Devaluation and revaluation expectations in
the Venezuela crawling band regime

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Abstract
The 90’s could be characterized as a decade in which both developed and emerging countries have suffered important episodes of exchange rate instability; some of these episodes have resulted in exchange rate devaluations and others, in important exchange rate depreciations. This paper focuses on the study of devaluation and revaluation expectation in the crawling band system adopted by Venezuela from 1996 until the first of 2002. We use a Binary Dependent Variable Model (Logit Method) to estimate the readjustment probability, in which the dependent variable is calculated from two different methods: Svensson simple credibility test and the drift adjustment method.

Keywords: Crawling-bands, Currency Crises, Readjustment Probability.

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1 Introduction

The last decade could be characterized as an intense period of events with respect to the International Financial System. Both emerging and developed countries have suffered important episodes of exchange rate instability resulting in realignment of parities or high volatilities. In either case, the monetary authority has been forced to intervene at the expense of huge losses in foreign reserves and/or large increases in interest rates. This turbulence has renewed the debate about the reform of the International Financial System, in order to avoid or lessen the virulence of currency crises.

In this context, both target zones and crawling bands are exchange rate regimes which have been recently implemented by a large number of countries, as a compromise between fixed and floating exchange rates. Following Williamson (1996) an exchange rate crawling-band can be defined as a system in which the exchange rate is forced to moves inside a band and the band is adjusted in small steps with a view to keeping it in line with the fundamentals. As in a target zone system, monetary authority intervenes when the exchange rate reaches the limits of the band. Therefore, a crawling-band system is similar to a target zone except by the fact that the central parity is not constant over time but increases at a constant positive rate (the rate of crawl). Both the bandwidth and the rate of crawl are preannounced.

As it is pointed out by Williamson (1996), the principal cause of changes in the parity (the crawl) is typically the inflation differential, to ensure that high domestic inflation does not lead to a progressive erosion in international competitiveness. The purpose of making parity changes in relatively small steps is to avoid creating situations where the market is able to profit through correct anticipation of an impending parity change. This exchange rate system have been adopted by developing countries which experiences high inflation rates. Examples are Chile, Colombia, Israel, Indonesia, Ecuador, Russia and Venezuela. The bandwidth goes to the ±5.5% of Ecuador to ±15% of Chile and Russia.

In this paper, we study devaluation and revaluation expectations in the Venezuela crawling band regime. During the period July 8, 1996-February 8, 2002 Venezuela adopted a crawling-band system to stabilize the exchange rate with a band of fluctuation of ±7.5%. During this period the central parity was readjusted several times, implying both revaluations and devaluations (four revaluations and one small devaluation at the end of the period). In a crawling band system readjustments of the central parity, others than the
crawl, are provoked by an evolution of the exchange rate which departs from the pre-fixed rate of depreciation. Therefore, when we speak about a revaluation in a crawling band regime, this implies that the depreciation rate of the exchange rate was lower than the expected devaluation rate by the Central Bank.

The purpose of this paper we study the different moments of speculative pressure in the crawling-band exchange rate system in Venezuela in order to explain the behaviour of the Bolivar/US dollar exchange rate during this regime. There are different methodologies which try to estimate the realignment expectations in exchange rate bands regimes. The most popular are the Svensson (1991) simple credibility tests and the drift adjustment method developed by Bertola and Svensson (1993). These methods have been widely applied in the target zone literature, among others, by Rose and Svensson (1995), Bertola and Svensson (1993) and Lindberg, Soderlind and Svensson (1993) to analyze ERM and Swedish devaluation risk.

Since the edition of Bertola and Svensson (1993), several new methods for extracting information about market expectations in target zone systems have been developed. Worthy of mention as perhaps the most relevant are: Mizrach (1995), Gómez Puig and Montalvo (1997), Söderlind and Svensson (1997) or Bekäert and Gray (1998). All of them study target zone models with stochastic devaluation risk.

There are other approaches, with non-structural features, to estimate the realignment probability which use a group of “fundamental” variables of the economy. We could point out two kinds of studies. First, Weber (1991), applies a Bayesian approach with Kalman multiprocessor filter. Secondly, we could mention the following: Edin and Vredin (1993) and Ayuso and Pérez-Jurado (1997), who estimate a multinomial dependent variable model.

Non-structural models of currency crises fall into two broad categories: those based on non-parametric tests e.g. Eichengreen, Rose and Wyplosz (1994), Sachs, Tornell and Velasco (1996) or Kaminsky, Lizondo and Reinhart (1998); all of which try to identify crises by looking at an index of exchange market pressure; and others based on binary dependent variable models, logit or probit, e.g. Eichengreen, Rose and Wyplosz (1996), Frankel and Rose (1996) and Kruger, Osakwe and Page (1998). They applied this methodology using data for emerging and/or developed countries, and all of them try to associate speculative attacks with some exogenous variables, such as the output growth, domestic credit growth, foreign interest rates, current account or budget deficits. The first one and the third one also consider the possibility
of contagion effects.

In this paper, we study the readjustment probability of the Bolivar/US dollar exchange rate during the crawling band period. We use a Binary Dependent Variable Model with a logistic distribution function. However, given the special features of a crawling band regime, we have to take into account the existence of both revaluations and devaluations episodes. Therefore, we estimate two separate models: one for the devaluation expectations and another for the revaluation expectations.

The first step in our research consists in the construction the dependent variable in each case. We use two methods: the Svensson simple credibility test and the drift adjustment method. From these methods we define the periods in which there are expectations of devaluation and expectations of revaluation, respectively. The estimated model predicts quite well the revaluations which take place during this regime, showing during most of the period the existence of a positive probability of revaluation. From this point of view, this regime was highly successfully in controlling the long-run depreciation of the Bolivar/US dollar exchange rate.

The structure of the paper is as follows. Section 2 presents the main characteristics of the Venezuela crawling band regime. Section 3 develops econometric specification we will use in the estimation. The results of the estimation will be offered in Section 4. Finally, Section 5 contains some concluding remarks.

2 The Venezuela Crawling Band Regime

On July 8, 1996, Venezuela adopted a crawling band system in order to manage the exchange rate. The exchange rate was forced to move inside a fluctuation band with an increasing central parity, significantly lower than expected inflation. Figure 1 shows the crawling-band system of Venezuela during the period. The solid line is the Bolivar/US dollar exchange rate. The data consists of daily observations for the period July 1996 to February 2002 for the Bolivar/US dollar exchange rate, and interest rate for 3 months to maturity. The data used have been obtained from the Venezuela Central Bank. The central parity we initially set to 470 Bolivares per US dollar. In order to fix this value (as an equilibrium exchange rate), the Venezuela Central Bank leaves the currency to float during the period April-July, 1996, that is, a few months before the system was established. The exchange rate
Table 1: Venezuela crawling-band regimes [1996-2002]

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Central parity (Bs/US$)</th>
<th>Rate of crawl (Percent per day)</th>
<th>Realignment (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July/08/96-Decem./31/96</td>
<td>470</td>
<td>0.070</td>
<td>8.15</td>
</tr>
<tr>
<td>Jan./02/97-July/31/97</td>
<td>472</td>
<td>0.064</td>
<td>3.85</td>
</tr>
<tr>
<td>Aug./01/97-Jan./12/98</td>
<td>497.50</td>
<td>0.055</td>
<td>3.67</td>
</tr>
<tr>
<td>Jan./13/98-Decem./29/00</td>
<td>508.50</td>
<td>0.046</td>
<td>7.52</td>
</tr>
<tr>
<td>Jan./02/01-Decem./31/01</td>
<td>700</td>
<td>0.030</td>
<td>-0.93</td>
</tr>
<tr>
<td>Jan./02/02-Febr./08/02</td>
<td>758</td>
<td>0.038</td>
<td>Free float</td>
</tr>
</tbody>
</table>

Note: A positive value of realignment implies a revaluation and a negative value a devaluation.

The crawling-band was officially declared to be ±7.5 percent during all the period. The system was abandoned on February 8, 2002.

As we can observe, during the period the central parity was realigned several times. The four first realignments are revaluations, implying a reduction in the central parity for the exchange rate. Some of these revaluations are consequence that the exchange rate reaches the lower limit of fluctuation, that is, the exchange rate was more stable than the depreciation rate fixed by the monetary authority. However, the last realignment were an increases in the central parity (i.e. a devaluation). Table 1 shows the regimes and the date of realignments and the rates of crawl for each regime.

The initial rate of crawl was fixed to 1.5 percent per month, according to the inflation target. However, during this initial period the exchange rate was very stable, and in December 12, 1996, the central parity was reduced, which at this time was fixed to be 513.87 Bolivares per US dollar given the rate of crawl, to 472, that is a revaluation of 8.15 percent. In the second regime, the rate of crawl was reduced to 1.32 percent per month. During this period the Bolivar depreciates with respect to the US dollar but at a rate lower than the rate of crawl. In July 31, 1997 the central parity was again readjusted, with a revaluation of 3.85 percent. The new central parity was set to a value of 497.5 Bolivares per US dollar, and the rate of crawl was reduced to a 1.16 percent per month. In January 2, 1998 the exchange rate was revaluated in a 3.67 percent, with a new central parity of 508.5 Bolivares per US dollar. During the period January 1998-December 2000, the central parity was stable regardless some episodes of turbulences in the
fall of 1998. In December 29, 2000, the central parity was readjusted again, with a revaluation of 7.72 percent. However, in December 31, 2001, the central parity was readjusted with a small devaluation of 0.93 percent.

By January 2002, this system appeared to be successful in managing exchange rates. In fact, monetary authorities readjusted the central parity four times as revaluations. This implies that the exchange rate depreciated at a lower rate than the pre-announced one. However, the system was suspended on February 8, 2002, mainly due to political factors.

Then, we shall now study whether a binary dependent variable model is adequate for explaining the crises and credibility periods of the Bolivar/US Dollar exchange rate during the sample crawling band.

3 Econometric Specification

The application of a binary dependent variable model means we have to specify the moments in which the dependent variable will assume only two values \{1, 0\}. Let \(j_t\) be our dependent variable and \(j_t = 1\) if there is a lack of credibility and then a high probability of readjustment [storm period if we used the “Currency Crises” name], and \(j_t = 0\) if it is a calm period with high credibility. Note that in our sample, we have positive (devaluations) and negative (revaluations) adjustments.

The logistic distribution function we shall use, \(F(\kappa, \beta)\), is the following:

\[
\Pr(\text{ob}(j_t = 1) = F(\kappa, \beta) = \frac{\exp[\beta'\kappa]}{1 + \exp[\beta'\kappa]} \tag{1}
\]

where \(\Pr(\text{ob}(j_t = 0) = 1 - \Pr(\text{ob}(j_t = 1))\), and \(\kappa\) is a vector of observed exogenous variables that we will use in the analysis, \(\beta\) being the parameter vector.

We use a Maximum Likelihood Estimation Method and the numerical optimization is reached through the iterative algorithm known as “Newton-Raphson”. The log Likelihood function is given by:

\[
\ln L = \sum_{t=1}^{n} j_t \ln F(\kappa, \beta) + \sum_{t=1}^{n} (1 - j_t) \ln [1 - F(\kappa, \beta)] \tag{2}
\]

We will specify two moments in which \(j_t = \{1, 0\}\), because we find both revaluation and devaluation moments. Then, we have to estimate the model
twice, in one of them our dependent variable will be $jr_t = 1$ if there is a lack of credibility and then a high probability of revaluation, and $jr_t = 0$ if it is a calm period with high credibility. In the second case, $jd_t = 1$ if there is a high probability of devaluation, and $jd_t = 0$ if it is a high credibility period.

We must specify the exogenous variables considered in the estimation. One of them is the interest rate differential minus the preannounced rate of crawl, $(i^*_t - i^* - \delta_t)$. We correct the interest rate differential with the rate of crawl because, in a crawling-band system, the central parity growth at a constant rate (the rate of crawl) between realignments, and this fact has to be consider in the model. Even we consider the rate of crawl in the period, $(\delta)$ as a exogenous variable. Other variable is the exchange rate deviation from the central parity, $x_t$ defined as:

$$x_t = s_t - c_t$$

(3)

where $s_t$ is (the natural logarithm of) the spot exchange rate in period $t$, defined as the domestic currency per unit of foreign currency and $c_t = c_0 + \delta t$ denotes (the natural logarithm of) the central parity, where $c_0$ represents a jump in the central parity, positive for a devaluation and negative for a revaluation, and $\delta$ is the rate of crawl. Finally, we consider as another exogenous variable (the natural logarithm of) the international reserves, $rv_t$.

We will show our results by calculating, as a first step, the dependent variable values, using the Svensson Test and the Drift-Adjustment Method results. Then, we will estimate, by the maximum likelihood procedure, the readjustment probability of the exchange rate, calculating both the revaluation and the devaluation probability.

4 Estimation Results

The purpose of this paper is to analyze whether a non-structural binary dependent variable model is a suitable method to adequately explain the turbulence and calm periods of the Bolivar/US dollar exchange rate during the crawling band period. We have estimated the Log Likelihood function expressed in equation (2).
4.1 Estimation using the Svensson Test results

Svensson (1991) develops a set of simple credibility tests to target zones. By computing the rate of return band, we can observe if domestic interest rates are inside this band. By adding assumption of uncovered interest parity, we can calculate the maximum and minimum expected rate of devaluation. The same results are obtained.

The annualized effective domestic-currency ex-post rate of return on a foreign currency investment period $t$ of duration $\tau$, $R_t^\tau$, is then given by

$$ R_t^\tau = (1 + i_t^\tau)(S_{t+\tau}/S_t)^{12/\tau} - 1 $$  \hspace{1cm} (4)

where $S_t$ is the spot exchange rate in period $t$, defined as the domestic currency per unit of foreign currency, $S_{t+\tau}$ is the exchange rate at time $t+\tau$, $i_t^\tau$ is the foreign interest rate in period $t$ for term $\tau$. In a crawling-bands system the exchange rate is restricted to a band with lower and upper bounds. These bounds are not constant as in a target zone system, but they change at a constant rate: the rate of crawl. However, as in a target zone system, the existence of this exchange rate band implies bounds on the amount of depreciation and appreciation of the domestic currency. This implies that the rates of return, $R_t^\tau$, will also be restricted to a band:

$$ R_t^\tau \leq R_t^\tau \leq \overline{R}_t^\tau $$  \hspace{1cm} (5)

which Svensson calls the rate-of-return band. In the case of a crawling-band system, the lower and upper bounds on the rates of return are given by:

$$ R_t^\tau = (1 + i_t^\tau)(\underline{S}_t + \delta \tau/S_t)^{12/\tau} - 1 $$  \hspace{1cm} (6)

$$ \overline{R}_t^\tau = (1 + i_t^\tau)(\overline{S}_t + \delta \tau/S_t)^{12/\tau} - 1 $$  \hspace{1cm} (7)

where $\underline{S}_t + \delta \tau$ is the lower band for the exchange rate at the duration of the investment subject to no realignment and $\overline{S}_t + \delta \tau$ is the upper band for the exchange rate that will exist at the end of the investment, under the assumption that the central parity for the exchange rate will be increasing at the rate of crawl. Under a completely credible crawling-band and with free capital mobility, the domestic interest rate, $i_t^\tau$, it must lie inside the rate-of-return band. If indeed the domestic interest rate in some period is outside the rate-of-return band and if capital is sufficiently internationally mobile,
the exchange rate regime cannot be completely credible. In computing the rate of return bands, as we use 3-months interest rates, we have to expand the exchange rate band for each regime 66 period ahead.

Figure 2 shows the results of the above test, showing the Venezuela three-month interest rate and the rate-of-return bands, computed as above. Interest rate must fall within the rate-of-return bands if the exchange rate regime is credible and the no arbitrage assumption holds. If the interest rate is outside the bands, profit opportunities exist, and then, a readjustment of the central parity (additionally to the crawl) is expected. If the interest rate is above the band, an agent can make a profit by borrowing abroad and lending at home. If it is below the band profits can be make by borrowing at home and lending abroad. As we can observe, we obtain the crawling-bands system of the Bolivar during the period has a high level of credibility. Most of the time the interest rate is inside the rate-of-return band. Note that the rate-of-return band in decreasing with the exchange rate: a higher exchange rate means a weaker domestic currency, which increases the scope for domestic currency appreciation. This lowers the domestic currency rate of return on foreign investments and shifts down the rate-of-return band.

During the period November 15, 1996 until January 2, 1997, the interest rate was below the band, just in the period previous to the first revaluation. This fact shows that the system was not credible during this period, and that the market expected a revaluation. This can be interpreted as a fact which indicates that the rate of crawl preannounced (1.5 percent per month) was too high. A similar situation is found during the period October, 2000 until December 29, 2000, just before the fourth revaluation.

On the other hand, we find two subperiods in which the interest rate is above the band. The first subperiod is in August-September 1998. In this period the interest rate and the exchange rate increase and therefore, the rate-of-return band was decreasing. This fact shows a situation of lack of credibility, with expectations of devaluation. However, the central parity was not readjusted and the turbulences disappear rapidly. The other situation reflecting no credibility and expectations of devaluation is found at the end of the period, just before the abandon of the system in February 2002.

We have to specify a criterion to use in order to choose the dependent variable values for the Logit Model. We shall assign the dependent variable value \( jr_t = 1 \) (high probability of revaluation) if the Venezuela three-month interest rate is below the lower bound on the rates of return, and \( jr_t = 0 \) if the interest rate is inside the rate-of-return band. On the other hand,
\( j \bar{d}_t = 1 \) (high probability of devaluation) if the interest rate is above the upper bound on the rates of return, and \( j \bar{d}_t = 0 \) if the interest rate is inside the rate-of-return band.

Empirical research should begin with a specification of the relationship to be estimated. The omitted variables test enable us to evaluate the set of significant variables to explain the variation in the dependent variable. Interpretation of the coefficient values is complicated by the fact that estimated coefficients from a binary model can not be interpreted as the marginal effect on the dependent variable. The marginal effect of \( \kappa_i \) on the conditional probability is given by:

\[
\frac{\partial E(j \mid \kappa_i, \beta)}{\partial \kappa_i} = f(-\kappa \beta) \beta_i
\]

where \( f(\kappa, \beta) = dF(\kappa, \beta)/d\kappa \) is the density function associated with \( F \).

Note that the direction of the effect of a change in \( \kappa_i \) depends only on the sign of the \( \beta_i \) coefficient. Positive values of \( \beta_i \) imply that increasing \( \kappa_i \) will increase the probability of the response; negative values imply the opposite. For computing marginal effects, we have evaluated the marginal effects at every observation and have used the sample average of the individual marginal effects.\(^1\)

Table 2 sets out the marginal effects of the explanatory variables. As we can observe, the coefficient of the corrected interest rate differential is negative in the revaluation model and positive in the devaluation model. As interest rate differential increases, the probability of revaluation decreases and the probability of devaluation increases. Second, the sign of the exchange rate deviations is negative in the revaluation model and positive in the devaluation model. The coefficient of the rate of crawl and the reserves is positive in the revaluation model, and not significant in the devaluation model.

Table 3 displays \((2 \times 2)\) table of correct and incorrect classification based on a user specified prediction rule. Observations have been classified as having predicted probabilities that are above or below the cutoff value of 0.3.\(^2\)

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\(^1\)For computing marginal effects, one can evaluate the expressions at the sample means of the data or evaluate the marginal effects at every observation and use the sample average of the individual marginal effects. In large samples these will give the same answer. Current practice favors averaging the individual marginal effects when it is possible to do so. \([9, Greene, p.816]\)

\(^2\)We have used a cutoff value of 0.3 because our dependent variable \((j_t)\) presents many
Table 2: Readjustment probability using logit binary model from Svensson test

<table>
<thead>
<tr>
<th></th>
<th>Revaluation Probability</th>
<th>Devaluation Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(t_t^* - t_t^{**} - \delta)$</td>
<td>-0.950 (−4.088)</td>
<td>0.071 (2.220)</td>
</tr>
<tr>
<td>$x_t$</td>
<td>-1.663 (−4.149)</td>
<td>0.847 (3.240)</td>
</tr>
<tr>
<td>$r_t$</td>
<td>0.395 (2.777)</td>
<td>0.071 (1.592)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>1.211 (2.629)</td>
<td>1.211 (0.220)</td>
</tr>
<tr>
<td>AIC</td>
<td>0.055</td>
<td>0.021</td>
</tr>
</tbody>
</table>

**Note:** The value into the parentheses in the estimated parameters is the z statistic; this statistic has a standard normal distribution. The AIC is the Akaike info Criterion.

Table 3: Prediction evaluation using logit binary model from Svensson test

<table>
<thead>
<tr>
<th></th>
<th>Revaluation Prob.</th>
<th>Devaluation Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$jr_t = 0$</td>
<td>$jr_t = 1$</td>
</tr>
<tr>
<td>$p(j_t = 1) \leq 0.3$</td>
<td>1281</td>
<td>1</td>
</tr>
<tr>
<td>$p(j_t = 1) &gt; 0.3$</td>
<td>7</td>
<td>83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1288</td>
<td>84</td>
</tr>
<tr>
<td><strong>% Correct</strong></td>
<td>99.46</td>
<td>98.81</td>
</tr>
</tbody>
</table>

**Note:** Correct classifications are obtained when the predicted probability is greater than 0.3 and the observed $j_t = 1$, or when the predicted probability is less than or equal to 0.3 and the observed $j_t = 0$.

It provides a measure of the predictive ability of our model. The estimated model correctly predicts almost 100% observations (99.46% of the $jr_t = 0$ or 100% of the $jd_t = 0$ and 98.81% of the $jr_t = 1$ or 95.83% of the $jd_t = 1$ observations).

Figures 3 and 4 illustrate the readjustment probability, revaluation and devaluation probability respectively. Using the estimated probability of revaluation we can observe in figure 3 that our model predicts the first, second and four revaluations. Figure 4 shows the probability of devaluation. More values of credibility ($j_t = 0$) than values of realignment probability ($j_t = 1$). Results do not change significantly if we use other cutoff value.

11
As we can observe, the model detects two episodes of a positive probability of devaluation. First, we find a high probability of devaluation during September 1998. In this date, the exchange rate depreciates and the interest differential increases significantly. Second, we find some probability of devaluation in September 2001.

4.1.1 Estimation using the drift adjustment method results

Let $c_t$ denotes (the natural logarithm of) the central parity. A realignment is defined as a jump in the central parity, positive for a devaluation and negative for a revaluation. In a crawling-band system the central parity growths at a constant rate (the rate of crawl) between realignments. The exchange rate deviation from the central parity, $x_t$, can be define as:

$$x_t = s_t - c_t$$

where $c_t = c_0 + \delta t$ and $\delta$ is the preannounced rate of crawl. Bertola and Svensson (1993) were the first to consider the possibility of realignment risk in the context of a target zone. Their method of calculating this realignment risk is based on the decomposition of the expected rate of depreciation (appreciation) rate in two components: the expected rate of depreciation within the band plus the expected rate of change in the central parity.

$$E_t \Delta s_{t+\tau} = E_t \Delta x_{t+\tau} + E_t \Delta c_{t+\tau}$$

Additionally, in the case of a crawling-bands system, the expected rate of change in the central parity has two components, one known, given the preannounced rate of crawl and another unknown, representing the expected rate of realignment:

$$E_t \Delta c_{t+\tau} = \delta \tau + E_t r_{t+\tau}$$

where $E_t r_{t+\tau}$ is the expected rate of realignment. One the value of the expected change within the band is obtained, it can be used to correct the interest rate differential for expectations of currency changes within the band and for the preannounced change in the central parity in order to obtain the expected rate of realignment:

$$E_t r_{t+\tau} = i_t^* - i_t^{\tau*} - E_t \Delta x_{t+\tau} - \delta \tau$$
From the above expression, it is clear that this method needs an econometric estimate of the expected rate of depreciation within the band. At it is noted by Svensson (1993), exchange rate within the band usually take a jump at a realignment. Therefore, it is complicated to estimate the expected rate of depreciation within the band inclusive of possible jumps inside the band at realignments, since there may be relative few realignments. Then expectations of realignment and jumps inside the band may introduce a Peso problem in the estimation of the expected rate of depreciation within the band. For these reasons it is necessary to estimate the expected rate of depreciation within the band conditional upon no realignment.

Following Bertola and Svensson (1993), an estimate of the expected rate of depreciation can be obtained by regressing the change in the exchange rate on the current exchange rate, both measured relative to the central parity, and on regime shift dummies. The estimated equation is as follows:

\[(x_{t+\tau} - x_t) \frac{12}{\tau} = \sum \alpha_j z_j + \beta_1 x_t + \epsilon_{t+\tau}\]  

(13)

The variable \(z_j\) is a dummy for regime \(j\), where a regime is the period between two realignments. Note that since the maturity of the interest rate is three months, the expected change in the exchange rate is based on the same time interval. Therefore, the regressand is multiplied by \(12/\tau\) in order to be annualized to maintain time consistency with the interest rate. Since we need to estimate the expected future exchange rate conditional upon no realignment, the observations within the time interval \(\tau\) before each realignment are excluded. This corresponds to 66 observations, given that one month corresponds to about 22 daily observations.

Equation (13) was estimated using ordinary least-squares with standard errors computed using a Newey-West estimator of the covariance matrix which allow for heteroskedastic and serially correlated error terms.

The results are presented in table 4. The significant negative coefficient of the level of the exchange rate deviation indicates that there is evidence of mean reversion of the Bolivar/US dollar exchange rate within the band.\(^3\)

Figure 5 gives time-series plot of the expected rate of realignment and the 95 percent confidence interval. As we can observe, the comparison of this estimation with the credibility test gives some differences. The confidence interval is below zero just during all the period between the

\(^3\)In fact, the ADF and PP unit root tests indicate that the null hypothesis that \(x_t\) is nonstationary is rejected.
Table 4: Estimated parameters value of the expected rate of depreciation within the band

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_1$</td>
<td>$-0.218$</td>
</tr>
<tr>
<td></td>
<td>($-27.073$)</td>
</tr>
<tr>
<td>$z_2$</td>
<td>$-0.118$</td>
</tr>
<tr>
<td></td>
<td>($-13.523$)</td>
</tr>
<tr>
<td>$z_3$</td>
<td>$-0.112$</td>
</tr>
<tr>
<td></td>
<td>($-15.582$)</td>
</tr>
<tr>
<td>$z_4$</td>
<td>$-0.058$</td>
</tr>
<tr>
<td></td>
<td>($-3.031$)</td>
</tr>
<tr>
<td>$z_5$</td>
<td>$0.007$</td>
</tr>
<tr>
<td></td>
<td>(1.252)</td>
</tr>
<tr>
<td>$x_t$</td>
<td>$-1.184$</td>
</tr>
<tr>
<td></td>
<td>($-2.444$)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.434</td>
</tr>
<tr>
<td>F-statistic</td>
<td>155,529</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Durbin-Watson statistic</td>
<td>0.014</td>
</tr>
<tr>
<td>White heteroskedasticity test</td>
<td>103.557</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

Note: The value in parentheses in the estimated parameters is the t statistic. The value in parentheses in both the F-statistic and the White heteroskedasticity Test is the p-value. Adjusted R-squared is used as a measure of goodness of fit.
first and the third realignments (except at the beginning of the sample, when the crawling band system was introduced), indicating the existence of expectations of revaluations. In fact, during this period the central parity was readjusted three times, as revaluations. On the other hand, the turbulences period of lack of credibility occurring at the end of 1998 obtained from the previous analysis, give an expectations of revaluations not significantly different from zero. The analysis shows clearly that after this period of turbulence, expectations of realignments are clearly negative, indicating the existence of expectations of revaluations. However, situation changes dramatically after the realignment of December 29, 2000. From this date the estimated realignment expectations start to increases, and it becomes significantly different from zero just at the end of the period, predicting the realignment (devaluation) of December 31, 2002. Resuming, our estimation of the realignment expectations predict all the realignments and their sign (devaluation or revaluation) of the Venezuela crawling peg system. The results we obtain demonstrate that the interest rate differential, corrected for expected depreciation within the band, is a reasonable estimation of expected realignment for Venezuela.

In order to specify a criterion to use in order to choose the dependent variable values for the Logit Model, we shall assign the dependent variable value \( j_d_t = 1 \) (high probability of devaluation) if the threshold is above zero. Otherwise, we will consider \( j_d_t = 0 \). On the other hand, \( j_r_t = 1 \) (high probability of revaluation) if the estimated realignment expectations is less than zero, and \( j_r_t = 0 \) otherwise.

Table 5 sets out the marginal effects of the explanatory variables. As we can observe, the sign of the variables is the expected. In the revaluation model, the interest differential, the exchange rate deviation and the rate of crawl show a negative coefficient, whereas the reserves show a positive coefficient. In the devaluation model only the reserves show a negative sign, as expected. Table 6 displays table of correct and incorrect classification based on a user specified prediction rule.

Figures 6 and 7 illustrate the readjustment probability of revaluation and devaluation, respectively. In this case, the revaluation model predict all the realignments. As we can observe, during most of the sample period, there are a positive probability of revaluation. Figure 7 shows the estimated probability of devaluation. We observe a positive probability of devaluation just at the beginning of the regime. It is natural to think that just at the beginning of the crawling band regime the credibility is null, so the market
Table 5: Readjustment probability using logit binary model from the drift adjustment method

<table>
<thead>
<tr>
<th></th>
<th>Revaluation Probability</th>
<th>Devaluation Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>((i_t^* - i_t^{**} - \delta \tau))</td>
<td>(-7,952) ((-5,552))</td>
<td>(1,042) ((3,527))</td>
</tr>
<tr>
<td>(x_t)</td>
<td>(-8,804) ((-5,073))</td>
<td>(1,351) ((3,324))</td>
</tr>
<tr>
<td>(rv_t)</td>
<td>0,0881 ((5,511))</td>
<td>(-0,038) ((-3,570))</td>
</tr>
<tr>
<td>(\delta \tau)</td>
<td>(-10,844) ((-5,596))</td>
<td>(1,865) ((3,573))</td>
</tr>
<tr>
<td>AIC</td>
<td>0,275</td>
<td>0,026</td>
</tr>
</tbody>
</table>

**Note:** The value into the parentheses in the estimated parameters is the z statistic; this statistic has a standard normal distribution. The AIC is the Akaike info Criterion.

Table 6: Prediction evaluation using logit binary model from the drift adjustment method

<table>
<thead>
<tr>
<th></th>
<th>Revaluation Prob.</th>
<th>Devaluation Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(jr_t = 0)</td>
<td>(jr_t = 1)</td>
</tr>
<tr>
<td>(p(j_t = 1) \leq 0,3)</td>
<td>818</td>
<td>8</td>
</tr>
<tr>
<td>(p(j_t = 1) &gt; 0,3)</td>
<td>66</td>
<td>480</td>
</tr>
<tr>
<td>Total</td>
<td>884</td>
<td>488</td>
</tr>
<tr>
<td>% Correct</td>
<td>92,53</td>
<td>98,36</td>
</tr>
</tbody>
</table>

**Note:** Correct classifications are obtained when the predicted probability is greater than 0,3 and the observed \(j_t = 1\), or when the predicted probability is less than or equal to 0,3 and the observed \(j_t = 0\).
expected a devaluation. However, this positive probability of devaluation disappears rapidly. Second, we observe that after the third revaluation, probability of devaluation becomes positive during a long period during 1998. Finally, probability of devaluation becomes positive just before the devaluation realignment of January 2002 and just before the breakdowns of the system.

5 Conclusions

During the 90’s, we have witnessed important episodes of exchange rate instability in both developed and emerging countries. Some of these periods have resulted in exchange rate devaluations and others, in important exchange rate depreciations.

We have analyzed whether a non-structural binary dependent variable model could be a suitable method to adequately explain the turbulence and calm periods that the Bolivar/US Dollar exchange rate during the crawling band period. During the period 1996-2002 Venezuela adopted a crawling-band regime in which the exchange rate was forced to move inside a fluctuation band with a increasing central parity. During this period, the central parity was readjusted (other than the crawl) five times: four were revaluations and one small devaluation at the end of the period.

We estimate two models: one for the probability of revaluation and another for the probability of devaluation. In choosing the dependent variables, we use two methods to estimate realignment expectations: the Svensson credibility test and the drift adjustment method. The model of revaluation shows that the interest differential, the exchange rate deviation from the central parity, the level of reserves and the rate of crawl, explain the probability of revaluation. The methodology could be considered as a mixture of approaches which have studied and carried out research on currency crises and credibility both of them widely applied to target zones.

References


![Figure 1: Venezuela crawling-band system](image-url)
Figure 2: The rate of return band (Svensson Test)

Figure 3: Realignment expectations (Drift adjustment method)
Figure 4: Readjustment probability (Revaluation) from Svensson test

Figure 5: Readjustment probability (Devaluation) from Svensson test
Figure 6: Readjustment probability (Revaluation) from drift adjustment method

Figure 7: Readjustment probability (Devaluation) from drift adjustment method