DONG-HYUN AHN[1], JACOB BOUDOUKH[2], MATTHEW RICHARDSON[2] and ROBERT F. WHITELAW[2]
[1] *University of North Carolina, Chapel Hill,* [2] *New York University*

12. Hedging the interest rate risk of Bradys: the case of Argentinian fixed and floating-rate bonds

Abstract

While there is significant interest in investing in Brady bonds, the source of attraction is often the exposure to sovereign risk (and its yield compensation), while the exposure to US interest rate risk is a 'necessary evil'. This paper addresses the problem of determining the interest rate sensitivity of Brady debt. We show that the most relevant state variables in determining the duration of a Brady bond are US interest rates and the bond's strip spread. Motivated by the difficulty of using structural models to price and hedge Brady debt, we provide a model-free approach to estimating the hedge ratio. Using our approach to hedge the Argentinian Par and Discount Brady bonds, we find that only a small fraction (15% or so) of the total risk is hedgeable, but our hedged portfolio exhibits little covariation with US interest rates.

Introduction

Brady bonds are sovereign debt issued to replace commercial bank loans made to developing countries over the past two decades.[1] This emerging market debt, which includes debt of Argentina, Brazil and Mexico, among many others, has several unique features. First, some of the bonds are highly liquid, giving investors the opportunity to invest in sovereign credit. Second, the majority of the Brady bonds are denominated in US dollars, and, credit risk aside, are therefore closely related to fixed and floating rate US government debt. Third, most of the Brady Bonds include some type of credit enhancement, usually in the form of the entire principal and some interest payments being collateralized by zero coupon US Treasury securities.

To the extent that there are ample opportunities to invest in US government debt, the primary reason for the success of the Brady bond market is the opportunity to invest in the sovereign debt of emerging markets. Thus, isolating the sovereign component of Brady bonds by hedging out the US interest rate risk of these bonds is especially important to market participants (Telljohann,

[1] Since 1990, a substantial number of Brady bonds have been issued, with billions of dollars in principal currently outstanding. Brady bonds get their name from the then Secretary of the Treasury Nicholas Brady, who emphasized a market-based approach in providing a plan for reducing emerging market debt.

R. Levich (ed.), Emerging Market Capital Flows, 307–317.

1994). Informal evidence for the appetite investors have for securities which afford liquid sovereign risk without the US interest rate risk can be found in the common practice of 'stripping off' Brady bonds (i.e., shorting the guaranteed component), and the enthusiasm which met the recent plan by the Mexican government for swapping Brady bonds for purely sovereign debt. This lack of appetite for US interest rate risk is not surprising since most financial institutions and pension funds consider this risk systematic, while the sovereign risk is often considered non-systematic. Hence, there is a significant interest in understanding, quantifying and hedging the interest rate risk of Brady bonds.

In the case of a fixed-rate Brady bond, estimating the bond's interest rate sensitivity involves knowledge of both the bond's characteristics (e.g., maturity, coupon and any embedded options) and the level of interest rates. It is important to note, however, that even if interest rates are independent of the Brady bond's default rate, hedging the interest rate risk of the Brady bond requires additional information regarding default probabilities. This result is true even in the simple world of a flat term structure and an equal probability of default each period. Ahn, Boudoukh, Richardson, and Whitelaw, 1997, show that, under these assumptions, the Macaulay duration of the bond not only changes as the default probability increases, but that this change may be positive or negative, depending on the coupon, the interest rate level, and the default probability.

Given the current values of the interest rate and default probability, one could dynamically adjust a hedged position by duration matching using, say, T-note futures, thus, completely isolating the Brady bond from instantaneous interest rate risk. The problem with this approach is that the assumptions underlying these theoretical duration measures are generally poor (Cumby and Evans, 1995; Nadler *et al.*, 1996). The goal of this paper is to develop a different approach for hedging Brady bonds using interest-rate instruments, such as T-note futures, following the methodology in Ahn *et al.*, 1997. The idea is to estimate a conditional hedge ratio between returns on a Brady bond and returns on T-note futures. The hedge ratio is conditional in the sense that we account for relevant current information. This is important for Brady bonds because, as interest rates and default rates change, the interest rate sensitivity of Brady bonds will change in a highly nonlinear fashion. In order to estimate this conditional hedge ratio, a structural model is usually required (as with most fixed-income valuation approaches). Unfortunately, this requirement involves making a number of assumptions on the underlying processes which may or may not be reasonable.

In this chapter we take an empirical approach to estimating a conditional hedge ratio for Brady bonds using T-note futures. We take a stand only on what the relevant state variables are, namely, the level of interest rates and the strip spread, but not on the precise functional form of their relation to duration. We implement an out-of-sample experiment, in which we re-estimate the hedge ratio using a moving window of past data, and compare various methods. We show that there is some, albeit limited advantage, to the use of conditioning information, relative to a simpler procedure of reestimating the hedge ratio repeatedly, but without any conditioning on state variables. We interpret these results as a reasonable outcome of the fact that our conditioning state variables are highly persistent. Overall, we find that only a small fraction of the volatility of Brady bonds can be hedged away, and most of the volatility (practically all, for the case of the Brady floater) is asset-specific.

THE HEDGING METHODOLOGY

Theoretical background

How sensitive are Brady bond returns to interest rate changes? Ahn *et al.*, 1997, address this issue in a formal setting; however, to gain some intuition, consider a simple economy in which there is a flat term structure with interest rate r and a constant probability of default p (with no recovery). A fixed-rate bond paying a coupon c with underlying principal F has a present value equal to

$$V = \sum_{t=1}^{T} \frac{C(1-p)^t}{(1+r)^t} + \frac{F(1-p)^T}{(1+r)^T}. \tag{1}$$

The Macaulay duration of the bond is given by the usual formula, i.e.,

$$D_{\text{mac}} \equiv -\frac{\partial V/V}{\partial r/1+r} = \sum_{t=1}^{T} \frac{\text{PV}_t(C)}{V} t + \frac{\text{PV}_T(F)}{V} T, \tag{2}$$

where $\text{PV}_t(\cdot)$ equals the present value of the cash flow in period t, adjusted for the probability of default. Thus, the Macaulay duration is simply a value-weighted sum of the maturities of the bond's cash flows. Both high interest rates and a high probability of default tend to substantially lower the present value of payoffs further in the future, thus reducing the duration of the bond. In fact, changes in the probability of default have much the same effect as interest rate changes, so that the standard convexity results follow.

Although Brady bonds face default, part of their cash flows are generally collateralized by US Treasuries. For example, it is standard to guarantee the principal, and sometimes the more immediate coupon payments (usually 12–18 months worth), using US Treasury strips. As an illustration, consider a fixed-rate bond with guaranteed principal. The valuation equation analogous to equation (1) is

$$V = \sum_{t=1}^{T} \frac{C(1-p)^t}{(1+r)^t} + \frac{F}{(1+r)^T}. \tag{3}$$

Note that the present value of the principal payment no longer depends on the default probability. Consequently, as the probability of default changes, the Macaulay duration of the bond changes in an indeterminate manner.

The above discussion considers a fixed rate Brady bond. However, a number of existing bonds offer floating rates. It is well known that floating rate bonds are relatively insensitive to interest rate changes, as long as the probability of default is not correlated with interest rates. Here, the guaranteed component of Brady bonds dramatically changes this result. As the probability of default increases, only the duration of the guaranteed component matters; thus, in the above example, the Macaulay duration is the maturity of the bond's principal. Therefore, in contrast to the fixed rate bond, the duration of the floating rate note can vary from six months to thirty years, depending on the likelihood of a default. Consequently, hedging floating rate Brady bonds may require substantial positions in the bond market, a vastly different result to that normally found.

METHODOLOGY

Since the interest rate sensitivity of Brady bonds changes with both the term structure of interest rates and the term structure of default probabilities, it is crucial to take these into account when forming the hedged position. The problem of implementing this hedged position is substantial. Specifically, the assumptions of a flat term structure and constant default probability are clearly inconsistent with the data. While models have been developed which generalize this base case (e.g., Cumby and Evans, 1995), these models involve strong parametric assumptions. Thus, the results can be difficult to interpret to the extent that these models are forced to fit the current interest rate and default probability environment.

An alternative method is to allow the model to have more flexibility and to take an empirical approach to estimating the hedge ratio. The difficulty is that, as we have seen, this hedge ratio varies substantially with important economic variables, such as interest rate levels and default probabilities. Thus, standard regression-based hedges will not be sufficient. Here, we take a different approach towards estimating the conditional hedge ratio. Using estimates of conditional comovements between Brady returns and the hedging instrument, we estimate the conditional hedge ratio directly. That is, we estimate the conditional relation between the rate of return on a Brady and the return on, say, a T-note futures, conditional on relevant information available at any point in time. Suppose we are given T observations, $\mathbf{z}_1, \mathbf{z}_2, \ldots, \mathbf{z}_T$, where each $\mathbf{z}_t$ is an m-dimensional vector. Specifically, let $\mathbf{z}_t \equiv (R^{B}_{t,t+j}, R^{TN}_{t,t+j}, \mathbf{x}_t)$, where $R^{B}_{t,t+j}$ and $R^{TN}_{t,t+j}$ are the j-day returns on the Brady bond and T-note futures, respectively, and $\mathbf{x}_t$ is an $(m-2)$-dimensional vector of relevant factors known at time t. Given the discussion above, two prime candidates for the $(m-2)$-dimensional set of variables are the current level of interest rates and some measure of the probability of default (such as the strip spread between the Brady bond's yield on the non-guaranteed portion and US Treasury rates).

There are a variety of methods for calculating the conditional relation between Brady bond returns and the hedging instrument. In particular, we want to estimate the conditional mean, $E[R^B_{t,t+1} \mid R^{TN}_{t,t+1}, \mathbf{x}_t]$, i.e., the expected Brady return given movements in the T-note return, conditional on the current economic state as described by $\mathbf{x}_t$. While there are a number of parametric and nonparametric techniques for estimating conditional means, consider one in particular based on standard regression methods:

$$R^B_{t,t+1} = \alpha + \beta_t R^{TN}_{t,t+1} + \varepsilon_{t,t+1}. \tag{4}$$

One way of estimating β_t is through a Taylor series expansion, that is, $\beta_t = g(i_t, s_t, \tau)$ where i_t is the current interest rate level, s_t is the strip spread, and τ is time-to-maturity. Equation (4) can then be estimated using multivariate linear regression methods.

The interpretation of equation (4) is simple and intuitive. To see this, first consider an empirical duration method in which the Brady bond return is regressed on the T-note futures returns, thus the hedge ratio is the resulting state-independent β coefficient. That is, the hedge ratio is constructed by taking pairs of past Brady and T-note returns, and then equally weighting these pairs' co-movements (in this case, by the variability of the T-note futures return). The problem with this approach is that all observations have equal weight. Thus, in estimating the hedge ratio today, comovements between Brady and T-note returns in high interest rate or high default probability environments get the same weight as in low interest rate or low default probability environments. A static hedge ratio, of course, is not appropriate for hedging Brady bonds.

The dynamic hedging strategy outlined above also has a clear interpretation. The state-dependent hedge ratio, β_t, is estimated by taking past pairs of Brady and T-note futures returns, and then differentially weighting these pairs' co-movements depending on the co-relations between $R^B_{t-i,t+j-i}$, $R^{TN}_{t-i,t+j-i}$ and economic information $\mathbf{x}_{t-i}$. Equation (4) is similar in spirit to a regression hedge, except that the weights are no longer constant, but instead depend on current information. The idea behind this estimation is that these weights are not estimated in an *ad hoc* manner, but instead depend on the true (albeit estimated) relation between the relevant variables. Our approach has a clear advantage over the regression hedge. The hedge ratio in equation (4) explicitly takes into account the current economic state. For example, if interest rates are currently high, but the default probability is low, then more weight will be given to past comovements between Brady and T-note futures returns in those states. Thus, the hedge ratio adjusts to current economic conditions.

Note that equation (4) provides a formula for the hedge ratio between an investor's Brady position and T-note futures. For example, if

$$\beta_t \equiv \frac{\partial E_{[R^B_{t,t+j} \mid R^{TN}_{t,t+j}, \mathbf{x}_t]}}{\partial R^{TN}_{t,t+j}} = 0.5,$$

then for every \$1 of a Brady bond held, the investor should short \$0.50 worth of T-note futures. This hedge ratio will change dynamically, depending on the current economic state described by $\mathbf{x}_t$. In our specific example, the hedge ratio should change in response to changes in the interest rate level and the probability of default.

Empirical analysis

Data description

In this study we employed several data sources over the period July 1992 to March 1996: (i) Brady bond prices of the Argentinian Par bonds (fixed rate) and the Argentinian Discount bonds (floating rate) from a major investment bank in the emerging markets area,[2] (ii) strip spreads for both of these bonds from the same investment bank, and (iii) 10-year T-note futures prices and various term structure information, including the 3-month, 1-year, 5-year and 10-year yields from Datastream.

With respect to the Brady bond data, we collected daily data on two Argentinian bonds: (i) the dollar denominated, \$12.7 billion 30-year Par bond, with fixed rates building up to 6%, and principal and 12 months coupon interest guaranteed by US Treasury strips, and (ii) the dollar denominated, \$4.3 billion 30-year Discount bond, with an floating rate of LIBOR plus 0.8125%, and principal and 12 months coupon interest (at 8%) guaranteed by US Treasuries. Both bonds mature on March 31, 2023. (For more information see Chase, 1995.)

US interest rates and futures returns are taken from Datastream. Specifically, the 1-year and 10-year rates are daily fixed-maturity series, compiled by the Federal Reserve Board of Governors. The 10-year T-note futures return series is a series of nearest to maturity futures, spliced at the last day of the month prior to the expiration month to avoid liquidity-related effects. The maturity effect in the futures contracts (which are issued in a 3 month cycle) may cause a seasonal pattern in the data, although this effect is secondary.[3]

While the Brady market is extremely liquid, data concerns related to non-synchronous quotes across the markets can be somewhat alleviated by using a longer measurement period. Throughout the study we analyzed weekly returns, which strike a reasonable compromise between measurement issues and the relatively small size of our data sample. We used overlapping data in

[2] These results differ somewhat from Ahn *et al.*, 1997, due to the nature of the strip spread calculation. Here our primary interest is in hedging a particular fixed and floating rate issue. For this application, the data from the investment bank is of high quality.

[3] A simple way to see this is by considering the corresponding forward contract, which is, essentially, a long position in a long bond financed by a short position in a short bond (for a long futures position). The first order effect on changes in this forward/futures price will be due to changes in the long rate due to its much higher duration.

Table 1. Summary statistics

	$Di^l_{t,t+5}$	$R^f_{t,t+5}$	i^s_t	i^l_t	$R^{\text{par}}_{t,t+5}$	s^{par}_t	$R^{\text{dis}}_{t,t+5}$	s^{dis}_t
Mean	−0.004	0.033	4.824	6.495	0.227	8.780	0.122	8.733
Std. dev.	0.126	0.842	1.230	0.740	3.386	3.103	3.430	3.207
$Di^l_{t,t+5}$	1.000	−0.943	−0.094	−0.082	−0.493	−0.240	−0.235	−0.238
$R^f_{t,t+5}$	−0.943	1.000	0.093	0.082	0.461	0.225	0.222	0.225
i^s_t	−0.094	0.093	1.000	0.705	−0.051	0.523	−0.081	0.603
i^l_t	−0.082	0.082	0.705	1.000	−0.100	0.238	−0.127	0.276
$R^{\text{par}}_{t,t+5}$	−0.493	0.461	−0.051	−0.100	1.000	0.210	0.830	0.198
s^{par}_t	−0.240	0.225	0.523	0.238	0.210	1.000	0.121	0.983
$R^{\text{dis}}_{t,t+5}$	−0.235	0.222	−0.081	−0.127	0.830	0.121	1.000	0.147
s^{dis}_t	−0.238	0.225	0.603	0.276	0.198	0.983	0.147	1.000

Summary statistics are provided regarding the Argentinian Par and Discount Brady bonds, and relevant state variables. Return data are for weekly changes, overlapping daily. The sample period is 10/15/1992 to 2/22/1996. The variables are: $Di^l_{t,t+5}$ the weekly change in the 10-year US par yield, $R^f_{t,t+5}$ the return on 10-year T-note futures, i^s_t the 1-year US par yield, i^l_t the 10-year US par yield, $R^{\text{par}}_{t,t+5}$ the return on the Brady Par bond, s^{par}_t the Brady Par bond strip spread, $R^{\text{dis}}_{t,t+5}$ the return on the Brady Discount bond, s^{dis}_t the Brady Discount bond strip spread.

order to use all available information, and where necessary, we adjusted for the overlap.

Table 1 provides basic summary statistics for our dataset. During the sample period (October 15 1992 to February 22 1996), there was an average weekly gain in both the Par and the Discount bonds of 0.23% and 0.12%, respectively. Some of this return can be attributed to the decline in US interest rates, and the rest to an improvement in the perceived credit worthiness of Argentina's debt.

The standard deviations of returns on both bonds are approximately 3.4% per week, about four times larger than the volatility of the corresponding T-note futures contract (with a return standard deviation of 0.84% per week). These standard deviations give us a preview of the results to follow, namely, that most of the variation in Brady bond prices will not be explained by variation in US Government bond returns or related derivatives. To see this, we simply need to recognize that the typical asset underlying a T-note futures contract is a par coupon-bearing US government bond, with cash flows which are fairly similar to the promised cash flows of the Argentinian Par bond. However, this Brady bond is much more volatile, and its correlation with the T-note futures contract is only 0.46. At the same time, the Argentinian Par bond is as volatile as the Argentinian Discount bond, and the correlation between the two Brady bonds is 0.83. This immediately indicates that sovereign risk is causing most of the variation, not dollar interest rate risk.

The volatility of Brady bond returns over our sample period can be largely attributed to the events that took place at the end of 1994. The collapse of the Mexican peso, and with it the decline in the perceived credit worthiness of Mexican sovereign and Brady debt, had large spillover effects throughout South

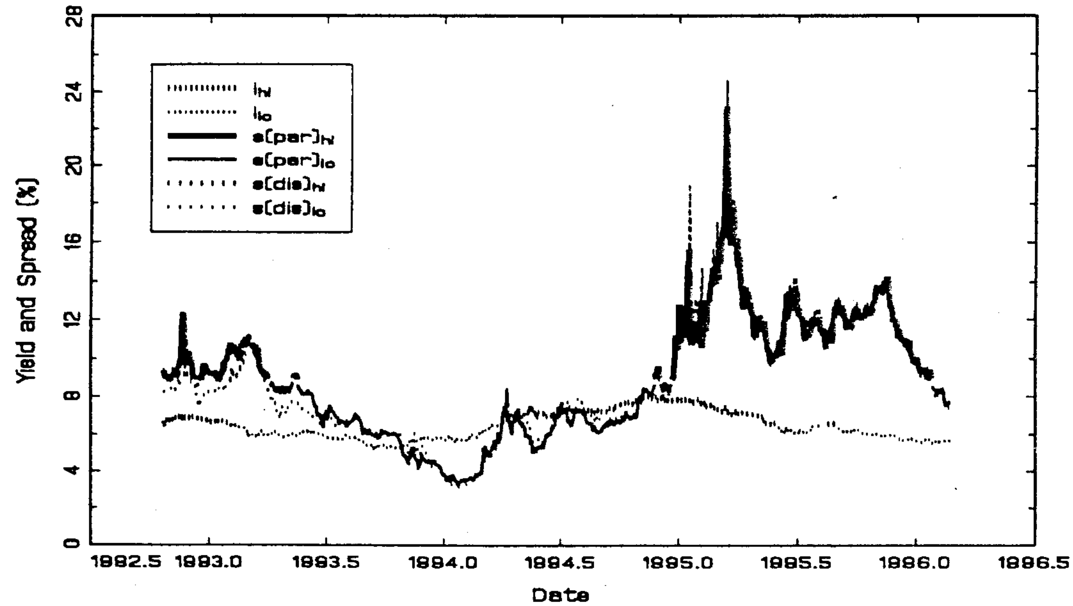

Figure 1. The strip spreads on Argentinian Par and Discount Brady bonds and the 10-year US Government par yield. The thick lines denote that the series is above its sample mean.

America. Specifically, during the half year surrounding the collapse of the Mexican Peso (most of which occurred during last weeks of 1994 and January 1995), the credibility of the Argentinian Peso's peg to the dollar became doubtful. The resultant impact on Argentinian Brady bonds was due to a perceived increase in the default probability. This is apparent in Figure 1, which depicts the path of the strip spreads of the Argentinian Par and Discount bonds.[4] The strip spread rose from about 6% prior to the event, to an average level of over 12%, with strip spreads as high as 20% or more at times.

Out-of-sample hedging

In this section we provide the results from a rolling out-of-sample hedging experiment, as outlined above. Specifically, for every date in our sample starting from the 251st date onward, we used the previous 250 observations (approximately one year of trading data) on Brady returns and T-note futures returns in order to determine the appropriate hedge ratio based on the covariance and variances of the variables. We also determined a state-dependent hedge ratio, which depends on the strip spread, the yield of the 10-year US government

[4] The strip spread is obtained in the following manner. Using a zero curve imputed from prices of US government bonds, the guaranteed payments of a given Brady bond are stripped off. The strip spread is then the difference between the default-free yield on the promised payments, and the defaultable yield given the value of the stripped bond. Some subtle issues arise with respect to the proper calculation given the rolling guarantee, which gives rise to some differences in strip spread calculations across methods. Irrespective of the method of calculation, however, the strip spread is the single best summary statistic for the market-perceived average default probability throughout the remaining life of the Brady bond.

par bond, and the Brady's time to maturity. We did so repeatedly using the 250-day window until the last day in our sample.

We experimented with a number of specifications for the functional form and the relevant conditioning variables in estimating the conditional hedge ratio, β_t. Our benchmark is a state-independent (although not time invariant) hedge ratio, which is estimated repeatedly but without any conditioning on the relevant state variables. We then assume that the function $\beta_t = g(i_t, s_t, \tau)$ is a linear function of these variables, and consider hedging first using i_t only, then adding s_t to the set of conditioning information, and last, the time to maturity τ. We also allowed for non-linearities by considering a second order Taylor expansion on the most interesting set of conditioning information, namely i_t and s_t. This expansion involves the addition of squared and interaction term of these variables (three additional variables in total) to the original set of two conditioning variables.

Table 2 documents results for the Par and Discount Brady bonds respectively. For each of the hedging procedures considered we provide two summary statistics. First we document the volatility of the returns on a hedged portfolio which involves a long position in the relevant Brady bond, hedged by the appropriate short position in 10-year T-note futures. The goal is to minimize the volatility of hedged returns. The second statistic is the correlation coefficient between hedged returns and the contemporaneous change in the 10-year rate. Since our experiment is conducted as an out-of-sample experiment, we are not guaranteed orthogonality between the hedging errors and interest rate changes. As pointed out in the introduction, one might consider the ability to hedge a specific source of risk, interest rate risk in our case, important.

With respect to hedging the Par bond, the total unhedged standard deviation of returns was 3.68% per week, and the correlation between returns and interest

Table 2. Hedging results for the Par and Discount Brady bonds respectively, using 10-year T-note futures contracts

		Conditioning information				
	Unhedged	*None*	i^l_t *linear*	i^l_t, s_t *linear*	i^l_t, s_t *Taylor*	i^l_t, s_t, τ *linear*
Argentinian Par bond						
$\sigma(\varepsilon_{t,t+5})$	3.676	3.092	3.136	3.087	3.275	3.094
$\rho(\varepsilon_{t,t+5}, Di^l_{t,t+5})$	−0.556	−0.104	−0.010	0.096	0.096	0.018
Argentinian Discount bond						
$\sigma(\varepsilon_{t,t+5})$	3.797	3.659	3.714	3.626	3.823	3.617
$\rho(\varepsilon_{t,t+5}, Di^l_{t,t+5})$	−0.296	−0.045	−0.010	0.155	0.101	0.079

Out-of-sample hedging errors are analyzed for the hedge regression $R^B_{t,t+5} = \alpha + \beta_t R^{TN}_{t,t+5} + \varepsilon_{t,t+5}$. At any given date starting the 251st date, the previous 250 daily observations are used for estimation. The hedge ratio β_t is allowed to depend linearly or nonlinearly on conditioning information. Two summary statistics are recorded: (i) hedged return volatility, and (ii) *ex post* correlation of the hedging error with changes in the 10-year par yield.

rate changes was -0.56. These numbers correspond closely, although not exactly, to the numbers in Table 1, due to the 'missing' 250 days upfront in the results of this section. The standard error using the state independent hedging method was reduced to 3.09%, and the correlation reduced to -0.10. With respect to the state-dependent hedge ratio results, the results overall can be considered disappointing. Using the 10-year rate as a single conditioning variable yields a standard deviation of 3.14% and the correlation of hedging errors with interest rate changes is -0.01. On the positive side, conditioning on the level of interest rates reduces whatever correlation with interest rate changes was left over from the unconditional hedge. This comes at the cost of increasing the variability of hedged returns.

Adding the spread to the set of conditioning information should, according to our theory, help to pin down the appropriate duration/hedge ratio. Indeed this bivariate hedge does yield the lowest return volatility (3.087%), but the improvement is hardly significant from an economic perspective. A Taylor expansion of the two-variable conditioning set provides no benefit, and, in fact, increases the return volatility (3.28%). This latter result is simply an artifact of estimation error, exacerbated by the highly volatile spread.

The results for the Discount bond were worse. There was very little, if any, reduction in the return volatility, and the only reduction was in the correlation coefficient between hedged returns and interest rate changes. This outcome would not be too surprising if the default probability was very low, since a default-free floater should exhibit very little volatility. However, the magnitude and variation of the strip spread suggest that conditioning on this variable should produce a viable hedge. Consequently, the empirical results are disappointing.

The results for both the Par and the Discount bonds are qualitatively robust to (i) the length of conditioning period, (ii) the hedging horizon, (iii) the specific subperiods, and (iv) the addition of the 1-year US interest rate to the set of conditioning variables. We also experimented with smoothing methods, which allow the state-dependent hedge ratio to vary more 'sluggishly'. Specifically, we considered an exponentially smoothed hedge ratio, with various smoothing parameters. Another refinement which we considered was the use of Stein estimators.[5] The results were not remarkably different for either of these attempted improvements.

Conclusion

Our empirical results and their weak link to the theory illustrate the difficulty in hedging Brady bonds. From an asset pricing perspective the results pose a

[5] Stein estimators are also known as 'shrinkage' estimators. They adjust for the signal to noise ratio by appropriately shrinking the hedge ratio. Stein estimators are often used by practitioners in the context of fixed income securities hedging and portfolio analysis (for a technical discussion see Judge *et al.*, 1985).

challenge, and perhaps an opportunity. They call for a further investigation of the appropriate missing variables and/or trading opportunities.

From a practical standpoint, the results in this paper provide one way to interpret the seemingly myopic hedging approach common to practitioners. It is quite common for investors to simply strip off the Brady bond's guaranteed component by taking a short position in a set of zeros corresponding to the set of guaranteed payments. Given our results, such a myopically hedged position would come close to being a pure 'sovereign play'.

The results in this paper also have interesting implications from a risk management perspective. They demonstrate the weak link which some dollar denominated bonds may have to the returns on US government bonds. (The high yield debt area may provide similar results.) Only 20–40% of the variation in Brady prices can be attributed to changes in dollar discount rates. Such low explanatory power has meaningful implications for the appropriate value at risk numbers of trading groups and some financial institutions with high stakes in any one specific market.

References

Ahn, D.-H., J. Boudoukh, M. Richardson and R.F. Whitelaw (1997). *The Interest Rate Risk of Brady Bonds.* Working paper, University of North Carolina, Chapel Hill and New York University.

Chase Manhattan (1995). *The Emerging Markets Handbook.*

Cumby, R. and M. Evans (1995). *The Term Structure of Credit Risk: Estimates and Specification Tests.* Stern School of Business, Economics Department working paper EC-95-14.

Judge, G., W.E. Griffiths, C. Hill, H. Lutkepohl and T.-C. Lee (1985). *The Theory and Practice of Econometrics.* New York: John Wiley and Sons.

Nadler, D., P. Tsoucas and C. Wierzynski (1996). *Brady Bond Valuation and the Universe of Credit Term Structures.* Goldman Sachs Fixed Income Research Series.

Telljohann, K. (1994). *Quantifying and Isolating the US Interest Rate Component of a Brady Par Bond.* Chicago Board of Trade working paper.