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Determinants of Bulgarian Brady Bond Prices

An Empirical Assessment

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Macroeconomic variables and changes in foreign reserves affect the secondary market price of Brady bonds in Bulgaria. So do changes in the external environment, including crises in other parts of the world

Summary findings

To analyze the main determinants of secondary market prices of Bulgarian Brady bonds, Budina and Mantchev investigate to what extent fluctuations in domestic fundamentals affect the bonds' secondary market price.

They also assess the extent to which external shocks affect the bonds' prices. They estimate the long-term relationship between domestic fundamentals and market prices of the bonds, using cointegration techniques.

In the long run, they find that gross foreign reserves and exports had a positive effect on bond prices and the real exchange rate and Mexico's nominal exchange rate depreciation had a negative effect.

In the short run, the Asian crisis had a negative impact, and Bulgaria's change in political regime and introduction of a currency board had a positive impact.

Mexico's economic crisis in 1995 had contagion effects.

The authors' empirical results confirm the view that the so-called fundamentals approach should be used to supplement the analysis of spillover effects for Bulgarian Brady bonds.

Determinants of Bulgarian Brady Bond Prices:

An Empirical Assessment

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Introduction

A little is known about the determinants that affect the prices and thus the yields of the emerging markets Brady bond issues. The issue of how the prices are determined requires a closer investigation taking into account the ongoing turbulence in emerging markets and the East European country prospects. This paper analyzes empirically the importance of the domestic indicators for pricing the Bulgarian Brady bonds.

The purpose of this paper is to analyze the importance of some macroeconomic indicators in determination of the secondary market price of Bulgarian Brady bonds after DDSR agreement of Bulgarian Government with the London Club in July 1994. Section 2 provides the theoretical background and surveys the empirical research in this area. Section three briefly discusses the DDSR agreement, attempts for macroeconomic stabilization and a potential candidates from macroeconomic variables that might affect the prices of Bulgarian Brady bonds. In section 4 we estimate an ECM model and a VAR system for DISC and IAB price determination and analyze the results. Tests for the stationarity of Bulgarian Brady bonds movement are also provided. Finally, we present some concluding remarks.

2.   Theoretical background

The existing literature on Brady bonds suggests three alternative approaches for pricing debt - option pricing, spillover effect and "fundamentals".

The option theory is generally used to price the debt of corporate companies, but it is also applicable for pricing other risky debt. Claessens and Wijnbergen (1993) used option theory to price the bonds of Brady type agreement - the Mexican deal. Budina and van Wijnbergen (1998) use the same approach to value the effect of Bulgarian Debt and Debt Service Reduction Agreement of 1994.

The approach based on spillover effect simply states that the different bond prices are interdependent and the level or variation of particular bond price in the market depends on the behavior of similar bonds. IMF (1995) reported the presence of Granger causality of the Mexican Brady bonds prices on prices of other Latin American countries.

Respectively, Calvo and Reinhart (1996) claimed for contagion effects on Brady bonds of shocks like the 1995 Mexican crisis.

Pricing a risky debt by using the so called "fundamentals approach" is considered complementary in the literature because it only add to the spillover effect in explanation of bond price movement. It relates secondary market debt prices to a set of explanatory variables like inflation, foreign reserves, foreign reserves to import ratio, exchange rates, debt, debt to export ratio, GDP growth. Some of the important thoughts in this area are Eaton and Gersovitz (1981), Sachs (1995), Edwards (1986), Cohen (1989), Olzer and Huizinga (1991), Haque, Kumar, Mark and Mathieson (1996). These analyses make the implicit assumption that bonds of different countries traded on the secondary market are directly compatible, no mater that some of them do not use Brady prices.

Eaton and Gersovitz (1981) pointed out the complexity of the lending to a sovereign country. They considered the probability of sovereign default as a function of macroeconomic sustainability of a given level of external debt. Through the econometric tests Cohen (1989) and Olzer and Huizinga (1991) identified the variables that best explain repayment capacity - debt to export ratio, foreign reserves to import ratio, inflation, etc. Sachs (1985) provided empirical rationale for using certain economic indicators in determination of the risk-premium in international bond markets. He demonstrated the importance of the exchange rate management and trade regime emphasizing the role of exchange rate and trade policy for a developing country performance. Edwards (1986) tested whether pricing of bonds and bank loans are significantly different and found out a positive effect of higher debt ratios on the risk premium testing the yields on low developing countries bonds traded in the secondary market. Haque, Kumar, Mark and Mathieson (1996) investigated the importance of certain ratios - the ratio of foreign reserves (excluding gold) to import, the ratio of current account to GDP, as well as of indicators like GDP growth and inflation, for the variation in credit ratings of developing countries. They tested data for 60 developing countries in their attempt to explain large variation in credit ratings.

3. DDSR Operation and Macroeconomic Stabilization Process in Bulgaria

The 1994 DDSR agreement converted USD 8.3 billion, including the original debt and interest arrears accumulated since the debt moratorium in1991. The market base debt and debt service reduction was estimated at about 46 percent in present value terms or at 38 percent when accounting for the up-front costs this debt deal.[1] The menu of options available in this agreement consisted of: cash buy-backs, par bonds with lower interest payments in the first 7 years, discount bonds issued at 50 percent discount but yielding market rates and interest arrears bonds converting past due interest. The impact of the DDSR agreement consisted of lowering the face value of Bulgarian debt meant to alleviate the problems of 'debt overhang' and would therefore raise market price of Bulgarian converted debt after this agreement. Houben (1995) shows that Bulgarian external debt was traded at deep discounts before the agreement – the price was varying between 0.20 and 0.30 USD per a dollar face value debt. Budina and van Wijnbergen (1998) estimated the break-even price of the external debt (when the eligible debt was converted to the various options offered) at 0.50 USD per 1 USD face value converted debt (debt with guarantees) or 0.38 USD per 1 USD face value debt without guarantees. Thus the DDSR agreement leads to a reduction of the uncertainty about future fiscal and exchange rate developments associated with debt overhang. It can increase the probability of success of the economic reforms and the restoration of the access to the international capital markets and growth recovery prospects. These opportunities can be beneficial to the country debtor only in the environment of economic and political stability. The objective of this paper is to show that Bulgaria can benefit from the debt deal only if the country follows a consistent and credible macroeconomic stabilization policy. In addition, we will show that developments on Latin American markets play important role in Bulgarian Brady bonds price dynamics. An important implication of this finding is that any future fiscal projections should take these world markets developments into account. We also show that various types of instruments react differently to domestic and external fluctuations in macroeconomic fundamentals.

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[1] See Budina and van Wijnbergen (1998) for the evaluation of the benefits f DDSR agreement of Bulgaria and its commercial creditors.

Bulgarian DDSR agreement proposed three different types of Brady Bonds in the menu: Discount bonds (DISC's), Front-loaded Interest Reduction Bonds (FLIRB's), and Interest Reduction Bonds (IAB's). Herewith, we will search the movement of Bulgarian DISC's and IAB's prices. The second group - FLIRB's - are somewhere between considering the safety and liquidity of Bulgarian Brady's. FLIRB's are convertible into equity, their interest is collateralized like DISC's, but the collateral is required only for first 7 years, and no principal collateral is required. FLIRB's are similar to IAB's according to maturity and grace period.

Discount bonds are 30 years maturity floating market interest rate, issued at a discount to the original face value of rescheduled loans, and do not involve market risk, so their prices are good measure of country risk. We will focus on the prices of Bulgarian DISC Brady bonds for several reasons. First,. DISC are considered the most safety and tradable instrument - among other Bulgarian Brady instruments DISC's are the only one, which principal is secured by zero coupon US bonds, 12 month interests are guaranteed, and they do not have any grace period. Second, the DISC prices are published regularly and usually are used as a starting point to asses the risk of Brady of bonds. Third, we also would expect that US interest rates on 30 years treasury bonds have been smoother than the risk premiums over the period of our study on Brady's, thus they could not have much impact on Brady bond prices.

IAB's are 17 years interest arrears bonds. A partial redemption on them must be made in 21 semi-annual installments, beginning July 2001. Each installment is defined as a percentage of the original principal. Installments and percents agreed are graduated as follows: first six installments - 1%, from the seventh to eleventh installments - 3%, from twelve to sixteen installments - 6%, and from seventeen to twenty first - 9%. IAB's pay the 6-month LIBOR plus 13/16% per annum. They are inconvertible into equity and are unsecured in terms of principal and interest. Thus, IAB can be considered as more risky and less liquid than DISC.

Figure 1   Bulgarian Brady Bond Prices
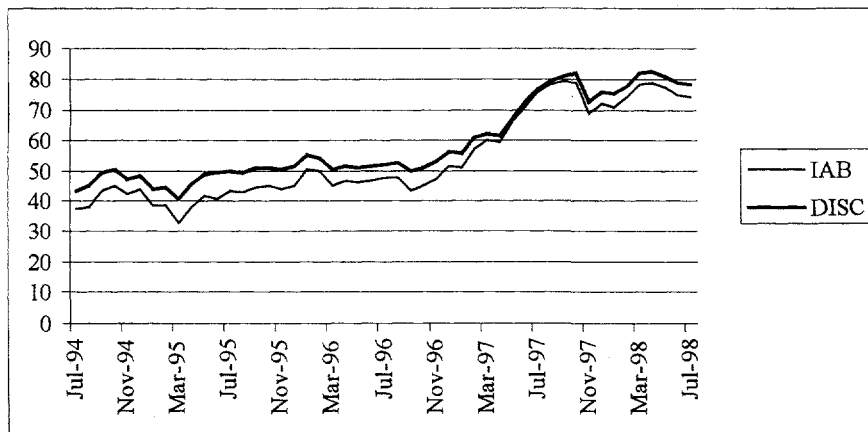
DISC and IAB price dynamic is shown on fig. 1. During almost the whole period of observation, DISC prices are higher, which is expected because the difference in the two represents the value of the guarantees provided for DISC bonds. The period of March - October 1997 is the only exception: there is a jump in prices of IAB and DISC and two bonds are traded at a very small price differential. This implies a drop in the value of guarantees during this period. Since November 1997 onwards, however, the IAB's price drops down by more then the drop in DISC's prices and the value of the guarantees increases respectively.

One explanation for high valuation of the IAB bonds could be enchanted investors' confidence in Bulgarian reforms. During March – July 1997, crucial political decisions were made - the 1 year agreement with the IMF to support economic reforms was reached by the caretaker government, on April 19, 1997 UDF right hand highly motivated to support both political and economic reforms political party won the elections, soon after the decision currency board to be introduced starting from July 1, 1997 was made. After the period mentioned the IAB's prices went down but with much lower margin confirming the investors confidence in Bulgarian reform process, no matter of the serious shocks impacted international capital markets.

Figure 2 Daily last prices of DISC and IAB
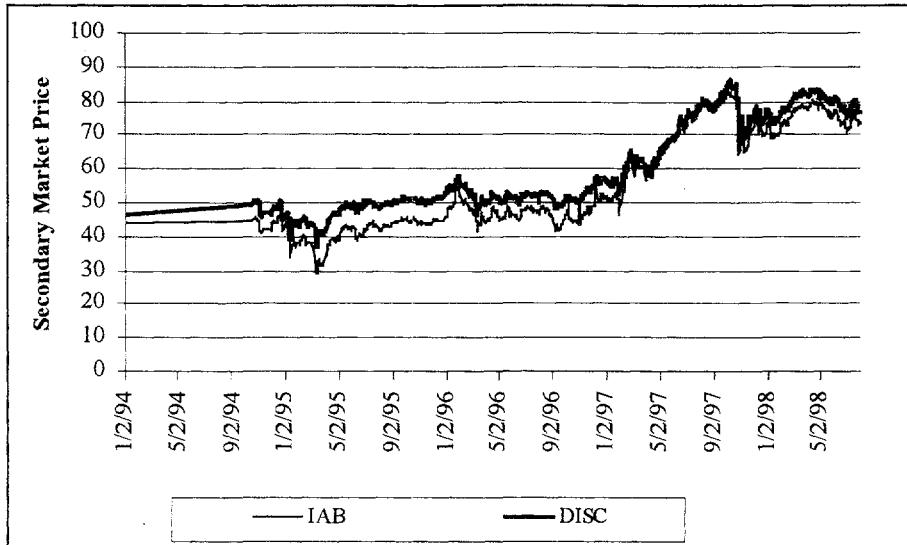
Three other shocks should be taken into account when we examine Bulgarian Brady bond price movements during July 1994-July 1998 period. The slow down of Bulgarian Brady bond prices in the beginning of 1995 comes together with the Mexican crisis (fig.2). Downward trend in the second half of 1996 could be associated with the banking crisis in the country, and the similar trend end of 1997 - with the beginning of East Asia crisis.

Figure 3 Mexican nominal exchange rate depreciation and Bulgarian Brady bonds
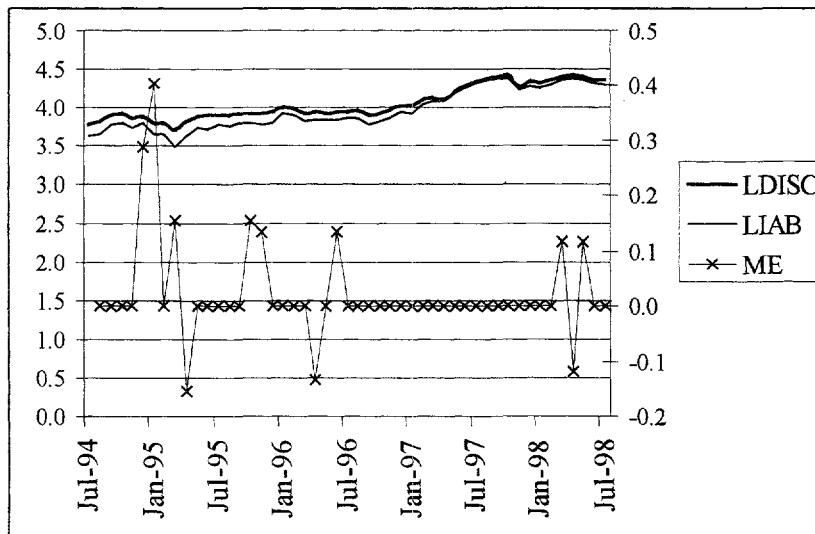
In our analysis we will emphasize on the real exchange rate, nominal exchange rate, gross foreign reserves and inflation as a fundamental domestic factors influencing the

DISC's and IAB's prices because these are macroeconomic indicators for Bulgaria officially reported on regular basis for the whole period since the DDSR agreement. Balance of payments data and the these for GDP, which the theory suggests, are published irregularly, mainly quarterly, and have been many times revised during the observed period. No statistically significant interdependence was observed in our analysis of preliminary and final data for the balance of payment and GDP. Thus, these data could not be considered as a reliable indicators for the analysis and decision-making when pricing Bulgarian Brady bonds. Information on Bulgarian foreign debt comes semi-annually and in the pace, which could not service the purpose of our analysis. The macroeconomic data set is summarized in figures 3,4, 5 and 6.

The real exchange rate[2] (REER) is considered as a measure for trade competitiveness of an economy. Sachs (1985)[3] demonstrated the importance of the exchange rate management for Latin America and East Asia. Especially in Latin American countries overvalued currencies caused substantial capital flights. A really appreciated exchange rate is expected to affect adversely prices.

Figure 4   Real Exchange Rate and Brady Bond Prices

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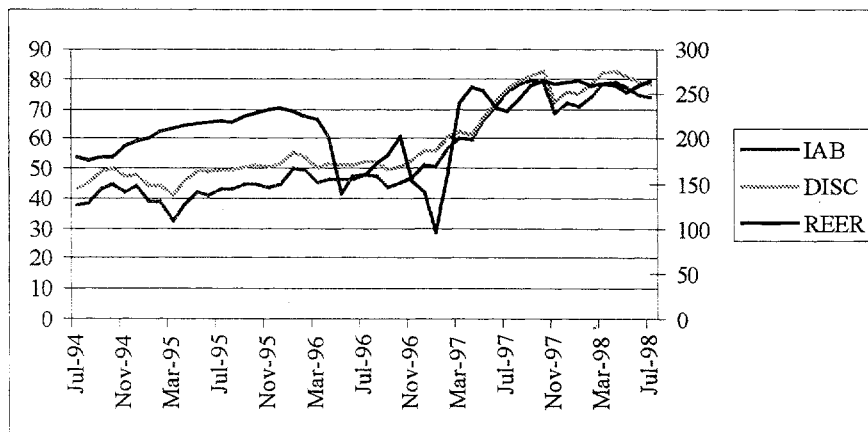
[2] We use the real effective exchange rate indices as they are calculated by the BNB. BNB calculates the real effective exchange rates using consumer prices indices and a basket of three currencies distributed as follows: USD - 75%, DEM - 20%, and CHF - 5%

[3] Sachs, Jeffrey D., "External Debt and Macroeconomic Performance in Latin America and East Asia", Brooking papers on Economic Activities, 2, pp. 523-65.

Since the issue of Brady bonds Bulgaria is trying to maintain positive in real terms exchange rate of the lev (fig. 3). Only two exceptions during the observed period can be seen when banking crisis in the mid-1996 and the economic crisis at the beginning of 1997 knocked down the economy.

In the period April 1996-April 1997 the real exchange rate fluctuations in Bulgaria are caused primarily by dramatic changes in the nominal exchange rate (EXCH) and subsequent changes in domestic inflation rate (INF). Both variables seem to have strong correlation in their movement, which should be considered in econometric analyses (fig. 4).

Figure 5 Bulgarian Exchange rate (Lev against USD) and Consumer Price
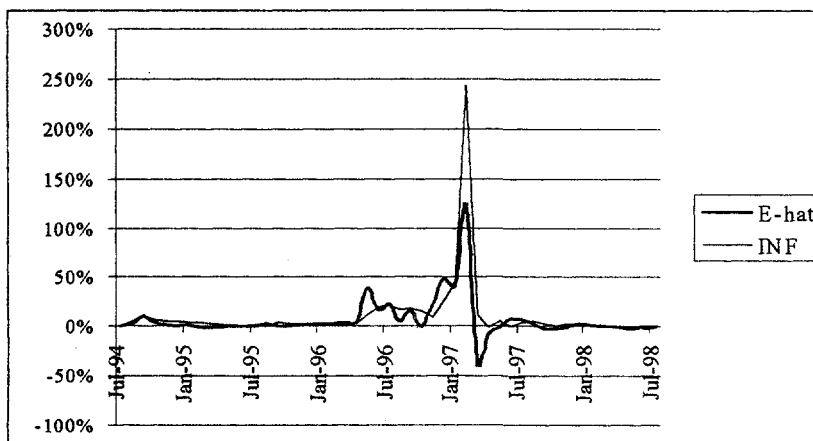
The progressive real appreciation of the lev during almost the whole 1995 and after January 1997 helped to increase imports significantly. This deteriorated the current account of the BOP and especially in the first period considered, when markedly budget deficit also existed, caused substantial imbalances in the real economy. BNB, the central bank of Bulgaria, wasted almost all the foreign reserves in the beginning of 1996 to maintain the domestic currency appreciated. At the same time it injected huge liquidity through financing the budget deficit and banks. As a result it was unable to fight with the following crisis.

The gross foreign exchange reserves are considered to be of first importance when discussing the possibility of sudden liquidity crisis. Thus the lower are the reserves the lower should be country's risk rating, as well as the Brady bonds prices, and the greater the possibility of default. During the transition Bulgaria uses gross foreign exchange reserves (F) as the ultimate resource to balance payments on current account and foreign

debt service. The BNB's participation in the domestic forex market is determined by the amount and dynamics of foreign exchange reserves. At the beginning of the considered period BNB succeeded to increase its foreign exchange reserves (to 1.5 USD billion in end-June 1995) due to prevalence of foreign currency supply over demand in the domestic interbank market and without any foreign financing (fig.5). In the last quarter of 1995 started the tendency BNB foreign reserves to fall down due to combination of internal speculative pressure following a temporary limit on the reduction of the basic interest rate and seasonal pressure on the BOP. During the first half of 1996 BNB forex reserves fell from 1.2 USD billion to USD 0.6 billion due to sizable foreign debt payments in January and the intensive interventions in the domestic foreign exchange market to compensate the eroded confidence in the lev and the banking system respectively. During that period foreign debt was serviced without any foreign financing. The extremely low level of forex reserves coupled with the fast rate of their fall had an adverse effect on economic agents' expectations during the second half of the year.

First trance extended under fourth stand-by agreement with the IMF in July 1996 and the funds extended in August 1996 by the EC compensated to a certain extent the sizable foreign debt payments and prevented temporarily the further sharp slow down of the BNB foreign reserves. This helped preserve the high confidence and the attractiveness of Bulgarian Brady's during the summer of 1996 (fig. 5).
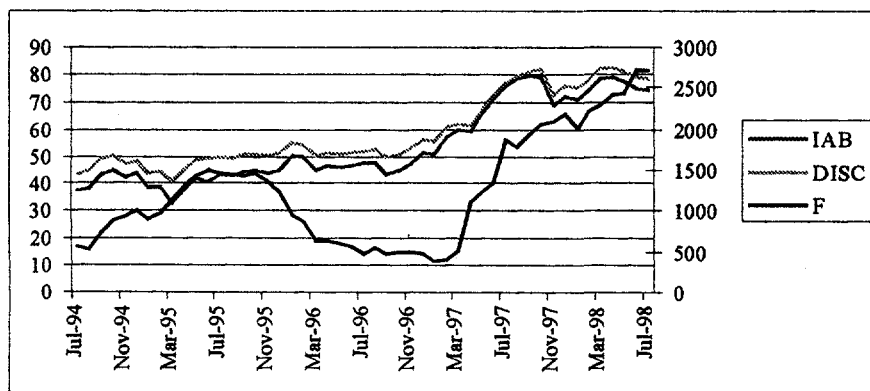
Figure 6   **Gross Foreign Reserves and Brady bond Prices.**

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The inflation rate (INF) is regarded here as a proxy for the quality of economic management of the country. As a result the higher is the inflation rate, the lower is the credibility in country policy-makers and thus the price of country's Brady bonds.

Figure 6 shows the inflationary development in Bulgaria and the Brady's price movement. During the considered period monthly inflation was quite high. Only exception was 1995, where monthly movements in the consumer prices were not so marked, lacking dramatic price jumps. Starting from the second quarter of 1996 inflation accelerated reaching hyperinflation at the beginning of 1997. After introduction of the currency board arrangement at the mid-1997 inflation steadily slowed down. Consumer price dynamics in 1997 diverged considerably from those displayed in the previous years. According to BNB, this was due both to the shocks to which the economy was subjected and delayed effects of certain processes resulting from previous administrative decisions.

Figure 7   Bulgarian CPI Inflation rate and the Brady bonds price dynamics
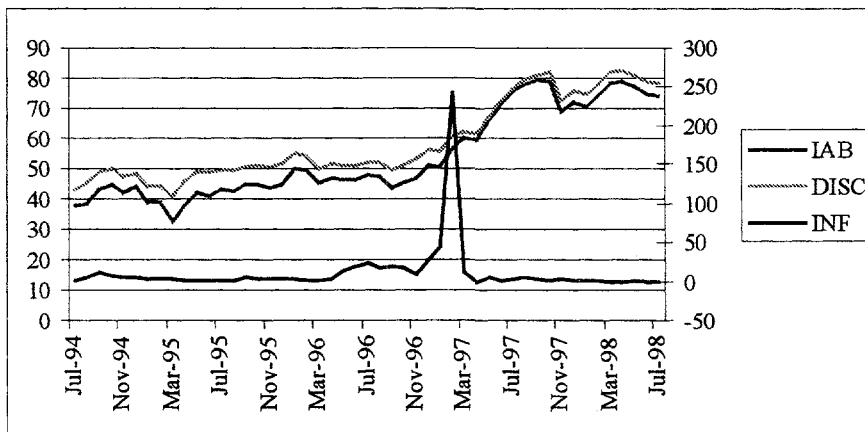
4.   Do Macroeconomic Fundamentals matter for Bulgarian Brady bonds prices: an Empirical Assessment

In this section, we investigate the relationship between the secondary market prices of Bulgarian Brady bonds and domestic macroeconomic fundamentals. Bulgarian DDSR agreement proposed three different types of Brady Bonds: 50 % Discount bond, DISC with full principal collateralization; Front-loaded interest reduction bond, FLIRB,

and Interest arrears bond, IAB. Both FLIRB and DISC had 1 year rolling interest guarantee. Despite the fact that prices of those bonds generally moved together, we are interested also to know whether they react differently on various fluctuations of macroeconomic fundamentals because they imply different risk exposure for the commercial creditors. For example, we would expect market price of a collateralized bond to be less sensitive to such fluctuations of fundamentals, than market price of uncollateralized bond. To check this hypothesis, we analyze separately market prices of fully collateralized DISC and of IAB bond, which is regarded as highly speculative instrument.

As suggested already in the previous sections, there are a few obvious candidates that can be used in our regressions as indicators of macroeconomic stance and have some correlation with the Brady bond prices. The most important and observable variables that reflect macroeconomic stance are the nominal exchange rate depreciation, REER, CPI inflation, gross foreign reserves, the change in gross foreign reserves to imports ratio and budget deficit.[4]

As suggested in our theoretical section, we would like to estimate the following econometric specification:

$$\text{Log}(DISC_t) = \alpha_0 + \alpha_1 \text{Log}(F_t) - \alpha_2 \text{Log}(EXP) - \alpha_3 \text{Log}(REER) + \varepsilon_t \qquad \textbf{Eq 1}$$

$$\text{Log}(IAB_t) = \beta_0 + \beta_1 \text{Log}(F_t) - \beta_2 \text{Log}(EXP) - \beta_3 \text{Log}(REER) + \eta_t \qquad \textbf{Eq 2}$$

If the collateralization of DISC matters, we would expect the prices of DISC to be less sensitive to the impact of our indicators of macroeconomic stance, thus the coefficients of the first equation must be different from the coefficients of the second equation.

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[4] Note, that since we use monthly data, we had difficulties in choosing other important variables, such as debt service, which is available semi-annually.

4.1 ADF tests for Unit Roots in Brady Prices and Macroeconomic Variables

The first step in our analysis is to check the order of integration of both dependent and independent variables used in our econometric model. If all variables are stationary, a simple OLS estimator will be sufficient. If they are non-stationary, however, estimation of equations for Brady bonds prices by a simple OLS in levels can result in a spurious regression.

Table A.1 from Annex 2 presents the ADF tests for unit roots for all the individual variables used in our econometric analysis. The ADF test results, including a constant term and a constant and a trend in the test equations, are also presented. The estimation period includes the period July 1994 – July 1998. The results in Table A.1 suggest that presence of unit root in all the series in levels cannot be rejected. Furthermore, we are interested to know the order of integration of all the series. To find out the order of integration, we apply the same ADF test to first differences of all the variables. The results from these tests, presented in table 1, reject the presence of unit roots in the differenced series. Thus we make the conclusion that all the variables are integrated of order 1[5]. Thus we have found that DISC and IAB bond log-prices, inflation, nominal exchange rate depreciation, REER, and gross foreign exchange reserves are all integrated of order one, which suggests that they maybe cointegrated.

To avoid spurious regression results that could arise if dependent and independent variables are non-stationary, we estimate the relationship between Bulgarian Brady bond prices and macroeconomic fundamentals in the form of an error correction model. Spurious regression[6] is one of the effects of the presence of unit roots in the econometric analysis of time series.

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[5] For more details, see the ADF tests for unit roots for all the variables in Annex 1.

[6] Often, in the presence of unit root, we can find an apparently significant relationship between two variables despite the fact that the two processes are independent. This is a direct consequence of the presence of a serial correlation displayed by the disturbances of the OLS equation in levels if the variables are non-stationary.

4.2   Results from the one-step error correction method

In this section we apply the one-step error correction model for Bulgarian DISC and IAB bond prices. The tests for weak exogeneity of gross foreign reserves, inflation and exchange rate depreciation are performed in the VAR analysis by using the Johansen procedure. The conclusion is that these variables can be treated as weakly exogenous and so we can proceed with our econometric analysis in the form of a one-step error correction method in modeling the relationship between Bulgarian Brady bond prices and macroeconomic fundamentals. For this purpose we must specify both the long-run relation and the short-term dynamics of this relationship. We can use the one-step error correction method to derive the error correction form of these functions. We regress the first difference of the 1

dependent variable on the lagged dependent and independent variables, the differenced independent variables, and possibly on a constant and a time trend:

$$\Delta(\log(P_t)) = \lambda\,(P_{t-1}) + \delta_j\,X_{j,t-1} + \gamma_j\Delta X_{j,t} + D_t + \eta_t \qquad (2)$$

where X is the vector of independent variables and ΔX_{it} is the vector of short-term adjustment variables. The dependent variable is the log-difference of DISC and IAB bond market prices.[7] The X vector includes the independent variables (macroeconomic fundamentals). The coefficients of the lagged dependent variables reflect the error correction mechanisms for these variables.

Table 1. One-step error correction estimates of Log(DISC) and Log(IAB)

Variables	$\Delta(log(DISC))$	$\Delta(log(IAB))$
(log(Brady))-1 *Log of bond's market price*	-0.253 (-3.72)	-0.262 (-3.08)
Log(EXP)-1 *Log of export, f.o.b., USD*	0.041 (1.32)	0.05 (1.03)
Log(REER)-1 *REER index*	-0.06 (-1.92)	-0.09 (-1.89)
α Constant	1.09 (3.02)	1.22 (2.47)
Δ(log(F)) *Growth of gross foreign reserves*	0.046 (1.47)	0.06 (1.35)
DASIA *Dummy for Asian crisis (1 in Nov 1997)*	-0.13 (-3.42)	-0.135 (-2.395)
DCB *Political and CB dummy (1 since April 98)*	0.13 (4.06)	0.154 (3.20)
ME(-1) *Mexican exchange rate depreciation, lagged.*	-0.23 (-2.85)	-0.33 (-2.69)
Δ(ME) *Change in Mexican exchange rate depreciation.*	-0.17 (-2.84)	-0.24 (-2.63)
R^2	0.56	0.47
DW	1.80	1.96

Sample Period: July 1994 – July 1998

The estimates for the long-run parameters can be calculated from equation 3[8]. The D_t vector includes: (a) a dummy for November 1997, DASIA, to account for the beginning of the financial crisis in East Asia, (b) dummy, DCB, to account for the new political elections, the introduction of the currency board agreement and introduction of credit rating by Moody's for Bulgaria, or in general, reinforcing of the process f political and economic stabilization since April 1997. Table 1 presents the econometric results by using the one-step error correction procedure.

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[7] Market price of DISC and IAB is calculated as average of ask and bid prices of the respective types of bonds. Data are obtained from Reuters.

[8] They are equal to the minus of the coefficients of the lagged independent variables over the coefficient of the lagged dependent variable in every equation:

$$(P_t) = -(\delta_j /\lambda) X_{j,t}$$

The T-statistics for δ_j can be used as tests for significance of the long-run coefficients, θ_j. According to Boswijk (1994) and (1996), a sufficient condition for the t-statistics to be valid is that the explanatory variables are weakly exogenous.

We present one of our econometric specifications for the market prices of DISC and IAB. We chose these two bonds in particular, because we are interested to know to what extent domestic and external factors matter for their market price fluctuations. Since these two bonds have difference in their characteristics (the most important being the absence of collateral for IAB bonds), we expect difference in their sensitivity with respect to various macro factors. In both regressions we found a positive impact of log of exports in USD on market prices, and a negative impact of the log of REER index on market prices. The difference, however, consist in the fact that exports coefficient is significant and REER index is insignificant in DISC equation, whereas exports are insignificant and REER is significant in IAB equation. In addition, the coefficient of REER is much bigger in IAB equation, than in DISC equation. In addition, we find much larger negative effect of both Mexican and Asian crisis for the IAB equation, than for DISC equation. Also, the reinforcement of political and economic stabilization process and the decision for Currency board introduction since May 1997, reflected by the dummy, DCB, had much larger positive effect on IAB as compared to the DISC market prices. These differences might reflect different features of these two Brady bonds. The most important impact is the effect of collateralization – because holders of DISC bonds are less exposed to market risk, they are less sensitive to both domestic and external shocks. IAB bonds, however, are more risky because they are not collateralized and are also less liquid. Therefore, any news for a real appreciation assuming constant labor productivity increases the risk of future drop in foreign reserves and discrete depreciations. This drop of foreign reserves increases the risk of default that drives down the market prices of IAB in the absence of collateral.

Unit root tests for the residuals are also performed. Boswijk (1994) and (1996) suggests using the Wald test for 'non-cointegration' hypothesis and provides tables for critical values of the Wald statistics. We have tested the hypothesis of 'non-cointegration' as proposed by Boswijk (1996). We have performed the Wald test for the joint hypothesis that the coefficients of all lagged variables on the RHS are equal to zero. The 'non-cointegration' hypothesis was rejected for all the equations.[9] Boswijk (1992, 1994) formulates the 'non-cointegration' hypothesis as a joint test on the restrictions $\lambda=0$ and

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[9] See Annex 2 for the Wald test statistics of the four equations and for the critical values of this test.

$\delta=0$. The Wald statistics is calculated as $\xi=nF$, where n is the number of restrictions and F is the f-statistics from the test. He provides tables for the critical values of ξ, and ξ_μ, which allows for a constant term, and of ξ_μ, which also allows for a linear trend.

Table 2 presents the long-run coefficients implied by the one-step ECM regression results presented in Table 1. Long run equations for DISC and IAB included a constant term, log of Bulgarian exports in USD, log of REER index as calculated by the Bulgarian National Bank (BNB), and Mexican nominal exchange rate depreciation. Note, that we have included both domestic and foreign macroeconomic fundamentals. The reason for inclusion of Mexican exchange rate depreciation in the long run equations for Bulgarian DISC and IAB prices is the fact that Mexico is often used as a benchmark in pricing all the Brady bonds and Mexican bonds have the biggest share in world trade with Brady bonds. Because Bulgarian share in total is insignificant, we expect that Mexican fundamentals play important role in determination of Bulgarian Brady bonds. We also find that this impact is larger for uncollateralized and less liquid bonds as IAB, than for the collateralized, liquid bonds, such as DISC (which can also play an important role in privatization process).

Table 2. Long-Run Estimates of DISC and IAB log-prices

Long run coefficients	Log(LDISC)	Log(LIAB)
Constant	4.34	4.65
Log(EXP), Log of Exports	0.16	0.19
Log(REER), Log of REER index	-0.25	-0.36
Log(ME) – Mexican depreciation, nominal	-0.89	-1.24

Note that for the Asian crisis, we assume that the direct effect is temporary as these countries do not have Brady bonds. This effect is negative and significant in both equations and its impact is bigger in the IAB price equation. The indirect effect, however, is included in our long term relation till extent to which Asian crisis has an impact of Mexican (Latin American) fundamentals.

4.3 VAR analysis for Bulgarian Brady bond prices

We continue the empirical analysis of market prices of Bulgarian Brady bonds with formulation of unrestricted VAR system. The multivariate approach is more efficient when independent variables are not weakly exogenous or to check the number of cointegrating relationships. Johansen's (1988) procedure allows for determining the number of cointegration vectors by specifying an unrestricted VAR system (UVAR) of the following form:

$$x_t = \sum_{j=1}^{k} A_j x_{t-j} + \gamma D_t + \varepsilon_t$$

where x_t contains all endogenous variables (log(DISC), log(IAB), log(F), log(EXP), log(REER)), D_t contains exogenous variables: constant term, d(log(Mexexch)), DASIA, dummy equal to 1 in Nov 1997 to account for the Asian crisis and DCB, dummy equal to 1 starting from May 1997 until Jul 1998, political stabilization and currency board dummy. Finally, ε_t is a vector of normally distributed error terms. Because our sample size is relatively small, we cover the period July 1994 – July 1998, we use two lags for setting up the conditional UVAR system.

After specifying the structure of the UVAR system, the Johansen's (1988) maximum eigenvalue (λ_{max}) tests are used to determine the rank of Π matrix. The values of the λ_{max} statistics for estimated UVAR and critical values are given in table 3.

First we show eigen-value test-statistics for the unrestricted conditional UVAR system. We condition the UVAR system on ME, DASIA and DCB1.

Table 3: UVAR with two lags, conditional on exogenous variables, ME, DASIA, DCB1

Rank	λ_{max}	λ_{max} using T − nk	95%	λ_{trace}	λ_{trace} using T − nk	95%
0	62.44**	48.86**	34.4	137.4**	107.5**	76.1
1	33.72**	26.39	28.1	74.95**	58.66*	53.1
2	24.15*	18.9	22.0	41.23**	32.27	34.9
3	12.73	9.966	15.7	17.08	13.37	20.0
4	4.347	3.402	9.2	4.347	3.402	9.2

*** denotes rejection at 1% critical value, ** denotes rejection at 5% critical value

Unrestricted standardized eigenvectors β' (conditional system), Variable

LDISC	LIAB	LF	LEX	LEER	Const	ME	DASIA	DCB1
1	-3.6291	0.13861	1.2865	-0.62436	4.4975	-0.20602	-1.1903	1.6399
-1.2723	1	0.21969	0.13558	-0.48487	1.4480	-0.016049	0.051739	-0.032652
-8.3705	5.9979	1	3.3797	1.9313	-27.518	2.0138	1.5786	-0.99031
17.640	-14.436	-0.09438	1	-0.26949	-18.182	-0.72741	0.25482	-0.32754
11.913	-5.4280	-1.1217	0.66894	1	-27.977	2.7927	-0.93419	-1.2756

Unrestricted standardized adjustment coefficients α (conditional system)

LDISC	0.096607	-0.11181	-0.017440	0.026826	0.0030976
LIAB	0.10466	-0.16077	-0.026065	0.056644	0.0045503
LF	-0.013985	-0.52128	-0.045723	-0.043718	0.063333
LEX	-0.11845	-0.10957	-0.080212	-0.010791	-0.057215
LEER	0.019191	1.7995	-0.041989	0.015617	0.032557

The Likelihood ratio test indicates 2 cointegrating equations at 5% significance level. Note, that we do impose restrictions on both β and α coefficients, in order to take into account that that we would like to assume a two different long term relations – one for the LDISC, as a function of domestic fundamentals and external variables, and second, for the LIAB as a function of the same parameters. This system can also be presented in the equivalent VECM (vector error correction) form:

$$\Delta x_t = \sum_{j=1}^{k-1} \Pi_j \Delta x_{t-j} + \Pi x_{t-1} + \gamma D_t + \varepsilon_t$$

where $\Pi = (\sum_{i=1}^{k} A_i - I)$ and $\Pi_j = (-\sum_{i=j+1}^{k} A_i)$ for j = 1,2,...(k-1). The Π matrix equals $\alpha\beta'$, where α represents the speed of adjustment to equilibrium and β the long-run coefficients. Johansen's (1988) procedure determines the rank of the Π matrix which is equivalent to the number of cointegration vectors.

Note, that according to the theory, the only endogenous variables are LDISC and LIAB, so when constructing the ECM, we do assume that domestic fundamentals are weakly exogenous to the system (there is no causal relations from Bulgarian Bond prices to the fundamentals) which means that our ECM representation of the VAR system will have two equations – one for Δ(LDISC) and one for Δ(LIAB), and that LDISC is weakly exogenous to second cointegrating vector, whereas LIAB is weakly exogenous to the first cointegrating vector.

First, we present restricted long-run β' vectors in table 4. The first vector is the long run dependence of Log(P_{DISC}) on domestic fundamentals, Mexican nominal exchange rate depreciation and dummy for the Asian crisis. The second vector is the long-term equation for Log(P_{IAB}) as a function of the same variables. Estimated coefficients have the expected signs – a positive impact of foreign exchange reserves and exports on Brady prices, and a negative impact of the index of real exchange rate depreciation. In addition, there is a positive impact of DCB1, currency board dummy, and a negative impact of nominal Mexican exchange rate depreciation and Asian crisis on Bulgarian Brady prices. Note, that the effect of Mexican and Asian crisis, as well as the positive impact of currency board dummy is stronger for the LIAB, then for LDISC, which is to be expected because LDISC are collateralized, whereas LIAB are not.

Table 4. Restricted standardized eigenvectors β' (conditional system), ECM vectors

LDISC	LIAB	LF	LEX	LEER	Const	ME	DASIA	DCB1
1	0	-0.10884	-0.38069	0.31201	-2.5849	0.63458	0.59605	-0.43753
0	1	-0.10364	-0.53852	0.38054	-1.9654	1.3465	0.98258	-0.50019

Next, we construct the ECM representation of the restricted VAR system. The results for the short term adjustment to equilibrium are presented in table 5:

Table 5. ECM system for restricted VAR (conditional system), Variable

	$ECM_{i,-1}$	$\Delta(LF)$	$\Delta(LEX)$	$\Delta(LEER)$	$\Delta(ME)$
$\Delta(LDISC)$	-0.15953	0.096556	0.027785	-0.049321	-0.11180
$\sigma = 0.0468$	(-3.699)	(2.029)	(0.55)	(-0.804)	(-1.89)
$\Delta(LIAB)$	-0.12293	0.12267	0.044986	-0.079127	-0.17345
$\sigma = 0.0644$	(-3.583)	(1.87)	(0.651)	(-0.945)	(-2.108)

Numbers in brackets are the t-values of the estimated coefficients.
$ECM_{i,-1}$ is a one lag of the error correction vectors presented in table 4 (i=1,2).
loglik = 336.40341

The ECM coefficients in both equations are negative and statistically significant, which confirms the fact that the series are co-integrated and that these are the long-term relations between Bulgarian Brady Bond Prices, domestic fundamentals and other international factors as outlined above. According to the estimated ECM coefficients, about 15.9 percent of adjustment towards the equilibrium is occurring in one month for the Brady Discount bonds, whereas 12.3 percent per month of adjustment in one month occurs for the IAB bonds. In addition, any change in Bulgarian forex reserves or Exports (not significant but with the right sign) will increase the prices of Bulgarian Brady Bonds, whereas any real depreciation would tend to have a negative but insignificant effect on Brady prices. Any increase in the nominal exchange rate depreciation in Mexico, however, has a negative and significant impact on Bulgarian Brady Prices. This finding, however, shows that Mexican fundamentals, play an important role for in Bulgarian Brady Bond price changes, besides the domestic fundamentals, which is what the theory and the empirical evidence so far suggests.

Furthermore, we would like to find out how sensitive these estimates are to any potential structural changes.[10] For this purpose, we run recursive estimates by FIML procedure in PCFIML and we present several important tests for structural stability of the estimated equations. Figure A.1 in the annex plots recursive residuals and the boundaries consisting of +/- two standard errors, as well as Chow Break-point and Forecast tests

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[10] Please note that we have already accounted for the change in the regime from floating exchange rate to the introduction of currency board in Bulgaria and a change in the political regime as well.

scaled by their critical values at the 5 percent probability level. These tests show reasonable constancy for all the equations.

Thus in this section we confirmed that there are two long run cointewgrating vectors – one for LDISC and the other one, for LIAB, expressed as a function of a constant, domestic fundamentals, Mexican nominal exchange rate depreciation and two dummies – one to account for the Asian crisis, and the other one to account for the introduction of the currency board and a change in political regime in Bulgaria. In addition, we found out that in the short term, about 15 and 12 percent of adjustment takes place in changes of prices of DISC and IAB, respectively, any increase in Bulgarian forex reserves rises DISC and IAB prices, whereas any increase in Mexican nominal exchange rate depreciation tends to lower Bulgarian DISC and IAB prices.

Conclusions

This paper focussed on the determinants of Bulgarian Brady bond prices. In particular, we are interested to see if domestic fundamentals matter and in addition, we investigate if international factors, such as nominal Mexican exchange rate depreciation and the Asian Crisis did have an impact on Bulgarian Brady prices.

We do use the prices of two types of Brady Bonds – DISC and IAB. The first one is a bond issued at a discount of its face value but it has a principal collateral and a one year rolling-interest guarantee. The second type of bond is issued at par, but is not collateralized and as·such is likely to be of more speculative nature and because of the value of the guarantee, DISC bonds are in general traded at prices higher than the IAB bond prices. In addition, as domestic fundamentals we have used the Bulgarian gross foreign reserves and exports (in USD million), the index of real exchange rate and a dummy that represents the introduction of a currency board in Bulgaria and political changes as well. We took logs of all the above listed variables. In addition, we used Mexican nominal exchange rate depreciation and dummy for the Asia crisis, which represents the impact of international factors on Bulgarian Brady bonds.

We do apply an error-correction and co-integration analysis in both a single-equation framework and in VAR framework.

First, preliminary checks for unit root on variables show that Log-prices of Bulgarian Brady bonds are integrated of order 1, I(1). Second, the empirical analysis suggest that as expected, domestic fundamentals, gross foreign reserves, exports and REER are important determinants of Bulgarian Brady Bonds price dynamics in the long run (they form the long run cointegrating relationship)

We find a positive impact of gross foreign reserves and exports and a negative impact of REER and Mexican nominal exchange rate depreciation on log-prices of Brady bonds in the long run. In the short term, the Asian crisis has a negative impact, whereas the change in political regime and the introduction of currency board in Bulgaria has a positive impact on the log prices of Bulgarian Brady bonds.

Mexican fundamentals (in our case nominal exchange rate depreciation) are important in the cointegrating relation that explains the dynamics of Bulgarian Brady bond prices in the long run. In addition, the Asian crisis dummy and the currency board dummy magnifies the impact of such shocks.

Our findings squarely suggests that positive influence of DDSR agreement is conditional on the introduction of credible and sustainable macroeconomic policies. However, any macroeconomic policy design should take into account the external environment primarily in Latin America

Future decisions of buy-back operations should consider estimates of both direct impact of such operations on the market price of converted foreign debt, as well as the indirect impact through the changes of foreign reserves and consequently on the other macroeconomic variables.

Finally, empirical results to a great extent confirm the view that so called "fundamentals' approach' should be used to supplement the analysis of spill-over effect for the case of Bulgaria.

TableA.1 ADF Test for stationarity

Levels	logDISC	LogIAB	INF	LogF	LogREER	LogEXRAV	DEF
w/o C	1.8846	1.2757	-2.2757	0.4015	0.5597	0.4845	-2.6916
C	-0.3696	-0.4461	-2.4921	-1.3035	-1.3827	-.04318	-3.1158
C and T	-2.0039	-2.5918	-2.4419	-1.6713	-1.5951	-1.8921	-3.3091

Critical values with 4 lags:

w/o C   1% -2.6155

        5% -1.9483

        10% -1.6197

C   1% -3.5850

    5% -2.9286

    10%- 2.6021

C and T 1% -4.1781

    5% - -3.5136

    10% - 3.1868

1-st difference	logDISC	LogIAB	INF	LogF*	LogREER	LogEXRAV	DEF
w/o C	-2.5630	-2.9285	-4.6606	-2.2281	-4.0445	2.8110	-7.1922
C	-3.1383	-3.2284	-4.5999	-2.2479	-4.0569	-3.0781	-7.1088
C and T	-3.1142	-3.2391	-4.5609	-2.3485	-4.0225	-3.0548	-7.0155

Order of integration:

	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Critical values with 4 lags:

w/o C   1%   -2.6168

    5%   -1.9486

    10%   - 1.6198

C   1% -3.5889

    5% -2.9303

    10% - 2.6030

C and T 1% - -4.1837

    5% - -3.5162

    10% - 3.1882

* Log(F) is I(1) integrated in 5% confidence interval with 2 lags when we include intercept, and with 1 lag, when we include intercept and trend.

Table:A1 ADF Test for stationarity(continued)

Levels	EX	E	ME
w/o C	0.2435	-1.9092	-3.1682
C	-1.6874	-2.2884	-3.3962
C and T	--1.0689	-4.8024	-6.7017
Critical values with 4 lags:			
w/o C	1% -2.6168		
	5% -1.9486		
	10% - 1.6198		
C	1% -3.5889		
	5% -2.9303		
	10% - 2.6030		
C and T	1% - -4.1837		
	5% - -3.5162		
	10% - 3.1882		

1-st difference	EX	E	ME
w/o C	-3.8078	-4.9017	-6.3622
C	-3.7812	-4.8356	-6.4013
C and T	--1.0689	-4.8024	-6.7017
Order of integration:			
	I(1)	I(1)	I(1)
Critical values with 4 lags:			
w/o C	1% -2.6182		
	5% -1.9488		
	10% - 1.6199		
C	1% -3.5930		
	5% -2.9320		
	10% - 2.6039		
C and T	1% - -4.1896		
	5% - 3.5189		
	10% --3.1898		

Annex 2   Wald tests for H_0 being 'non-cointegration' hypothesis

	D(Log(DISC))	D(Log(IAB))
n, # of restrictions	4	4
F-Statistics**	6.142	5.003
=nF	24.568	20.012
Critical values*	$\xi = 19.69$	$\xi = 19.69$

*The critical values are taken from Boswijk and van Dijk (1996) and are for a 0.05 level of significance.

Figure A.1 Recursive Residuals and Chow Break-Point and Forecast Tests
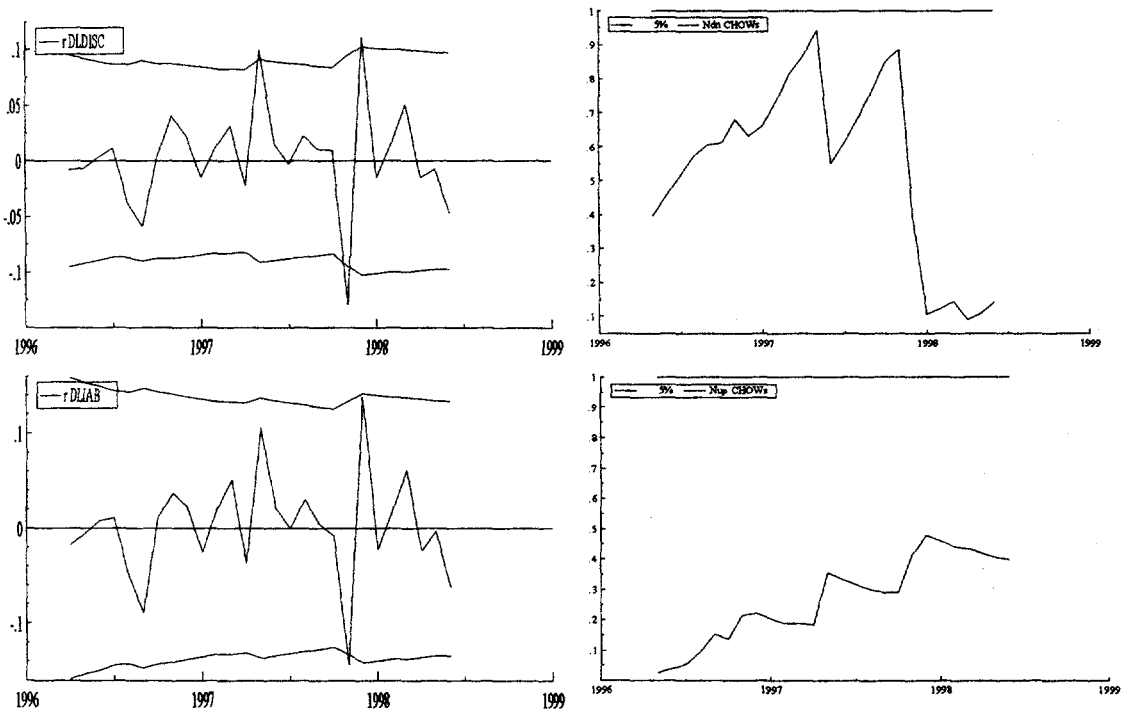
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