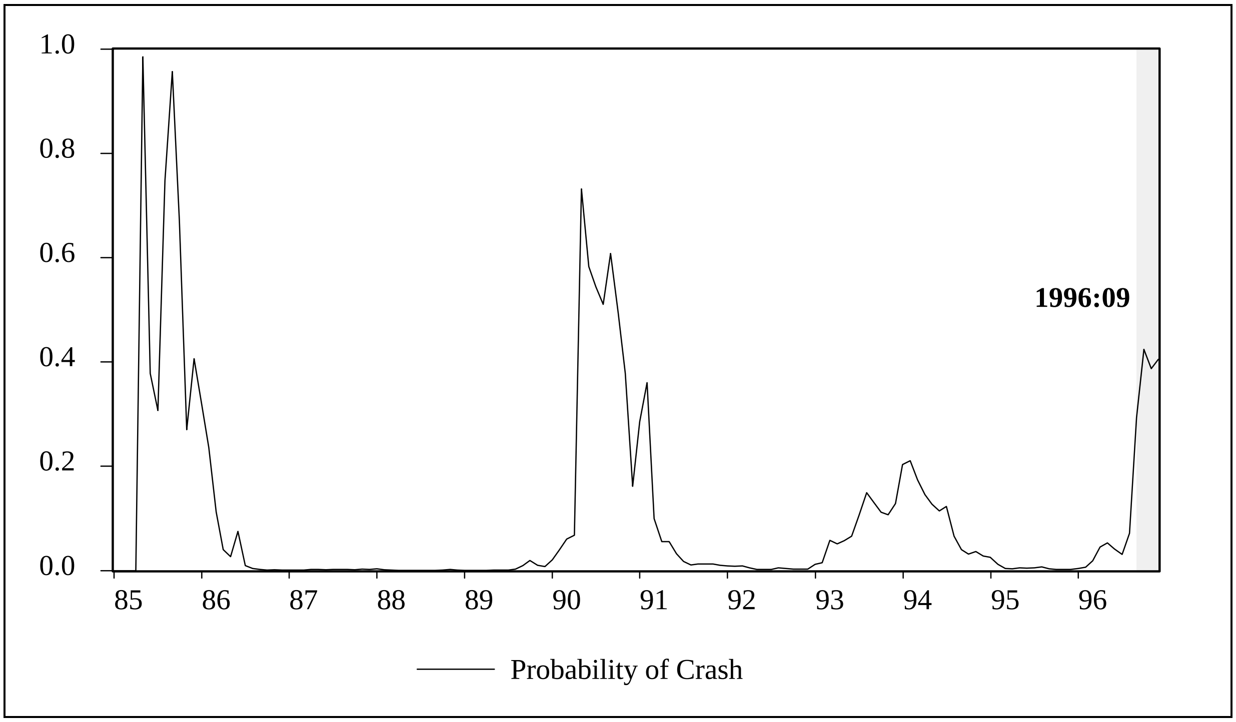
Hypothesis B: Given an inflation target of the Central Bank, from time to time a "recession" break is needed in economic activity in order to meet the target. According to this hypothesis then there would be a linkage between "recessions" and inflation, so that "recessions" would be a "necessary illness" if the stabilization objectives are to be achieved.

Clearly, if hypothesis A is true the judgment of our monetary policy would be a very bad one. If hypothesis B is true, the judgment would be much better (provided we agree on the goodness of the pre-set stabilization targets). Future research should focus then on the linkages between recessions and stabilization objectives.

At any event, the above results should prevent against the initiation of a monetary tightening phase based only on the information of high growth levels of IMACEC. Such a policy could easily result in the kind of useless cycles suggested by hypothesis A.

When the logit model is applied to current data, we find that there is a 42% chance of having a "recession" during this last quarter of this year (see Figure 3). Therefore, the current economic juncture presents a very interesting case in point to thoroughly examine the validity of two hypothesis stated before: is the current monetary tightening being imposed because of our inflation targets or simply, because the monetary authorities do not believe that the economy can growth sustainably at 8% per year?

Figure 3
Forecast of the Estimated Probability of a Crash



Notes: Estimated probabilities with information available until 1996:08.

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