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# Inflation and the Bulgarian Currency Board

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**Summary.** Why did inflation fall so dramatically after the establishment of a currency board in Bulgaria in 1997? The establishment of the currency board was the response to a very severe financial crisis where inflation reached hyperinflationary levels. After the currency board was introduced, inflation decreased even more spectacularly than it had increased with prices rising less than 10% annually during 1998 and 1999. Was this sudden drop in inflation due to a 'discipline' effect caused by a reduction in money growth rates or to a 'confidence' effect that created lower inflation expectations thus leading to higher money demand? We find strong evidence for a 'confidence' effect but less support for a 'discipline' effect.

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# I. Introduction

Why did inflation fall so dramatically after the establishment of a currency board in Bulgaria in 1997? The establishment of the currency board was the response to a very severe financial crisis. The exchange rate went from BGL 78 per USD 1 in March 1996 to more than BGL 2,000 per USD 1 in February 1997. Inflation went from 1.71% *per month* in March 1996 to 242% *per month* in February 1997. Faced with this crisis, a currency board was introduced on 1 July 1997. Inflation then fell even more spectacularly than it had risen. In 1998 and 1999 consumer price inflation was less then 10% *annually* and rose to only 11.4% in 2000 when imported oil prices rose.

*Hanke and Schuler* (1994) argue that a crucial aspect of a currency board is that it creates credibility in the exchange rate fix. A currency board is bound by a very strict set of rules: the exchange rate is fixed and the money supply adjusts to imbalances in the balance of payments. The discretion of monetary authorities is extremely limited. According to this argument the establishment of credibility should lower inflationary expectations, and this reduction in inflationary expectations should cause inflation to fall as wage setters and prices setters adjust their behavior to avoid being priced out of the market (*Williamson*, 1995).

A currency board can affect price dynamics in two ways. One is through the control of the monetary aggregates, as in the quantity theory (discipline effect) and the other is through inflationary expectations which influence the expected 'returns' on money holdings, hence the demand for money (confidence effect). Inflationary expectations can in turn be a function of the expected growth in monetary aggregates or of other factors.

*Cagan*'s (1956) model unifies both these possibilities in a single equation and has been widely used to study hyperinflations. In this paper we estimate Cagan's model over the entire period of available data by explicitly allowing for a structural break at the time of the currency board implementation. One approach would be to model this as a discrete event, i.e. a regime change over a single observation period (one month). Alternatively, however, it is plausible that the regime change occurred gradually as the need and likelihood of regime change grew more apparent to the population in the months leading up to the currency board. Both abrupt and gradual regime switching models were estimated in this paper.

Interestingly, we find that while the establishment of the currency board appears to have had a significant impact on inflationary expectations, there is less evidence that money aggregates played the role predicted by *Hanke and Schuler* (1994). We interpret this as evidence for a confidence effect of the currency board but the evidence for discipline effect is not as strong. Our search for another explanation of the regime change in inflationary expectations led us to investigate other variables. We found government credit to be a significant factor. This suggests that the budgetary restrictions imposed by the currency board had a strong effect on inflationary expectations, a constraint that was not present in Argentina during the last days of its currency board.[1]

The rest of the paper is divided as follows: Section II briefly discusses the initial conditions that preceded the implementation of the Bulgarian currency board. Section III discusses empirical studies of currency boards with a special emphasis on previous studies of the Bulgarian economy. In section IV, we present the theory and specify the model. In section V, we provide a description of the data. Then in section VI, we present our estimates of Cagan's model. In section VII we investigate the determinants of inflation. Section VIII contains the conclusion.

## II. Establishment of the Bulgarian Currency Board

The onset of the 1996–1997 financial crisis in Bulgaria came after an extended period of financial instability. Two important factors that brought on the financial crisis were very weak commercial balance sheets and large government deficits. During the early transition period, commercial banks were refinanced by the central bank, the Bulgarian National Bank (BNB). The banks then loaned the money to enterprises with little chance of repayment. To recapitalize the banks, the government carried out several programs to replace the bad loans made to enterprises with government bonds. The largest of these was the ZUNK bond program in late 1993. The refinancing did not stop the flow of bad loans, however, as more bad loans soon appeared on bank balance sheets. By 1996, nine of ten state banks accounting for more than 80% of the banking sector assets had negative capital, and more than half of state banks' portfolios were nonperforming. Moreover, half the private banks went bankrupt (*Gulde,* 1999).

At the same time government debt levels and government interest obligations were also increasing; in part due to the refinancing of the commercial banks. High nominal interest rates also contributed to large government debt

[1] There is considerable evidence that this disciplinary effect was real, both in the political rhetoric and the much smaller budget deficits following the introduction of the currency board.

* ZUNK – *Bulgarian abbreviation of the Law on Settlement of Nonperforming Credits Negotiated prior to 31 December 1990 (LSNC)*

service obligations. By 1996 the government budget deficit was 18% of GDP.[2]

The table below outlines the key events that took place during the crisis period. As foreign currency reserves began to fall, confidence in the lev deteriorated. The BNB could no longer intervene and support the lev. Interest rates were raised, but this did not prevent the lev from depreciating sharply. The BNB lent more money to the government to finance its deficits and to the commercial banks to keep them afloat.

**MAJOR EVENTS OF THE FINANCIAL CRISIS OF 1996–1997**

| Dates | Major Events |
|---|---|
| **1995**: 4th quarter | Early warning signs: |
| | Foreign currency reserves begin to fall (after rising in 1994). |
| | First bank runs occur. |
| | BNB refinances banks as lender of last resort. |
| **1996**: 1st quarter | Foreign currency reserves fall sharply. |
| 2nd quarter | Foreign currency reserves reach such a low level that the BNB no longer intervenes in the foreign currency markets. |
| | Basic interest rate rises in several steps from 34% to 108% (annual rate). |
| | Lev depreciates by 100%. |
| | BNB lending to banks and the government accelerates. |
| 3rd quarter | In September the following program is implemented: |
| | Conservators appointed for nine banks (bringing the total to 15 or about 1/3 of banks). |
| | Basic interest rate is raised to 25% *per month*. |
| | More support given to the viable banks. |
| 4th quarter | Basic interest rate lowered to 15% per month to help banks. |
| | November: IMF recommends the establishment of a currency board. |
| | December: There are street demonstrations in Sofia and the government resigns. |
| **1997**: 1st quarter | Early February: Political crisis is finally resolved and an interim government is appointed and dates for new elections are announced. |
| | Negotiations between the IMF and the new interim government begin almost immediately. |
| 2nd quarter | April: Agreement is reached with IMF on new standby package. |
| | April: United Democratic Forces (UDF) wins majority in parliamentary elections. |
| 3rd quarter | 1 July: Currency Board established. |

Source: *Balyozov* (1999).

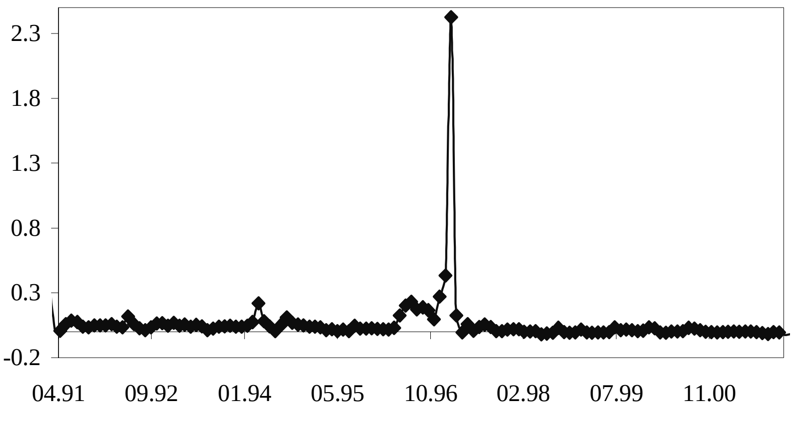
[2] *Tang, et al.* (2000) analyze financial crises in twelve transition economies: Bulgaria, the Czech Republic, Hungary, Macedonia, Poland, Estonia, Latvia, Lithuania, Georgia, Kazakhstan, the Kirgiz Republic and Ukraine. They point to similar problems in the other countries. They calculate the cost of the banking crises in each country and find that the cost in Bulgaria was the highest (41% of GDP). By comparison Macedonia was the next most costly (30.3%). The cost in the Czech Republic was 25.4%.

Throughout the financial crisis period (beginning in the late spring of 1996) difficult negotiations were taking place between the Socialist government and the IMF. In November 1996, the IMF recommended the introduction of a currency board. In December and January the economic situation deteriorated further. This led to street demonstrations and the government fell. An interim government was appointed in February, and the IMF immediately entered into negotiations with this new government. The opposition, United Democratic Forces (UDF), was elected in April, and a currency board was established with the support of the IMF on 1 July 1997.

Inflation, which had been rising at about 2% a month, rose significantly in May 1996 (12% a month) and stayed in the double digit range until February 1997 when prices soared by 242% (see Chart 1). In March 1997 monthly inflation decreased to 12% and the exchange rate appreciated by 30%. Prices actually fell in April. This was several months before the establishment of the currency board in July, but after that there were new agreements with the IMF, and the establishment of the currency board was imminent.

**Chart 1**

**INFLATION (1991–-2001)**




It is interesting to note that these developments are similar to the events which unfolded in Austria in 1921–1922. The Austrian case is used by *Sargent* (1986) as one of the four examples to describe how a regime change can bring down very high inflation without causing a rise in unemployment when the policy is credible. In Austria the exchange rate and inflation stabilized in August 1922 when negotiations began with the Council of the League of Nations. This took place two months *prior to signing* three protocols that provided for international loans and restructuring of monetary and fiscal institutions.

## III. Empirical Studies of Currency Boards

Relatively little empirical work has been done on the advantages of currency boards. An important study was carried out by *Ghosh, Gulde, and Wolf* (2000).[3] They compared the macroeconomic performance of countries with currency boards to those with other forms of pegged exchange rate regimes.

Their study was based on annual data covering the period 1970–1996. The full sample consisted of Antigua and Barbuda (1981–1996), Argentina (1991–1996), Dominica (1978–1996), Dijibouti (1978–1996), Estonia (1992–1996), Grenada (1977–1996), Hong Kong (1983–1996), Lithuania (1994–1996), St. Lucia (1980–1996), and St. Vincent and the Grenadines (1980–1996), yielding 136 observations.

They found that, on average, inflation under currency board arrangements was about 4 percentage points lower than that under pegged exchange rate regimes. In part, this lower inflation was achieved by having lower money growth rates (discipline effect). However, the difference in money growth was not sufficient to explain all the differences in inflation. This suggested an additional effect (confidence effect) in which higher money demand lowers inflation. Numerically, the confidence effect was larger than the discipline effect, accounting for 3.5 percentage points out of 4.0 percentage point differential. They also found that the volatility of inflation was lower under currency board arrangements and growth was, on average, higher in countries with a currency board.

Empirical studies of Bulgarian inflation have been carried out by *Mihov* (2002) and *Carlson and Valev* (2001).[4] Mihov analyzed the effect of monetary policy tightening using a VAR model. He found that monetary tightening (i.e. raising the base interest rate) *increases* inflation in the short-run during the pre-currency board period. He explained this result by arguing that higher interest rates may be a signal of higher fiscal stress and, therefore, lead to expectations of higher future inflation.

Carlson and Valev look at a similar question to the one posed in this pa-

[3] Another empirical study of the credibility of the Hong Kong currency board was carried out by *Kwan, Lui and Cheng* (2000). They found that the credibility of the currency board varied over time, and its credibility was greatest when fixed rules were followed.

[4] *Nenovsky and Hristov* (1999) investigate the impact of the Bulgarian currency board from a somewhat different perspective and analyze the effect of the board on real variables in the economy. They conclude that the currency board has had little effect on the economy.

per. They were interested in understanding whether individuals' inflationary expectations were affected by the creation of a currency board. They presented results from a survey undertaken just before the currency board was established. The survey asked individuals about their inflationary expectations both with and without a currency board. The responses showed that people expected inflation to be lower with a currency board, but the average expected inflation was still 25% per month. (There was a wide dispersion of responses. The median was 10% per month.) Since inflation during the preceding three months was 12.3%, –0.7% and 5.7%, these survey results were not a strong endorsement of the anti-inflation powers of the currency board. However, the expectations of monthly inflation without a currency board were 50% per month.

*Slavova* (2001) approached the Bulgarian experience from a slightly different perspective. Slavova estimated demand for money functions over the period 1991–2000. She estimated the demand relations over three distinct periods: pre-crisis, crisis and currency board. She found that the functional determinants differ in each of these periods. During the pre-crisis period she found that the demand for money depended on deposit interest rates and the price level; during the crisis period the main determinant was inflation; and in the currency board period the wage rate and the Treasury bill rate were the best predictors of the demand for money. She concluded that the currency board stabilized the demand for money.

Although our approach is different, our results are largely supported by previous studies. Like *Ghosh*, *et al.* (2000) and *Mihov* (2002), we find inflation to be significantly affected by variables other than money growth that act as proxies for the credibility of government policy. Our results are also consistent with *Carlson and Valev* (2001). Their surveys found that people had lower inflationary expectations because the currency board was being implemented, but these expectations were still higher than the eventual inflation. Our results support the notion that there was a structural break and that inflationary expectations were less important as determinants of the price level after the currency board was implemented.

## IV. Theory and Specification

To analyze the inflationary experience in Bulgaria we use Cagan's hyperinflation model. Because of the short time period and the extreme nature of money stock changes, we follow Cagan and ignore the effects of real income and real interest rate changes. The behavior of the price level is then solely determined by the money stock and price expectations.

The usual money market equilibrium condition is:

(1) $m_t - p_t = a_0 + a_1 y_t + a_2 i_t$

where $m_t$ = logarithm of money stock in $t$;
$p_t$ = logarithm of the price level;
$y_t$ = logarithm of the real income;
$i_t$ = the nominal interest rate.

Note that $i_t = (r_t + \Delta p^e_{t+1})$ where $r_t$ is the real interest rate and $\Delta p^e_{t+1}$ is the expected change in the log of the price level. Assume $y_t$ and $r_t$ are virtually constant and units are chosen so that the intercept is zero (in logs). Since $m_t$ is exogenously determined, it is moved to the right hand side, so:

(2) $p_t = m_t - \beta \Delta p^e_{t+1}$

where $\beta = a_2$ and $\Delta p^e_{t+1} = (p^e_{t+1} - p_t)$.

If we assume rational expectations, then by interactive substitution we obtain (see *Obstfeld and Rogoff,* 1996, p. 520):

(3) $$p_t = \frac{\beta}{1+\beta} \Sigma^{\infty}_{j=t} \left(\frac{\beta}{1+\beta}\right)^{j-t} E_t(m_j)$$

If the public expects the domestic money supply process to follow a rule, for example $m_t = cm_{t-1} + e_t$, then this expression can be simplified to:

(4) $$p_t = \frac{m_t}{1+\beta-\beta c}$$

In first difference form, the model is:

(5) $$\Delta p_t = \frac{\Delta m_t}{1+\beta-\beta c}$$

**We estimated three forms of Cagan model:**

*a) Equation (4): Rational Expectation Formulization*

Estimates of equation (4) showed considerable residual serial correlation despite the inclusion of additional lags of $m_t$ to account for delays in data collection and information dissemination. This serial correlation is an indication of an omitted variable problem. (Results are available upon request.) We concluded that, for Bulgaria, the assumption that agents' expectations are based upon a monetary policy rule that is a function solely of previous monetary aggregates is untenable. This is, perhaps, not so surprising given that large structural changes were very probably anticipated by the population. A similar conclusion was reached by *Mihov* (2002).

*b) Equation (2): Price Level with Backward-looking Expectations*

Next we estimated (2) which is a form of Cagan's equation that explicitly includes inflationary expectations. Rather than substitute forward expectations of money growth for price expectations as in equations (3) and (4), equation (2) makes no assumption about how these expectations are formed. However, it is necessary to find a proxy for inflationary expectations since we do not have direct observations. We considered three proxies: lagged inflation rate, lagged exchange rate changes, and contemporaneous interest rates.[5] Of these proxies, lagged inflation rates proved to be the best measure, based on significance and on the elimination of residual serial correlation. Estimations for the lagged inflation rate proxy are reported in the text (section VI) and results using the other proxies are reported in the Appendices. The superior performance of the lagged inflation rate over the exchange rate changes and interest rates might be due to government intervention in the markets at various points during the 1990s.

Instead of contemporaneous money, we substitute our earlier expression for money as a function of lagged money growth $m_t = cm_{t-1} + e_t$, which include additional lags to account for delays in information dissemination. We expect $c$ to be smaller after the regime change to a currency board than before, reflecting the discipline effect the currency board has on money growth.

*c) Equation (5): Model of Inflation*

Since we found that the effect of inflationary expectations on the price level had undergone a significant regime change, even though money variables did not have the effect hypothesized by theory, we investigated the factors behind inflation further in section VII. We recast the Cagan model in first differences, (5), with inflation as a function of money growth. Again, we found that money did not have a significant role as money growth rates were not an adequate explanation for inflation.

We then considered the possibility that money growth was not exogenous, but instead a function of other exogenous variables. Our reasoning is that before the currency board was established in Bulgaria, government deficits and transfers (*via* banks) to insolvent state enterprises were largely financed through money creation. Thus, we treat the money supply process as deter-

[5] It is necessary to use lags of the exchange rates rather than the contemporaneous exchange rate to avoid simultaneity bias. This is because the price level includes the prices of imported as well as domestic products.

mined by the expansion of government credit, i.e. $\Delta m_t = f(\Delta b_t)$, where $b_t$ is government credit.[6] During the second regime, however, the money supply is automatically adjusted to maintain its value relative to the Deutschemark (and euro) under the currency board. Under this regime the rate of change in the exchange rate equals zero, so relative purchasing power parity implies that the Bulgarian inflation rate should converge to the German (later, European) inflation rate in the steady state. Thus, $\Delta m_t = f(\Delta p_t^f)$ where $p_t^f$ is the German (or Euroland) price level in the second regime. We estimate a switching regime model to test this hypothesis. We expect the rate of Bulgarian government credit expansion to be the significant factor in determining the inflation rate before the regime change, and the rate of inflation in Europe after the regime change. We are particularly interested in whether the effect of the government credit variables is smaller in the second regime, as would be expected if the currency board were credible.

## V. Data Description

The data used here are the monthly consumer price index (CPI) drawn from the 2001 IMF country report on Bulgaria (*IMF*, 2001) and the National Statistical Institute web site. All other data is drawn from the annual reports of the Bulgarian National Bank and its web site.[7, 8] M2 was chosen because it is the most consistent series throughout this period. Since demand deposits are not used by individuals for transactions purposes, this is the narrowest definition of money which captures deposits of individuals. The Cagan hypothesis relates domestic money supply to inflation, so we subtract foreign currency deposits from M2 to get our money variable. During the currency crisis many people lost money in banks. After the crisis, individuals largely

[6] *Woodford* (1995, 2001) argues that fiscal variables need not work indirectly through monetary aggregates but can have a direct impact on the price level. Our results, as discussed below, are consistent with this hypothesis.

[7] We do not include results for the producer price series. Especially during the early 1990s inflation recorded by the consumer price index was much higher than inflation recorded by the producer price index. There are several possible reasons for this (*Miller*, 1997). One of the most significant reasons may have been that producer prices measured at the factory gate may not have been true market prices. Many managers of state firms sold goods to private 'shadow' firms which they owned or were owned by relatives. By selling at below market prices, profits were shifted from the state firm to the private firm. Because of problems with the collection of the producer price index in the early 1990s, this series was not accepted by the IMF for publication in its tables until well after other statistics had been approved.

[8] We use data that are not seasonally adjusted. Since we have a short time series with a large structural shift, seasonality factors calculated on this data introduced, rather than reduced, the distortions. To control annual end-of-year adjustments in the M2 series, a dummy variable was included in some estimations.

withdrew from the banking system. The level of time and savings deposits, which are included in M2, fell dramatically.

To capture the pressures on the government budget in a monthly series, we use the central bank refinancing series in the annual reports of the Bulgarian National Bank. During the early 1990s commercial banks were pressured by the government to loan to state enterprises that were in financial difficulty. The commercial banks, in turn, were supported by refinancing from the central bank. Therefore, refinancing mirrored the budgetary pressure the government experienced during the pre-currency board period. After the currency board was established, new refinancing ceased and the level of outstanding refinancing slowly diminished.

The period covered in this study is from April 1991 to December 2001. Prices were decontrolled in February 1991. Initially inflation surged as a result of the monetary overhang. For this reason, the first three months of 1991 are excluded from our analysis. To determine the appropriate estimation technique we first tested the series for stationarity. We started by examining the data series for evidence of structural change. Inspection of the money and price data series reveals a very large shift in both series around the end of 1996 and the beginning of 1997 (see Charts 2 and 3). This shift, and any deterministic trends in the data, must be accounted for when testing the series for unit roots (*Perron*, 1989). One issue examined in many studies is the timing of the structural break. There has been a number of studies on this topic (e.g., *Zivot and Andrews*, 1992; *Perron*, 1997). We follow the approach outlined by *Vogelsang and Perron* (1998) because it incorporates the preceding literature.

The model that captures the type of structural break likely to occur in this case is Vogelsang and Perron's 'innovational outlier model'. This model allows the break to occur over time rather than at a single point in time. The particular version used here allows for a break in both the intercept and the trend of the function representing the data generating process, i.e.

$$(6) \quad y_t = \mu + \beta t + \delta D(T_b)_t + \theta DU_t + \gamma DT_t + \alpha y_{t-1} + \sum_{K=1}^{K} c_K y_{t-K} + u_t$$

where
$y_t$ = data series tested;
$t$ = time trend;
$T_b$ = breakpoint;
$D(T_b)_t$ = 1 when $t = T_b + 1$;
$DU_t$ = 1 when $t > T_b$;
$DT_t$ = $t - T_b$ when $t > T_b$.

**Chart 2**

**CONSUMER PRICE INDEX**

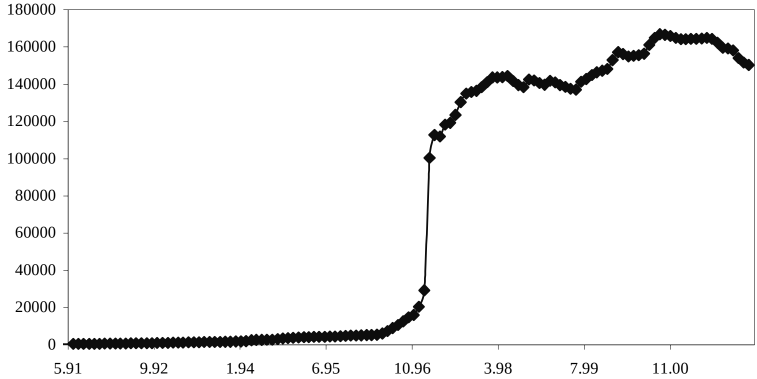
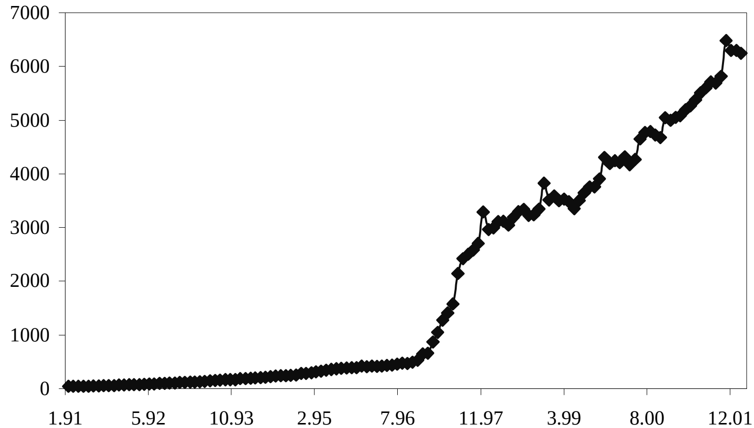



**Chart 3**

**MONEY SUPPLY (M2-FOREIGN CURRENCY DEPOSITS)**




To determine the optimal lag length, *k* (6), was estimated for $k = 0,1\ldots6$ for all reasonable breakpoints, $T_b$. Cases where the series appeared over- or under-differenced according to the Breusch-Godfrey LM statistics (calculated up to order 2) were eliminated. The optimal lag length, *k*, was determined using all three criteria suggested in Vogelsang and Perron: the Akaike Information Criterion, the Schwarz-Bayesian Criterion and the 10% significance level cutoff for $c_k$. Using these criteria, we determined that $k = 0$ for both the CPI and M2.

Vogelsang and Perron also offer criteria for determining the optimal break point, $T_b$. These are: minimum value of the $t$-statistics of $\alpha$ ($H_0$: $\alpha = 1$), and the maximum of the $F$-statistics ($H_0$: $\theta = \gamma = 0$). These criteria result in the same choices for each data series. The optimal $T_b$ corresponds to November 1996 for the price series and December 1996 for the money series, i.e., the structural break occurs after this point in each case.

The $t$-statistics of $\alpha$ where $H_0$: $\alpha = 1$ were compared to those reported by *Vogelsang and Perron* (1998) and *Perron* (1997). The corresponding values are –10.04 for the CPI and –8.45 for M2. They indicate that the null hypothesis can be rejected (see Table 3, *Vogelsang and Perron*, 1998, p. 1082). This conclusion is collaborated by Charts 2 and 3, which show that the data follow processes with strong trends and structural breaks but are not random walks. Because there are no stochastic trends, standard rather than cointegration techniques are used for the estimations that follow.

## VI. Estimation of Models of the Price Level

Since the unit root tests showed that both price and money series followed deterministic trends with structural breaks, we first estimated (2) with OLS. The proxies for expected inflation that were investigated were: lags of the inflation rate, lags of the lev/US dollar exchange rate changes, the base rate and the deposit rate. The criteria for choosing the proxy and the number of lags included was, first, the elimination of serial correlation (measured by LM statistics up to the sixth order) and, second, the significance level (measured by $t$-statistics and $F$-statistics). Based on these criteria, lagged inflation rates served as the best proxy for the expected inflation rate. (See Appendix A for results using other proxies including interest rates and the exchange rate.) The equation we estimated is:

$$(7)\quad p_t = \beta_0 + \beta_1 D + (\beta_2 + \beta_3 D)m_{t-1} + (\beta_4 + \beta_5 D)m_{t-2} + (\beta_6 + \beta_7 D)\Delta p_{t-1} + (\beta_8 + \beta_9 D)\Delta p_{t-2} + (\beta_{10} + \beta_{11} D)time + u_t$$

where $D = 1$ if $time$ > October 1996 and 0 otherwise.

The break point was determined by searching over a small range of possible dates around the break point dates (November and December 1996) identified in the unit root tests. The date chosen here, October 1996, resulted in acceptable residual serial correlation levels as measured by LM statistics up to the sixth order and using the 5% cutoff level. Other breakpoints did not result in acceptable levels of residual serial correlation. The number of lags of

$m_t$ and $\Delta p_t$ were determined, first by examining the serial correlation properties of the residuals, then by their significance level, as measured by *t*-statistics.

The estimated regression is:

$$p_t = 4.23 + .31D + (.82 + .06D)m_{t-1} + (-.43 + .19D)m_{t-2} + (1.21 - .96D)\Delta p_{t-1} +$$
$$(4.15) \quad (5.49) \quad (1.89) \quad (6.59) \qquad (-1.62) \quad (3.86) \qquad (2.84) \quad (-2.39)$$

$$+ (1.34 - 1.06D)\Delta p_{t-2} + (.03 - .04D)\ time - 0.15\ January + u_t$$
$$(3.12) \quad (-2.48) \qquad (3.17) \quad (-5.60) \qquad (-1.98)$$

adjusted $R^2 = .99$ standard error of the regression = .102

$F_{(6,114)} = 108.95$

*Note*: Figures beneath coefficients in parentheses are *t*-statistics with $H_0 = 0$. All data is computed with heteroskedastic-consistent estimates. LM statistics for serial correlations up to the sixth order were below the 5% cut-off level. The *F*-statistic tests the null hypothesis that there is no regime shift i.e. coefficients $\beta_1 = \beta_3 = \beta_5 = \beta_7 = \beta_9 = \beta_{11} = 0$.

Coefficient estimates for expected inflation (measured by lagged inflation) are significantly different than zero and are as hypothesized. Before the regime change the total impact of expected inflation was 2.55 (1.21 + 1.34). After the regime change it is .53 (1.21 + 1.34 – .96 – 1.06), indicating the reduced role inflationary expectations play in determining the price level under the currency board. The money coefficients were not all significant nor were the values as hypothesized. Including past significant coefficients, the total effect of lagged money on the price level was .82 whereas after the regime change it is 1.07 (.82 + .06 + .19). Recall that we hypothesized that the effect of lagged money on the price level would be lower after the regime change to the currency board due to the discipline effect on the growth of money stock. These estimates show little evidence of this.

One possible reason that the discipline effect is not apparent in these estimates is that this model does not accurately capture the transition to the currency board. For example, the transition is assumed to occur between October and November 1996 in this estimation, but the outline of events provided earlier suggests that the transition to a currency board took place over a longer and later time period.

The Bulgarian CPI series in Chart 2 show that a steep jump immediately after decontrol in early 1991 occurred, and again during the very high inflation in 1996 and early 1997 occurred. As the IMF plan and the currency board were proposed and implemented, the price level rose at a slower pace. This resulted in an S-shaped path from the first regime into the second. This reflects the effect of a gradual lowering of inflationary expectations on the price level in the second regime from the hyperinflationary spiral that had been set off in the first regime. Thus, this graph suggests that a smooth transition model to approximate the transition is appropriate.

Based on this reasoning, we reestimate (2) using the smooth transition model described in *Maddala* (1977, pp. 395–396). More recent variations are the STAR model of *Terasvirta* (1994) and *Terasvirta and Anderson* (1992). One interesting feature of the model is that it endogenously estimates two parameters: (1) the point of structural change, $T_b$, which here is the midpoint of the regime change and (2) the timeframe of the regime change. Therefore, the period over which the regime change occurs is endogenous in this model rather than assumed to be a single period, as in the earlier model.

The specification that we estimated is:

(8) $p_t = c_0 + c_1F_t + (c_2+c_3F_t)m_{t-1} + (c_4+c_5F_t)m_{t-2} + (c_6+c_7F_t)?p_{t-1} + (c_8+c_9F_t)time + u_t$

where $F_t = [1 + \exp(-\gamma(t - T_b)/T_b]^{-1}$.

$F_t$ replaces the dummy variable, $D$, in the first model and is equal to zero at low values of $t$ (the first regime) and approaches one as $t$ increases (the second regime). During the regime change $F_t$ is between zero and one. The parameter $g$ determines the duration of the regime change, i.e., the number of observations over which $0 < F_t < 1$.

We determined that a single lag of the inflation rate captures the inflationary expectations variable and two lags of the money supply captured the expected money supply process.[9] Our estimated model is:

$$p_t = \underset{(10.08)}{4.92} + \underset{(7.25)}{6.43}\,F_t + (\underset{(1.50)}{.92} - \underset{(-2.06)}{1.16}\,F_t)m_{t-1} + (\underset{(-1.22)}{-.71} + \underset{(1.76)}{.97}\,F_t)m_{t-2} + (\underset{(5.02)}{1.70} - \underset{(-4.38)}{1.70}\,F_t)\Delta p_{t-1} +$$

$$+ (\underset{(-1.73)}{-.117} + \underset{(1.63)}{.117}\,F_t)January + (\underset{(7.48)}{.04} - \underset{(-6.37)}{.04}\,F_t)time + u_t \quad \text{and } \gamma = \underset{(3.47)}{69.33}; \quad T_b = \underset{(154.09)}{73.07}$$

adjusted $R^2 = .998$ standard error of the regression = .077

*Note*: Figures beneath coefficients in parentheses are $t$-statistics with $H_0 = 0$. All data is computed with heteroskedastic-consistent estimates.[10]

This procedure estimates the midpoint of the regime change to be mid-January 1997 and the duration of the regime change as September 1996 to June 1997, which is consistent with the timetable outlined earlier.[11] The BNB

[9] We retained lags that were significant (as measured by the $t$-statistics) and/or reduced residual serial correlation (measured by the Box-Ljung statistics).

[10] Estimates using other proxies for expected inflation appear in Appendix B.

[11] The beginning of the regime change is defined here to start when $F_t > .02$ and end when $F_t > .98$.

instituted a new program to salvage the situation in September 1996 which failed. The currency board established in July 1997 was more successful.

These estimates have the expected signs. The coefficient on the inflationary expectation variable was 1.70 and highly significant before the currency board and zero (0 = 1.70 – 1.70) after. The money variables are insignificant. Because the Ljung-Box statistics also indicated a problem of positive residual serial correlation, significance levels must be interpreted cautiously.[12] However, since positive residual correlation generally yields erroneously high significance levels, even if this were corrected, the money variables would probably still be insignificant. This suggests that other factors were more important in determining the price level.

In conclusion, our estimates indicate that there was a structural change in the relationship between inflationary expectations and price behavior. It is not clear, however, that the money supply is significant in the manner of the Cagan model. Moreover, the presence of residual correlation suggests the presence of an omitted variable that is not captured by any variables typically found in Cagan's model. To further investigate our unexpected results on the nonsignificance of the monetary variables, we next estimate the model in first differenced form. In Cagan's model, inflation is a function of money growth (5). We will show that money growth is not a significant factor behind inflation growth. Therefore, based on our discussion in section IV, we then model inflation as a function of government credit and foreign inflation. We find that government credit is a significant factor whereas foreign inflation rates are not. These results are presented in the next section.

## VII. A Model of Inflation

First, we present the effects of the growth rate in money on the inflation rate. Then, we estimate the impact of the growth of government credit and of foreign inflation on Bulgarian inflation. In the second set of estimations we expect the government credit variable and foreign inflation variable to differ between the two regimes. We assume that the government credit variable is significant in the first regime because the objective of the Bulgarian authorities was to finance government 'loans' to money-losing state enterprises through money supply expansion . We expect foreign inflation to be signifi-

[12] A number of possible omitted explanatory variables were investigated, including additional lags of the independent variables, the rate of change in inflation and its lags, the rate of exchange rate depreciation and its lags, and lags of the dependent variable. Serial correlation was not reduced and sometimes aggravated. The addition of the lagged dependent variable resulted in non-convergence.

cant in the second regime, since the objective is to peg the lev/Deutschemark (and later the lev/euro) exchange rate. Hence, in the steady state, relative purchasing power parity obtains.

Chart 1 presents the Bulgarian inflation rate. This graph shows a large outlier in the data at the time when there was a political crisis at the end of January 1997. This indicates that an ordinary least squares model of structural change with dummies representing the regime change around January 1997 is appropriate. Two specifications were estimated. These are:

$$(9)\ \Delta p_t = g_0 + g_1D_1 + (g_2 + g_3D_1)\Delta m_t + (g_4 + g_5D_1)\Delta m_{t-1} + (g_6 + g_7D_1)\Delta m_{t-2} + \\ + (g_8 + g_9D_1)\Delta p_{t-1} + (g_{10} + g_{11}D_1)\Delta p_{t-2} + g_{12}D_{\mathrm{Feb97}} + g_{13}D_{\mathrm{Mar97}} + u_t$$

and

$$(10)\quad \Delta p_t = h_0 + h_1D_1 + (h_2 + h_3D_1)\Delta b_t + (h_4 + h_5D_1)\Delta b_{t-1} + (h_6 + h_7D_1)\Delta b_{t-2} + \\ + (h_8 + h_9\,D_1)\Delta p^f_t + (g_{10} + g_{11}D_1)\Delta p^f_{t-1} + (g_{10} + g_{11}D_1)\Delta p^f_{t-2} + \\ + (g_8 + g_9D_1)\Delta p_{t-1} + (g_{10} + g_{11}D_1)\Delta p_{t-2} + g_{12}D_{\mathrm{Feb97}} + g_{13}D_{\mathrm{Mar97}} + u_t,$$

where $D_1 = 1$ after February 1997.

The dummies for February and March 1997 capture the fall of the government and the following transition. Lags were included if they were significant (measured by the *t*-statistics) and/or if residual serial correlation was reduced (measured by the LM statistics up to the sixth order). All *t*-statistics are computed with heteroskedastic-consistent variance estimates.

The estimates for (9) are :

$$\underset{}{\Delta p_t} = \underset{(-.202)}{-.003} - \underset{(.114)}{(.002)}D_1 + (\underset{(.320)}{.074} - \underset{(-.246)}{.058}D_1)\Delta m_t + (\underset{(1.316)}{.240} + \underset{(-.708)}{-.131}D_1)\Delta m_{t-1} +$$

$$+ (\underset{(.893)}{.107} \underset{(-.319)}{-.040}D_1)\Delta m_{t-2} + (\underset{(5.719)}{.925} - \underset{(-4.584)}{.773}D_1)\Delta p_{t-1} + (\underset{(1.699)}{-.066} + \underset{(1.816)}{.156}D_1)\Delta p_{t-2} +$$

$$+ \underset{(11.320)}{.870}D_{Feb97} - \underset{(-5.037)}{1.072}D_{Mar97} + u_t$$

$F_{(5,113)} = 1.92$ (fails null at 5%, passes at 10%)

adjusted $R^2 = .93$ standard error of the regression = .032

*Note*: Figures in parentheses below coefficients are *t*-statistics with the $H_0 = 0$. All data is computed with heteroskedastic-consistent estimates. LM statistics for residual correlation up to the sixth order are below the 5% cut-off level.

The coefficients of the money growth variables are once again insignificant. Other than the transition dummy variable, the only other significant variable is the one-period lagged inflation rate. Its coefficient is smaller (0.925 –

0.773) after the regime change whereas it is nearly one prior to that point. Assuming that lagged inflation rates act as proxies for expected inflation, this indicates that the influence of expected inflation on current inflation has experienced a regime change, consistent with our earlier results.

In the estimation of (10) we wished to determine whether there has been a change in the reaction of inflation to government credit changes in the first regime and foreign (European) inflation. The estimates for (10) are:

$$\underset{}{\Delta p_t} = \underset{(1.368)}{.009} - \underset{(-1.373)}{.010D_1} + (\underset{(3.128)}{.153} - \underset{(-2.034)}{.116D_1})\Delta b_t + (\underset{(2.969)}{.332} - \underset{(-2.894)}{.335D_1})\Delta b_{t-1} + (\underset{(.875)}{.043} -$$

$$\underset{(-.271)}{.017D_1})\Delta b_{t-2} + (\underset{(1.440)}{1.665} - \underset{(-.337)}{.470D_1})\Delta p^f_t + (\underset{(-1.748)}{-1.733} + \underset{(1.361)}{1.788D_1})\Delta p^f_{t-1} + (\underset{(-1.667)}{-1.561} +$$

$$\underset{(1.853)}{2.375D_1})\Delta p^f_{t-2} + (\underset{(7.191)}{.630} - \underset{(-2.351)}{.341D_1})\Delta p_{t-1} + (\underset{(-1.329)}{-.041} + \underset{(2.438)}{.308D_1})\Delta p_{t-2} +$$

$$+ \underset{(15.611)}{.720D_{Feb97}} - \underset{(-8.31)}{.838D_{Mar97}} + u_t$$

adjusted $R^2 = .95$ standard error of the regression = .024

$F_{(8,113)} = 4.59$

LM statistics for residual correlation are below the 5% level for up to the sixth order.

*Note*: Figures in parentheses below coefficients are $t$-statistics with $H_0 = 0$. Null hypothesis for the $F$-statistics is that there was no regime change. All data is computed with heteroskedastic-consistent estimates.

The $\Delta b_t$ coefficients are positive and two of three are significant in the first regime. The impact of government credit changes is higher during the first regime than in the second. The three foreign inflation coefficients are insignificant. While theory suggests that they should be significant, this is not a total surprise since currency board countries frequently have inflation rates higher than the reserve currency country. Bulgaria is no exception. The $F$-statistics indicates that the impact of the structural change variables together is significant at the 99% level.

# VIII. Conclusion

After many failed attempts to deal with the financial crisis, a currency board was established in Bulgaria in July 1997. Judging by its initial performance, the currency board was a success. Hyperinflation ended and signs of early recovery started to emerge. So what essential aspect of the currency board restored financial stability that could not have been achieved otherwise? The answer lies in the key word ‘confidence’.

The literature predicts that the establishment of a currency board increases credibility and thereby lowers inflationary expectations. As a result, economic agents face a lower opportunity cost of holding money, and their demand for money increases. We called this effect on the money demand the ‘confidence’ effect. In addition, a currency board limits the ability of monetary authorities to create money. We have referred to this as the ‘discipline’ effect. These two effects need not be mutually exclusive. Our findings provide solid evidence for a confidence effect but little support for a discipline effect.

Modification of the Cagan model to incorporate structural change shows that the currency board did have an impact. While we find little role for money aggregates, our results show a significant *decrease* in inflationary expectations. These results remain robust regardless of whether the abrupt or the smooth transition regime change model is estimated. We interpret these consistent findings as evidence for the strong role that inflationary expectations play.

A thorough analysis of the currency board effect required a further investigation of factors behind the inflation. We find that the effects of the regime change on inflation were not adequately captured by money growth rates.[13] Searching for an explanation, we found that changes in government credit significantly affects inflation. Budget deficits may act as a proxy for “trust in government policy” which we cannot measure directly. This suggests that one must look beyond simple control of the money supply to the control of inflationary expectations. Our empirical results are consistent with recently published work on the fiscal theory of price determination (*Woodford*, 2001) which argues that fiscal variables have a direct impact on price levels that is independent of monetary policy.

[13] These results are consistent with the results that *Mihov* (2002) found using his VAR model. In his description of the period immediately preceding the establishment of the currency board, Mihov states “it is hard to find a predictive role for past monetary growth” (p. 424).

The fact that inflationary expectations had a smaller impact on price behavior after the establishment of the currency board may also explain why the results of *Carlson and Valev* (2001) seem so inconsistent with what actually occurred. Inflationary expectations were high immediately before the currency board was established (when they did their survey). However, these high expectations may have had little effect on actual price behavior because of improved confidence resulting from the regime change.

The structural change in the relationship between inflation expectations and price behavior is also important in explaining inflation behavior since the currency board was established. During the currency board period, the Bulgarian economy has been buffeted by increases in world oil prices and the need to raise important controlled prices closer to world levels. Before the currency board was established, similar price adjustments fed the inflationary cycle, but since 1997 these changes have led to higher price levels but not higher ongoing inflation. Thus, the fact that inflationary expectations have had a smaller impact on inflation behavior since 1997 may be an important reason why inflation has been so much lower during the currency board period.

# Appendix A

Alternative estimates of (2) by OLS (first model)

(a) **Using Lagged Exchange Rate Depreciation**:

$$p_t = 4.75 + .48D + (.95 + .05D)\, m_{t-1} + (-.68 + .18D)\, m_{t-2} +$$
(5.11) (7.28) (1.84) (5.84) (–2.13) (4.12)

$$+ (.26 - .30D)\, \Delta s_{t-1} + (.65 - .53D)\, \Delta s_{t-2} + (.04 - .04D)\, time - .19\, January$$
(1.13) (–1.06) (2.64) (–2.21) (3.86) (–6.33) (–1.88)

adjusted $R^2 = .99$ standard error of the regression = .122

D.W.= 1.51

*Note*: LM statistics on residual correlation at higher orders not acceptable at 5% cutoff levels.

$F_{(6,114)} = 82.60$

(null: no regime change, see paper)

(b) **Using Deposit Rate:**

$$p_t = 4.59 + .74D + (1.03 + .03D)\, m_{t-1} + (-.76 + .18D)\, m_{t-2} +$$
(6.50) (3.51) (2.16) (6.74) (–2.24) (4.60)

$$+ (4.14 - 4.38D)\, depositrate + (.04 - .04D)\, time - .19\, January$$
(5.08) (–2.02) (5.28) (–8.57) (–1.94)

adjusted $R^2 = .99$ standard error of the regression= .109

D.W. = 1.82 *Note*: LM statistics on serial correlation at higher orders acceptable at 5% cutoff levels.

$F_{(5,116)} = 94.86$

(null: no regime change)

(c) **Using the Base Rate:**

$$p_t = 4.44 + .55D + (1.09 + .03D)\, m_{t-1} + (-.74 + .18D)\, m_{t-2} +$$
(4.98) (4.25) (2.20) (9.63) (–2.35) (4.56)

$$+ (.06 - .04D)\, baserate + (.03 - .04D)\, time - .20\, January$$
(5.11) (–1.49) (3.65) (–6.29) (–1.91)

adjusted $R^2$=.99 standard error of the regression= .113

D.W.= 1.65

*Note*: LM statistics on serial correlation at higher orders not acceptable at 5% cutoff levels.

$F_{(5,116)}$ = 87.50

(null: no regime change)

(d) **Using Deposit Rate and Base Rate:**

$p_t$= 5.16 + 1.28*D* + (.63 – .02*D*) $m_{t-1}$+ (–.56 + .18*D*) $m_{t-2}$+

(9.66) (3.02) (1.54) (1.24) (–1.74) (4.49)

+ (–.09+.41*D*) *baserate* + (9.23–27.42*D*) *depositrate* + (.05–.05*D*) *time* –.14 *January*

(–2.77) (1.90) (4.91) (–2.13) (8.30) (–12.77) (–2.03)

adjusted $R^2$=.99 standard error of the regression= .101

D.W.= 1.83

*Note*: LM statistics on serial correlation at higher orders not acceptable at 5% cutoff levels.

$F_{(6,114)}$ = 94.09 (null: no regime change)

(e) **Using Base Rate, Deposit Rate, Lagged inflation Rates:**

$p_t$= 5.52+ 1.47*D* + (.32 + .02*D*) $m_{t-1}$ + (–.34+ .17*D*) $m_{t-2}$

(12.28) (3.07) (1.42) (1.48) (–1.93) (3.16)

+ (–.09 – .67*D*) *baserate* + (7.60 – 40.07*D*) *depositrate*

(–3.37) (1.18) (4.43) (–1.63)

+ (.48 – .74*D*) $\Delta p_{t-1}$+ (.90 – .38D) $\Delta p_{t-2}$+ (.05 – .04D) *time* – .08 *January*

(2.22) (–.91) (2.48) (–.89) (10.05) (–13.42) (–2.21)

adjusted $R^2$=.99 standard error of the regression= .084

D.W.= 1.83

*Note*: LM statistics on serial correlation acceptable for orders 1,2 and not acceptable for higher orders assuming a 5% cutoff.

$F_{(8,114)}$ = 92.26

(null: no regime change)

# Appendix B

(a) **Using Lagged Exchange Rate Depreciation:**

$p_t = (5.62 + 6.52F_t) + (-.10 + .11F_t)\ January + (.04 - .04F_t)\ time +$
(8.64) (4.55) (–1.23) (1.22) (6.11) (–4.80)

$+ (.50 - .82\ F_t)\ m_{t-1} + (-.46 + .68\ F_t)\ m_{t-2} + (.18 - .01\ F_t)\ \Delta s_{t-1}$
(.66) (–1.14) (–.62) (.98) (.99) (–.03)

$\gamma = 55.94$ $t_b = 73.02$
(3.83) (126.12)

adjusted $R^2 = .99$ standard error = .092
D.W. = .98

*Note*: Lyung Box statistics rejected the null hypothesis of no residual correlation for all orders of correlation. (This was also the case for all the equations in this appendix.)

(b) **Using Deposit Rate:**

$p_t = (1.25 + 8.92F_t) + (-.10 + .05F_t)\ January + (1.06 - .82F_t)\ m_{t-1} +$
(8.31) (22.75) (–1.29) (.68) (1.26) (–1.21)

$+ (-.15 - .17\ F_t)\ m_{t-2} + (2.71 + 4.60\ F_t)\ depositrate$
(.18) (-.26) (1.58) (.80)

$\gamma = 38.54$ $t_b = 73.41$
(3.51) (65.99)

adjusted $R^2 = .99$ standard error = .102
D.W. = .975

(c) **Using Base Interest Rate:**

$p_t = (1.46 + 8.89\ F_t) + (-.08 + .03F_t)\ January + (.90 - .66F_t)\ m_{t-1} +$
(11.90) (22.90) (-.98) (.32) (1.06) (–.92)

$+ (.27 - .33\ F_t)\ m_{t-2} + (.01 + .13\ F_t)\ baserate$

(.32) (–.47) (.39) (1.48)

$\gamma = 33.96$ (3.84) $t_b = 73.17$ (87.91)

adjusted $R^2$=.998 standard error = .103

D.W.= .86

(d) **Using Both Deposit Rate and Base Interest Rates:**

$p_t = (1.08 + 9.47F_t) + (-.05 - .04F_t)\ January + (.56 - .15F_t)\ m_{t-1} +$

(6.17) (23.39) (–.62) (-.42) (.66) (–.23)

$+ (.65 - .90F_t)\ m_{t-2} + (8.79 - 16.91F_t)\ depositrate + (-.20 + .52F_t)\ baserate$

(.78) (–1.31) (3.59) (–2.31) (–2.90) (2.84)

$\gamma = 26.84$ (5.60) $t_b = 72.69$ (68.05)

adjusted $R^2$ = .99 standard error = .099

D.W.= .98

(e) **Using Both Base and Deposit rates and Lagged Inflation:**

$p_t = (.99 + 9.05F_t) + (-.17 + .12F_t)\ January + (1.93 - 1.75F_t)\ m_{t-1} +$

(5.59) (33.77) (–2.36) (1.61) (3.13) (–2.83)

$+ (-.69 + .75F_t)\ m_{t-2} + (1.88 - 2.48F_t)\ \Delta p_{t-1} + (.02 + .26F_t)\ baserate +$

(–1.12) (1.21) (3.87) (–3.25) (.31) (1.01)

$+ (2.87 - 12.46F_t)\ depositrate$

(1.08) (–1.19)

$\gamma = 82.21$ (3.08) $t_b = 73.18$ (157.22)

adjusted $R^2$ = .99 standard error = .087

D.W. = 1.28

## References


**Balyozov, Zdravko.** The Bulgarian Financial Crisis of 1996–1997. *Discussion Paper No. 7*, Sofia, Bulgarian National Bank, 1999.

**Cagan, Phillip.** The Monetary Dynamics of Hyperinflation in Milton Friedman (ed.) *Studies in the Quantity Theory of Money*, Chicago: University of Chicago Press, 1956.

**Carlson, John A. and Neven T. Valev**, Credibility of a New Monetary Regime: The Currency Board in Bulgaria. *Journal of Monetary Economics,* June, 2001.

**Calvo, Guillermo and Carlos Vegh.** Inflation Stabilization and BOP Crises in Developing Countries. *NBER Working Paper No. 6925,* February 1999.

**Ghosh, Atish, Anne Marie Gulde and Holger Wolf.** Currency Boards: More Than a Quick Fix? *Economic Policy: A European Forum* 0(31), October 2000, pp. 269–321.

**Gulde, Anne Marie**. (1999) The Role of the Currency Board in Bulgarian Stabilization, *Finance and Development*, September 1999.

**Hanke, Steve**, **and Kurt Shuler.** *Currency Boards for Developing Countries,* San Francisco, International Center for Economic Growth, 1994.

International Monetary Fund, Bulgaria: Selected Issues and Statistical Appendix, *IMF Country Report, No. 01/54*, March 2001.

**Kwan, Yum, Francis Lui, and Leonard Chang.** *Credibility of Hong Kong's Currency Board: The Role of Institutional Arrangements*, unpublished manuscript, City University of Hong Kong (Kwan), 2000.

**Maddala, G. S.** *Econometrics,* New York, NY: McGraw–Hill, 1977.

**Mihov, Ilian.** The Economic Transition in Bulgaria, 1989–1999, Mario I. Blejer and Marko Skreb, *Transition: The First Decade* Cambridge, Mass.: MIT Press, 2002, pp. 401–440.

**Miller, Jeffrey.** The Price Gap in Bulgaria. *The Bulgarian Economy: Lessons from Reform during Early Transition,* ed. by Derek Jones and Jeffrey Miller. Aldershot, England: Ashgate, 1997.

**Nenovsky, N. and K. Hristov.** Monetary Regimes and the Real Economy: Empirical Tests before and after the Introduction of the Currency Board in Bulgaria, Discussion Paper No. 10, Sofia, Bulgarian National Bank, 1999.

**Obstfeld, M. and K. Rogoff.** *Foundations of International Macroeconomics* Cambridge, MA: MIT, 1996.

**Perron, P.** The Great Crash, the Oil Price Shock and the Unit Root Hypothesis, *Econometrica* 57 (1989), pp. 1361–1401.

**Perron, P.** Further Evidence on Breaking Trend Functions in Macroeconomics Variables, *Journal of Econometrics* 80 (1997), pp. 355–385.

**Sargent, Thomas** (1986) The End of Four Big Inflations, in Thomas Sargent, *Rational Expectations and Inflation,* Cambridge, Mass: Harper & Row.

**Slavova, Stefka.** Money Demand during Hyperinflation and Stabilization: Bulgaria, 1991–2000, *Working Paper,* World Bank, 2001.

**Tang, Melena, Edda Zoli and Irina Klytchnikova.** Banking Crises in Transition Countries: Fiscal Costs and related Issues, *Policy Research Working Paper No. 2484*, Washington D.C.: World Bank, 2000.

**Terasvirta, T.** Specification, Estimation and Evaluation of Smooth Transition Autoregressive Models, *Journal of The American Statistical Association* 89 (1994) pp. 208–218.

**Terasvirta, T. and H. Anderson.** Characterizing Nonlinearities in Business Cycles Using Smooth Transition Autoregressive Models, *Journal of Applied Econometrics* 7 (1992), pp. 119–136.

**Vogelsang, T. and P. Perron.** Additional Tests for a Unit Root Allowing for a Break in the Trend Function at an Unknown Date, *International Economic Review* 39 (1998), pp. 1073–1100.

**Wicker, Elmus.** Terminating Hyperinflation in the Dismembered Hapsburg Monarchy *American Economic Review*, Vol. 76, No. 3, June 1986, pp. 350–64.

**Williamson, John** (1995) "What Role Currency Boards?" Institute for International Economics, Washington, D.C.

**Woodford, Michael.** Price Level Determinancy without Control of a Monetary Aggregate, *Carnegie-Rochester Conference Series on Public Policy* 43 (December 1995), pp. 1–46.

**Woodford, Michael.** "Fiscal Requirements for Price Stability," *Journal of Money, Credit and Banking* 33 (2001), pp. 669–728.

**Zivot, E. and D. Andrews.** Further Evidence on the Great Crash, the Oil Price Shock and the Unit Root Hypothesis, *Journal of Business and Economic Statistics* 10 (1992), pp. 251–270.

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