

## The credibility of the Venezuela crawling-band system

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**Abstract.** This paper studies the credibility of the Venezuela crawling-band exchange rate regime during the period July, 1996-February, 2002. We show that, introducing some modifications, the credibility analysis widely applied to target zone regimes can also be used in studying the credibility of crawling-band regimes. In analyzing the credibility of the Venezuela crawling band, first we use the so-called simple credibility tests developed by Svensson (1991). Additionally, we estimate the expected rate of realignment using the drift-adjustment method. Both the credibility tests and the drift-adjustment method give similar results, showing that the crawling-band system was highly credible during the period.

**Key words:** crawling-band exchange rate system, credibility, realignments.

**JEL classification:** F31, F33.

**Resumen.** Este artículo estudia la credibilidad del régimen cambiario de bandas de fluctuación crecientes a tasa constante de Venezuela durante el periodo julio de 1996-febrero de 2002. Mostramos que los análisis de credibilidad aplicados a zonas objetivo, introduciendo algunas modificaciones, también pueden utilizarse para estudiar la credibilidad de sistemas cambiarios de bandas de fluctuación crecientes a tasa constante. En este trabajo aplicamos tanto el denominado test de credibilidad de Svensson como el método de ajuste de la deriva. Con ambos métodos obtenemos resultados similares en cuanto al alto grado de credibilidad del sistema durante el periodo analizado.

**Palabras clave:** sistema cambiario de bandas de fluctuación crecientes a tasa constante, credibilidad, realineamientos.

**Clasificación JEL:** F31, F33.

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## 1. Introduction

This paper studies the credibility of the crawling-band exchange rate system implemented by the Central Bank of Venezuela during the period 1996-2002. Following Williamson (1996), an exchange rate crawling-band can be defined as a system in which the exchange rate is forced to move inside a band with the band being adjusted in small steps aiming to keeping it in line with the fundamentals. As in a target zone system, the 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 for the fact that central parity is not constant over time but increases at a constant positive rate (the crawl rate). Both the bandwidth and the crawl rate are preannounced.

As pointed out by Williamson (1996), the principal cause of changes in the exchange rate 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 has been adopted by developing countries experiencing high inflation. Examples are Chile, Colombia, Israel, Indonesia, Ecuador, Russia and Venezuela, with bandwidths ranging from the  $\pm 5.5$  percent of Ecuador to the  $\pm 15$  percent of Chile and Russia.

During the period July 8, 1996-February 8, 2002, Venezuela adopted a crawling-band system, rate with a bandwidth of  $\pm 7.5$  percent and an initial crawl rate of 1.5 percent by month, to stabilize the exchange rate. During this period, the exchange rate central parity was readjusted several times, besides the crawl, implying both revaluations and devaluations (four revaluations and one small devaluation at the end of the period).

The purpose of this paper is two-fold: first, we show that credibility analysis, widely applied to target zones, can be applied to crawling bands after minor changes in order to take into account the fact that in the latter regimes central parity is not constant but increases continuously over time. Second, we investigate the credibility of the crawling-band system adopted recently by Venezuela.

In the empirical analysis, we first study the credibility of the crawling-band exchange rate system adopted by Venezuela using the so-called simple credibility tests. Svensson (1991) developed a set of simple credibility tests for target zones. By computing the rate of return band, we can see whether domestic interest rates are inside this band. By adding the assumption of uncovered interest parity, we can calculate the maximum and minimum expected rate of depreciation.

Second, we use a more precise method to estimate the expected rates of devaluation (revaluation). Bertola and Svensson (1993) developed the so-called drift adjustment method to estimate the probability of realignments. The idea involves extracting devaluation expectations by adjusting interest rate differentials for expected rates of depreciation within the band. This method has

been used, among others, by Rose and Svensson (1995), Bertola and Svensson (1993), and Lindberg, Soderlind and Svensson (1993) to analyze ERM and Swedish devaluation risk.

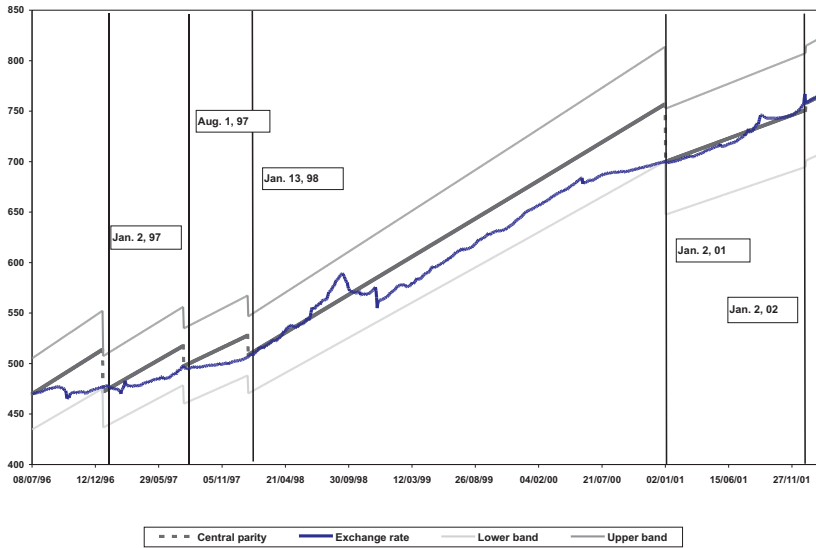
Our empirical results are highly suggestive of the credibility of the Venezuela crawling-band regime. Simple credibility tests show that the system was not-credible over some short periods, indicating the existence of expectations of both revaluation and devaluation. We find expectations of revaluation just before the first and fourth realignments (revaluations). On the other hand, these tests indicate the existence of expectations of devaluation at the end of the period, just before the fifth realignment (in fact, a devaluation). Nevertheless, the simple credibility tests seem to indicate that the regime was credible most of the time. Second, the drift adjustment method gives a more precise estimate about expectations of realignment, indicating that the regime was highly stable, with a probability of realignment not significantly different from zero over most of the period. Moreover, our estimate can predict all the realignments, and their sign, during the existence of the crawling-band system. In general, the results obtained show that the regime was highly credible and successful in managing the exchange rate.

The rest of the paper is as follows: the main characteristics of the Venezuela crawling-band system experience are discussed in Section 2. Section 3 presents the simple credibility tests and their results in the case of Venezuela. Section 4 presents the results of the estimation of the expected rate of realignment using the drift adjustment method. Finally, Section 5 concludes the paper.

## 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. The central parity was initially set to 470 Bolívars per US dollar. In order to fix this value (as an equilibrium exchange rate), the Venezuela Central Bank left the currency to float during the period April-July, 1996, that is, a few months before the system was established. The exchange rate band was officially declared to be  $\pm 7.5$  percent during all the period. The system was abandoned on February 8, 2002. Figure 1 shows the crawling-band system of Venezuela during the period, plotting the Bolívar/US Dollar exchange rate, central parity and the lower and upper bands.

As can be seen in Table 1, the exchange rate central parity was realigned several times during the period. The four first realignments were revaluations, implying a reduction in central parity for the exchange rate. Some of these revaluations were a consequence of the exchange rate reaching 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 consisted of small increases in central parity (i.e., a devaluation). Table 1 shows the realignment, and the crawl rate for each regime.

**Figure 1.** Venezuela crawling-band system**Table 1.** Venezuela crawling-band regimes [1996-2002]

	Central parity (Bs/US\$)	Crawl rate (Percent per day)	Realignment (Percent)
July/08/96-Dec./31/96	470	0.070	-8.15
Jan./02/97-July/31/97	472	0.064	-3.85
Aug./01/97-Jan./12/98	497.50	0.055	-3.67
Jan./13/98-Dec./29/00	508.50	0.046	-7.52
Jan./02/01-Dec./31/01	700	0.030	0.93
Jan./02/02-Feb./08/02	758	0.038	Free float

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

The initial crawl rate was fixed at 1.5 percent per month, according to the inflation target. However, during this initial period the exchange rate was very stable and, on December 12, 1996, central parity—which at this time was fixed at 513.87 Bolivares per US dollar given the crawl rate—was reduced to 472, i.e., a revaluation of 8.15 percent. In the second regime, the crawl rate was reduced to 1.32 percent per month. During this period, the Bolivar depreciated with respect to the US dollar but at a rate lower than the crawl rate. On July 31, 1997, 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 crawl rate was reduced to 1.16 percent per month. On January 2, 1998,

the exchange rate was revaluated by 3.67 percent, with a new central parity of 508.5 Bolívares per US dollar. During the period January, 1998-December, 2000, central parity was stable regardless of some turbulent episodes in the fall of 1998. On December 29, 2000, central parity was readjusted again, with a revaluation of 7.52 percent. However, on December 31, 2001, central parity was readjusted with a small devaluation of 0.93 percent.

By January, 2002, this system appeared to be successful in managing the exchange rate. In fact, the monetary authorities readjusted the central parity four times as revaluations, this implying 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.

### 3. Crawling-band simple credibility tests

When analyzing the credibility of the crawling-band system adopted by Venezuela, we first use a set of credibility tests proposed by Svensson (1991): the rate-of-return band and the expected exchange rate tests.<sup>1</sup>

These simple credibility tests have been widely used in testing the credibility of target zones. For instance, Svensson (1991) applied the simple tests to the Swedish krona and Hughes and Hurley (1994) applied them to the Irish pound.

These credibility tests can be applied to crawling-band systems only by taking into account that the fluctuation band is not constant, but changes at the constant crawl rate. In fact, in a crawling band, the announced target is to maintain the exchange rate inside a band during each period:

$$\underline{s}_t < s_t < \bar{s}_t \quad (1)$$

where

$$\underline{s}_t = \underline{s}_0 + \delta t \quad (2)$$

$$\bar{s}_t = \bar{s}_0 + \delta t \quad (3)$$

and  $\delta > 0$  is the crawl rate. This is a pre-announced, constant crawl rate of central parity, i.e.,  $c_t = c_0 + \delta t$ . This means that central parity continuously depreciates at a constant rate, in small steps. Note that this system implies that the bandwidth is constant over time, but both the lower and upper limits increase over time.

The data consists of daily observations for the period July, 1996-February, 2002 for the Bolívar/US dollar exchange rate, and interest rate for 3 months to maturity. The data used have been obtained from the Venezuela Central Bank. Note that since we use a 3-month interest rate and daily data, the fluctuation bands for each regime have to be extended 66 periods ahead (given that each month has approximately 22 observations) using the preannounced crawl rate for each.

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<sup>1</sup>Following Krugman (1991), an exchange rate bands regime is credible when the market agents believe that the lower and upper edges of the band will remain fixed and no changes in central parity are expected.

### 3.1. Rate-of-return band test

Svensson (1991) developed a simple test of credibility for a target zone system. Deriving rate-of-return bands around a foreign interest rate (the bands are implied by limits on the size of an appreciation or depreciation of the exchange rate), he tested whether the domestic interest rate was inside or outside the bands.

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

$$R_t^\tau = (1 + i_t^{*\tau}) \left( \frac{S_{t+\tau}}{S_t} \right)^{12/\tau} - 1 \quad (4)$$

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  $t + \tau$ , and  $i_t^{*\tau}$  is the foreign interest rate in period  $t$  for term  $\tau$ . In a crawling-band 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 crawl rate. 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,  $R_t^\tau$ , are also restricted to a band

$$\underline{R}_t^\tau \leq R_t^\tau \leq \overline{R}_t^\tau \quad (5)$$

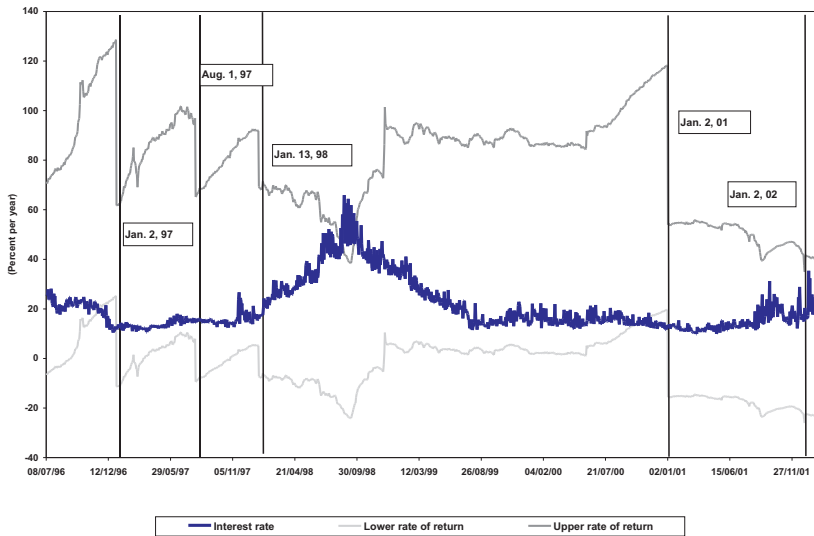
which Svensson calls the rate-of-return band. In the case of a crawling-band system, the lower and upper bounds on the rates of return are given by

$$\underline{R}_t^\tau = (1 + i_t^{*\tau}) \left( \frac{\underline{S}_t + \delta\tau}{S_t} \right)^{12/\tau} - 1 \quad (6)$$

$$\overline{R}_t^\tau = (1 + i_t^{*\tau}) \left( \frac{\overline{S}_t + \delta\tau}{S_t} \right)^{12/\tau} - 1 \quad (7)$$

where  $\underline{S}_t + \delta\tau$  is the lower band for the exchange rate for 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 central parity for the exchange rate will be increasing at the crawl rate. Under a completely credible crawling-band, and with free capital mobility, the domestic interest rate,  $i_t^\tau$ , 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, since we use 3-month interest rates, the exchange rate band for each regime has to be extended 66 periods ahead using the preannounced crawl rate.

Figure 2 plots the results of the above test, showing the Venezuela 3-month interest rate and the rate-of-return bands, computed as above. The interest

**Figure 2.** The rate-of-return band

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 central parity (in addition 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 made by borrowing at home and lending abroad. As can be seen, the crawling-band system for the Bolivar during the period seems to show 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 is 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.

The test shows several periods, albeit short, with a clear lack of credibility. During the period November 15, 1996-January 2, 1997, the interest rate was below the band just previous to the first revaluation. This fact shows that the system was not credible during this subperiod, and that the foreign exchange market expected a revaluation. This can be interpreted as indicating that the preannounced crawl rate (1.5 percent per month) was too high. A similar situation is found during the period October, 2000-December 29, 2000, just before the fourth revaluation. Note that these results indicate that both realignments were expected or anticipated by the foreign exchange market.

On the other hand, we find two subperiods in which the interest rate is above the band, indicating a lack of credibility with expectations of devaluation. First, in the subperiod August-September, 1998 the interest rate and the exchange

rate increased and, therefore, the rate-of-return band was decreasing. However, central parity was not readjusted and the turbulence disappeared rapidly. The other situation reflecting no-credibility and expectations of devaluation is found at the end of the period, just before abandoning the system in February, 2002.

3.2. *Expected exchange rate test*

Another test proposed by Svensson (1991) is to compute the expected exchange rate under the assumption of uncovered interest parity.<sup>2</sup> The idea is simple: uncovered interest rate parity can be written as

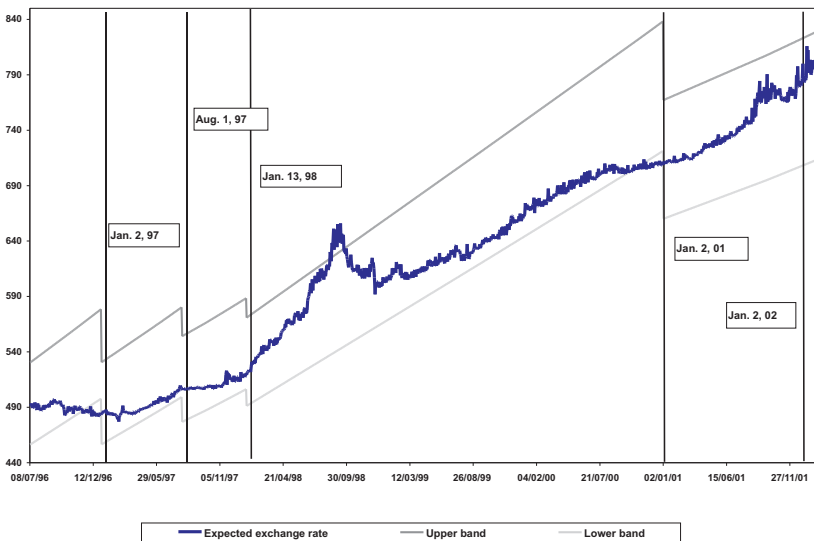
$$E_t S_{t+\tau} = S_t \left[ \frac{1 + i_t^\tau}{1 + i_t^{*\tau}} \right]^{\tau/12} \tag{8}$$

where  $E_t S_{t+\tau}$  denotes the exchange value in month  $t$  of the exchange rate to rule in month  $t + \tau$ . Therefore, this expected exchange rate can be compared with the bands of the system. Credibility of the bands implies that

$$\underline{S}_t + \delta\tau \leq E_t S_{t+\tau} \leq \overline{S}_t + \delta\tau \tag{9}$$

That is, whether the month's expectation of the exchange rate in month  $t + \tau$  is inside or outside the exchange rate band that will exist in month  $t + \tau$ , given the existing crawl rate.

**Figure 3.** The expected exchange rate



<sup>2</sup>Zambrano (2000) shows that uncovered interest parity partially holds in the Venezuela crawling-band regime for the period January, 1998-July, 1999.



Figure 3 shows the expected exchange rate, calculated using expression (8), and the expected exchange rate band under the assumption of no realignment. As can be seen, under the assumption of uncovered interest rate parity, the expected exchange rate is inside the crawling bands during most of the period. This result is similar to that of the rate-of-return test. The first and the fourth revaluations were justified by an expected exchange rate below the lower band of fluctuation. We can also see that the expected exchange rates were close to the lower band of fluctuation for the second and third revaluations. As in the previous test, we found two situations in which the expected exchange rate was higher than the upper band of fluctuation: in August-September, 1998, and at the end of the period, just before the devaluation of January 2, 2002.

In general, the above results show that the credibility of the crawling-band system of Venezuela was high, except during some short periods. In fact, two of the revaluations were predicted by the market. We note that the market predicted the devaluation at the end of the period. However, in the next section, we use a more precise method to analyse the credibility of this system.

#### 4. The expected rate of realignment

In this section we estimate the expected rates of realignment using the so-called drift adjustment method developed by Bertola and Svensson (1993). Lindberg, Soderlind and Svensson (1993) applied this analysis to the Swedish krone, showing that the drift adjustment method gives better power than simple credibility tests. Thomas (1994) used the drift adjustment method to estimate the risk of devaluation of the French frank, the Italian lira and the British pound against the Deutsche mark.

Let  $c_t$  denote (the natural logarithm of) central parity. A realignment is defined as a jump in central parity, positive for a devaluation and negative for a revaluation. As noted above, in a crawling-band system central parity grows at a constant rate (the crawl rate) between realignments. Thus, the exchange rate deviation from central parity,  $x_t$ , can be defined as

$$x_t = s_t - c_t \quad (10)$$

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

$$E_t \Delta s_{t+\tau} = E_t \Delta x_{t+\tau} + E_t \Delta c_{t+\tau} \quad (11)$$

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

$$E_t \Delta c_{t+\tau} = \delta\tau + E_t r_{t+\tau} \quad (12)$$

where  $E_t r_{t+\tau}$  is the expected rate of realignment. Therefore, in a crawling-band regime, the expected rate of depreciation has three components:

$$E_t \Delta s_{t+\tau} = E_t \Delta x_{t+\tau} + \delta\tau + E_t r_{t+\tau} \quad (13)$$

Once the value of the expected change within the band is obtained, and under the assumption of uncovered interest parity, it can be used to correct the interest rate differential for expectations of currency changes within the band and the preannounced change in the central parity, in order to obtain the expected rate of realignment:

$$E_t r_{t+\tau} = i_t^\tau - i_t^{*\tau} - E_t \Delta x_{t+\tau} - \delta\tau \quad (14)$$

From the above expression, it is clear that this method needs an econometric estimate of the expected rate of depreciation within the band. As noted by Svensson (1993), the exchange rate within the band usually takes a jump at a realignment. Therefore, expectations of realignments and jumps inside the band may introduce problems in the estimation of the expected rate of depreciation within the band. For this reason 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 central parity, and on regime shift dummies. The estimated equation is as follows:

$$(x_{t+\tau} - x_t) \frac{12}{\tau} = \sum \alpha_j z_j + \beta x_t + \varepsilon_{t+\tau} \quad (15)$$

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 3 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 (15) was estimated using ordinary least-squares with standard errors computed using a Newey-West estimator of the covariance matrix which allows for heteroskedastic and serially correlated error terms.<sup>3</sup> The results are presented in Table 2. The significant negative coefficient of the level of the exchange rate deviation indicates that there is evidence of mean reversion of the

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<sup>3</sup>The Durbin-Watson test indicates that the level of autocorrelation is very large and, therefore, correction of the Newey-West standard errors could be insufficient.

Bolivar/US dollar exchange rate within the band. Similar analyses by Svensson (1991), Caramazza (1993) and Thomas (1994) for European currencies also find mean reversion. In fact, unit root tests indicate that the null hypothesis that  $x_t$  is nonstationary is rejected.<sup>4</sup>

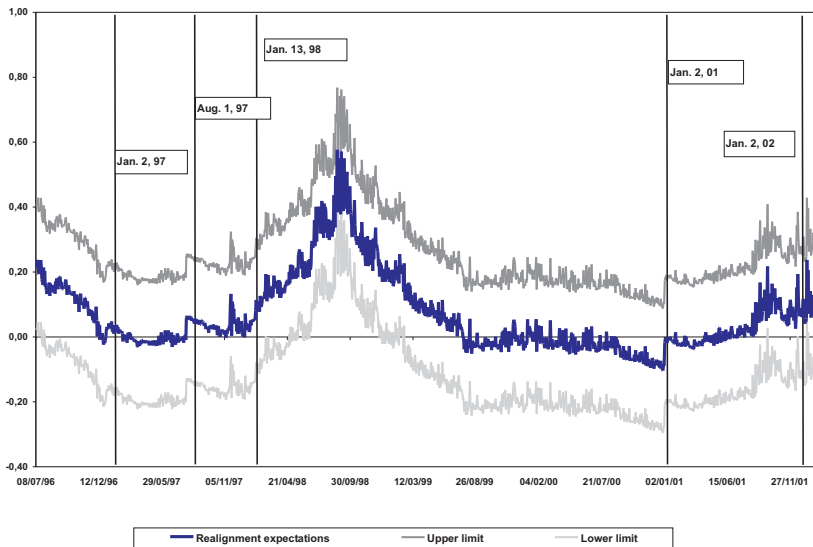
**Table 2.** Estimated parameters value for the expected rate of depreciation within the band

Variables	Estimated values
$z_1$	-0,218 (-27,073)
$z_2$	-0,118 (-13,523)
$z_3$	-0,112 (-15,582)
$z_4$	-0,058 (-3,031)
$z_5$	0,007 (1,252)
$x_t$	-1,184 (-2,444)
$\overline{R}^2$	0.434
$F$ -statistic	155,529 (0,000)
Durbin-Watson statistic	0,014
White heteroskedasticity test	103.557 (0,000)

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.

Figure 4 shows a time-series plot of the expected rate of realignment and the 95 percent confidence interval. As can be seen, the comparison of this estimation with the credibility tests yields some differences. We can see that, during most of the period, the expected rate of realignment is not significantly different from zero. At the beginning of the system, the expected rate of realignment is positive, indicating the existence of expectations of depreciation. However, the expected rate of realignment decreases rapidly. The confidence interval is below zero during the entire period between the first and the third realignments, 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 turbulent period of lack of credibility occurring

<sup>4</sup>The ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) unit root tests indicate that the null hypothesis that  $x_t$  is nonstationary is rejected.

**Figure 4.** The expected rate of realignment

at the end of 1998 obtained from the previous analysis, yielded an expectation of revaluations not significantly different from zero. The analysis shows that after this period of turbulence, expectations of realignments are clearly negative, indicating the existence of expectations of revaluations. However, the situation changes dramatically after the realignment of December, 2000. From this date on, estimated expectations of realignment start to increase and become significantly different from zero just at the end of the period, predicting the small realignment (devaluation) of December, 2002. In sum, our estimation of the realignment expectations of the Venezuela crawling-band system predicts all its realignments and their sign (devaluation or revaluation). The results we obtain demonstrate that the interest rate differential, corrected for expected depreciation within the band, is a reasonable estimate of expected realignment for Venezuela.

## 5. Conclusions

In this paper we analyze the credibility of the crawling-band exchange rate system adopted by Venezuela during the period 1996-2002. During this period, the monetary authorities set an exchange rate fluctuation band of  $\pm 7.5$  percent around a central parity which increased at a constant rate (the crawl rate). We use the simple tests developed by Svensson (1991). The results we obtain show that the exchange rate system of Venezuela was credible during most of the period. We find situations in which credibility is lacking due to expectations of both revaluation and devaluation.

We estimate the expectations of realignment using the drift adjustment method proposed by Bertola and Svensson (1993). The results we obtain are very significant. Our estimate can predict all the realignments that occurred during the crawling-band system in Venezuela, showing, during most of the period, the existence of a significant negative expectation of realignment, that is, an expectation of revaluation.

The results we obtain seem to indicate that the crawling-band system adopted by Venezuela was a very credible system and very effective in controlling the evolution of the Bolivar/US dollar exchange rate. In fact, central parity was readjusted four times as revaluations. This evidence is corroborated if we consider the evolution of the Bolivar/US dollar exchange rate after this system was abandoned: after the breakdown of the system, the Bolivar/US dollar exchange rate depreciated significantly; in a few months, the depreciation was larger than that experienced during the more than 5 years of the crawling-band system.

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