Analyzing structural change in the secondary market for developing-country debt: a translog approach

Thomas J. Webster[§]
Michael Szenberg[¤]

RESUMO

O trabalho examina as mudanças nas relações de preços relativos entre instrumentos de débito externo latino-americanos, com o uso de uma função de utilidade translogarítmica. Um exame dos dados de preços e dívida externa para cinco países latino-americanos altamente endividados, no período janeiro de 1986 a dezembro de 1993, sugere que o Plano Brady provavelmente afetou as decisões de diversificação de portfólio de investidores em instrumentos de dívida externa de países em desenvolvimento, acelerando os retornos de Argentina, Brasil, México e Venezuela à credibilidade internacional. Este estudo encontrou que, como resultado de melhoria nas performances de crédito e as mudanças estruturais resultantes no mercado secundário para dívidas de países em desenvolvimento, os instrumentos de dívida externa de quatro em cinco países latino-americanos devedores examinados neste estudo tendem a tornar-se mais substituíveis entre si, quando mantidos em um portfólio fracamente separável.

Palavras-chave: dívida, países em desenvolvimento, translogaritmo, mercado secundário.

ABSTRACT

This paper examines changes in the relative price relationships between Latin American external debt instruments with the use of a translogarithmic utility function. An examination of price and external debt data for five heavily indebted Latin American countries over the period January 1986 to December 1993 suggests that the Brady Plan probably affected the portfolio diversification decisions of investors in developing-country external-debt instruments by accelerating the return of Argentina, Brazil, Mexico and Venezuela to international credit worthiness. This study found that as a result of improved credit ratings and the resulting structural change in the secondary market for developing country debt, the external-debt instruments of four of five Latin American debtor countries examined in this study tended to become more substitutable with each other when held in a weakly separable portfolio.

Key words: debt, developing-country, translog, secondary-market.

---

§ Department of Finance and Economics, Lubin School of Business, Pace University.

¤ Department of Finance and Economics, Lubin School of Business, Pace University.

Recebido em outubro de 1997. Aceito em janeiro de 1998.

I Introduction

The secondary market for developing country debt is one of the fastest growing segments of the fixed-income securities market. From 1988 to 1992, for example, secondary -market transaction volume grew more than $150 billion, to nearly $200 billion. Although many of these loans were converted into bonds backed by the U.S. Treasury bonds, secondary-market prices continued to be characterized by extreme volatility.

Developing-country debt primarily represents troubled or non-performing commercial-bank loans to developing countries.[1] Most of these loans were extended to Latin American countries in the late-1970's and early-1980's in the wake of the first and second oil-price shocks. The formidable external debt burden of many developing countries has been the subject of intense analytical scrutiny since 1982 when Mexico suspended principal repayments on official international commercial-bank debt. This action also marked the onset of what came to be known as the international debt crisis.[2]

Largely in response to the promulgation of debt-for-equity swaps offered by debtor countries to reduce dollar-denominated foreign commercial-bank debt, which was preceded by commercial banks portfolio adjustment and widespread dumping of debt paper, an active secondary market for developing country debt evolved. To avoid the chronic rescheduling episodes that plagued the debt-management process, large money-center commercial banks began to securitize developing country loans into more easily tradable bonds. This trend was accelerated in March 1989 when U.S. Treasury Secretary Nicholas Brady announced that financial support from the IMF, the World Bank, the Inter-American Development Bank and the government of Japan would be used to negotiate reductions in loan principal and debt service.

Under the Brady Plan, commercial-bank loans to Mexico were swapped for tradable bonds that either paid lower interest, or were set at less than the loans' face value. The main variants of these "Brady bonds" were 30-year conversion bonds that either kept full face value and paid reduced interest rates (par bonds), or called for a one-third reduction in the face value of the debt but kept LIBOR-based interest rates (discount bonds). Principal and typically 18 months' interest were collateralized, with most packages offering the alternative of new money.

---

1 Developing country debt primarily represents troubled or non-performing commercial bank loans made primarily to Latin American countries in the wake of the first and second oil price shocks in the mid- and late-1970's.

2 The belief that this crisis threatened the stability of the international financial system led to a number of innovative debt reduction schemes, included debt-for-equity swaps, debt-for-debt swaps, debt buy-backs, and debt-for-bond swaps.

The Brady Plan enabled primarily Latin American countries to exchange their commercial-bank debt at a discount for new bonds or at par for bonds carrying reduced rates of interest, or both. The attraction of these arrangements was that interest and principle were guaranteed by U.S. Treasury bonds held by the Federal Reserve. Under Brady-plan restructurings the U.S. government effectively underwrote debtor countries' default and rescheduling risks. Table 1 summarizes the Brady bonds outstanding as of year-end 1994.

It is a well established tenet of finance theory that default risk is a distinguishing characteristic of financial assets (Weston and Brigham, 1993). Cash holdings, for example, are considered riskless and perfectly liquid. While U.S. government securities are subject to market risk, they are considered free of default risk. Corporate bonds, on the other hand, are "graded" according to the specific risks associated with nominal debt servicing.

Table 1
Brady Bonds Outstanding
($ Billions)

Country/Sector	Issue Date	Amount
Argentina	April 1993; October 1993	$25.3
Brazil	November 1992, April 1994	49.5
Bulgaria	July 1994	4.8
Costa Rica	May 1990	0.5
Dominican Republic	August 1994	0.5
Jordan	December 1993	0.8
Mexico	March 1990	23.6
Nigeria	January 1992	2.0
Philippines	May 1990, December 1992	3.7
Poland	October 1994	7.5
Uruguay	February 1991	1.0
Venezuela	December 1990	16.6
Fixed-Rate	--	65.9
Floating-Rate	--	69.9
Latin	--	117.0
Non-Latin	--	18.8
Total	**--**	**$135.8**

Moody's Investor Service rates the investment grade of bonds based upon the probability of default. A Moody's Aaa rated corporate bond, for example, is considered by the market to be superior to Aa, A, Baa, Ba, B, Caa, or C rated corporate bonds. These ratings reflect the underlying financial strength of the institution and expectations regarding future nominal debt servicing. While Aa rated bonds are not perfect substitutes for Aaa rated bonds, they are more substitutable than Caa rated bonds because they share a greater number of investment grade characteristics.

Economic theory argues that assets with similar characteristics (real or perceived) are more substitutable than are those with dissimilar characteristics. A reduction in default risk for any particular class of debt instruments more homogeneous and, therefore, more substitutable. The Brady Plan enabled many Latin American countries to exchange their value-impaired commercial-bank debt at a discount for new bonds in which interest and/or principle is guaranteed by U.S. Treasury bonds held by the Federal Reserve. Under Brady-plan restructurings the U.S. government effectively underwrites debtor countries' default and rescheduling risks. In terms of bond ratings, these have the effect of upgrading developing country debt from substandard or speculative status to investment grade status. In other words, the external debt of Latin American debtor countries became more similar, i.e. substitutable, as a consequence of issuing Brady bonds. In fact, according to some traders, the liquidity of some Brady bonds were rated second only to that of U.S. Treasury securities.

Since the original Mexican restructuring, at least eleven other countries restructured some of their external debt obligations under the Brady Plan. By year-end 1994, nearly $140 billion worth of "Brady bonds" had been issued, with total secondary-market transaction volume in excess of $1 trillion, compared with about $500 billion in 1992.

As with all debt instruments, a reduction in default risk is matched by a reduction in the asset's risk premium and expected yield, and an increase in the secondary market price. Other things equal, including risk preferences, this would result in a decline in demand by investors with a higher risk-return preference. On the other hand, a general reduction in perceived risk tends to make financial assets more attractive to relatively risk-adverse investors. This suggests that a reduction in default risk tends to make assets with similar risk-return characteristics more homogeneous and, therefore, more substitutable.

The purpose of this study is to investigate changes in the relative price relationships between Latin American external debt instruments resulting from the implementation of the Brady Plan. This paper uses a translogarithmic utility function to examine whether changes in risk premiums resulting from Brady-plan restructurings resulted in a structural change in the secondary market

for Latin American debt by altering relative price relationships between Latin American external debt instruments. Own- and cross-price elasticities of demand are examined to ascertain whether debt for bond conversions under the Brady Plan significantly altered investor attitudes towards investing in Latin American external debt instruments.

II Translog utility function

The transcendental logarithmic (translogarithmic or translog) indirect utility function (Christensen, Jorgenson, and Lau, 1971), which is one of the most widely used functional forms in empirical demand estimation, is extremely flexible in that it is a second-order local approximation of an arbitrary indirect utility function. This paper assumes that investors' utility is a function of a portfolio of $n+m$ financial assets and V the market value of the portfolio, which may be characterized as

$$(1) \qquad U=U(\varsigma_1,\ldots, \varsigma_n, \varsigma_{n+1},\ldots, \varsigma_{n+m}, V)$$

If we assume that investment instruments ς_{n+1} through ς_{n+m} represent a weakly separable class of financial assets then Equation (1) may be rewritten as

$$(2) \qquad U=U\{\varsigma_1,\ldots, \varsigma_n, V, \Phi(\varsigma_{n+1},\ldots, \varsigma_{n+m}, V)\}$$

Assuming that the investor's objective is to maximize the value of Φ, then the indirect objective function may be rewritten as

$$(3) \qquad \Phi(\rho)=\Phi^*\{\varsigma_{n+1}(\rho_{n+1},\ldots, \rho_{n+m}),\ldots,\varsigma_{n+m}(\rho_{n+1},\ldots, \rho_{n+m}), V\}= \Phi^*(\rho_{n+1},\ldots, \rho_{n+m}, V)$$

where $\rho_{n+1},\ldots, \rho_{n+m}$ are m parameters representing prices of financial instruments in the portfolio. $\Phi(\rho)$ is the maximum value of Φ^* for any specified constellation of $\rho_{n+1},\ldots, \rho_{n+m}$. This function is assumed to be monotonic, quasi-concave, and homogeneous of degree one.

The basic translog specification is given by

$$(4) \qquad ln\Phi^*(\rho_{n+1},\ldots, \rho_{n+m}, V) = -\Sigma_j \alpha_j ln(\rho_j/V) + \tfrac{1}{2}\Sigma_k\Sigma_j\beta_{kj} ln(\rho_k/V)ln(\rho_j/V)$$

where $\Sigma_j\alpha_j = 1$ and $\beta_{kj} = \beta_{jk}$. Equation (4) may be rewritten as

$$(5) \qquad ln\Phi^* = \ln V -\Sigma_j\alpha_j ln\rho_j + \tfrac{1}{2}\Sigma_k\Sigma_j\beta_{kj}(ln\rho_k \quad lnV)(ln\rho_j - ln/V)$$

It is often more convenient to work with expenditure share equations instead of demand equations using translog specifications. Noting that

$$(6) \qquad (\partial ln\Phi^*/\partial ln\rho_i)/(\partial ln\Phi^*/\partial ln V) = \{(\partial\Phi^*/\partial\rho_i)/(\partial\Phi^*/\partial V)\}\{(\rho_i/\Phi^*)(V/\Phi^*)$$

The shares S_i can be obtained after logarithmically differentiating Equation (6):

$$(7) \qquad S_i = (\alpha_i + \Sigma_j\beta_{ij} ln(\rho_j/V)/(1 + \Sigma_k\Sigma_j\beta_{kj} ln(\rho_j/V); I = 1, ..., n$$

A special case of the basic translog specification is the homothetic translog function, which is obtained by imposing the restriction that

$$(8) \qquad \Sigma_j\beta_{kj} = 0; k = 1,..., n$$

Homothetic functions preserve the property that the slopes along a radial blowup of the level curves remains unchanged. In the present context this is equivalent to the assertion at investors preferences are invariant with respect to the size (value) of the portfolio.

With these n restrictions the translog indirect utility function and share equations are

$$(9) \qquad ln\Phi^* = ln V - \Sigma_j\alpha_j ln\rho_j + \tfrac{1}{2}\Sigma_k\Sigma_j\beta_{kj} ln\rho_k ln\rho_j$$

Note also that the indirect utility function of Equation (9) can be inverted to obtain the homothetic translog expenditure function:

$$(10) \qquad ln V^*(\rho_{n+1},..., \rho_{n+m}, \Phi) = ln\Phi + \Sigma_j\alpha_j ln\rho_j + \tfrac{1}{2}\Sigma_k\Sigma_j\beta_{kj} ln\rho_k ln\rho_j$$

Applying Shephard's Lemma (Shephard, 1970) the portfolio share equations become:

$$(11) \qquad S_i = \alpha_i + \Sigma_j\beta_{ij} ln\rho_j, \quad I = 1, ..., n$$

Equation (11) indicates that the portfolio shares, S_i, are functions of asset prices and independent of the value of the portfolio, which confirms that investor preferences are homothetic.

Latin American external debt represents a unique class of financial assets because of similar (albeit not identical) socioeconomic, cultural, political, historical traditions. The so-called international debt crisis in large part was a consequence of the first and second oil- price "shocks" of the mid- and late-1970s and the ensuing petrodollar recycling episode. For this

reason, as well as for analytical convenience, we have assumed that a portfolio of Latin American external debt instruments represents a such a weakly separable class of financial assets. With this proviso, equation (3) may be rewritten as

$$(12) \qquad \Phi(\rho)=\Phi^*(\rho_A, \rho_B, \rho_C, \rho_M, \rho_V, V)$$

where ρ_A, ρ_B, ρ_C, ρ_M, and ρ_V represent secondary market loan discounts for privately held, external debt instruments of Argentina, Brazil, Chile, Mexico, and Venezuela, respectively, and V represents the value of the portfolio. The elasticities of substitution between the corresponding investments can be determined directly from the special case of the indirect, homothetic, investor utility function. Adding stochastic error terms to Equation (11) yields the simultaneous system:

$$(13a) \qquad S_A=\alpha_A+\beta_{AA}ln\rho_A+\beta_{AB}ln\rho_B+\beta_{AC}ln\rho_C+\beta_{AM}ln\rho_M-(\beta_{AA}+\beta_{AB}+\beta_{AC}+\beta_{AM})ln\rho_V+e_A$$

$$(13b) \qquad S_B=\alpha_B+\beta_{AB}ln\rho_A+\beta_{BB}ln\rho_B+\beta_{BC}ln\rho_C+\beta_{BM}ln\rho_M-(\beta_{BA}+\beta_{BB}+\beta_{BC}+\beta_{BM})ln\rho_V+e_B$$

$$(13c) \qquad S_C=\alpha_C+\beta_{AC}ln\rho_A+\beta_{BB}ln\rho_B+\beta_{BC}ln\rho_C+\beta_{CM}ln\rho_M-(\beta_{BA}+\beta_{BB}+\beta_{BC}+\beta_{BM})ln\rho_V+e_C$$

$$(13d) \qquad S_M=\alpha_M+\beta_{AM}ln\rho_A+\beta_{BM}ln\rho_B+\beta_{MC}ln\rho_C+\beta_{MM}ln\rho_M-(\beta_{AM}+\beta_{BM}+\beta_{MC}+\beta_{MM})ln\rho_V+e_M$$

$$(13e) \qquad S_V=\alpha_V+\beta_{AV}ln\rho_A+\beta_{VB}ln\rho_B+\beta_{VC}ln\rho_C+\beta_{VM}ln\rho_M-(\beta_{AV}+\beta_{VB}+\beta_{VC}+\beta_{VM})ln\rho_V+e_V$$

where S_A, S_B, S_C, S_M, and S_V represent the ratios of secondary-market external-debt transaction volume for Argentina, Brazil, Chile, Mexico, and Venezuela to total Latin American secondary-market external-debt transaction volume. The slope coefficients of Equations (13a-e) represent first partial derivatives of market shares with respect to the natural logs of secondary market prices. In other words, β_{kj} represents the change in market share of asset k given a percentage change in the price of asset j.

The assumption of weak separability implies that the shares S_A, S_B, S_C, S_M, and S_V sum to unity.[3] One of these equations, therefore, may be eliminated to derive efficient estimators for

3 According to *Latin Finance*, from 1989 until 1993 more than 95 percent of Latin American secondary-market transaction volume involved the external debt issues of Argentina, Brazil, Chile, Venezuela, and Mexico.

the remaining four equations. Zellner's Iterative Seemingly Unrelated Regression (ITSUR), which is equivalent to maximum likelihood estimation, was used to generate parameter estimates.(Zellner, 1962)[4]

The Allen-Uzawa partial elasticities of substitution between investment instruments may be estimated as:

$$\varepsilon_{kj}=(\beta_{kj}+S_kS_j)/S_kS_j;\ k,j = A, B, C, M, V \tag{14a}$$

$$\varepsilon_{kk}=(\beta_{kk}+S_k^2-S_k)/S_k^2;\ k,j = A, B, C, M, V \tag{14b}$$

The price elasticities of demand for investment instruments are given as

$$\eta_{kj}=S_j\varepsilon_{kj},\ k,j = A, B, C, M, V \tag{15}$$

III Data

To test for structural change in the secondary market for developing-country debt, this paper examined secondary-market developing-country external-debt prices for five heavily indebted developing countries (Argentina, Brazil, Chile, Mexico, and Venezuela), which were actively traded during the period January 1986 to December 1993. Average monthly developing country debt prices primarily were obtained from *Emerging Markets Update*, which is published by Morgan Guaranty Trust Company.

In the aggregate, total outstanding external debt must be held as a portion of investors' portfolios. Data on total outstanding sovereign external debt, including loans from private banks and other private financial institutions, and publicly issued or privately placed bonds, which were used to calculate investor portfolio shares, were obtained from the *World Debt Tables* (published by the International Monetary Fund).

4 ITSUR may be applied when a multi-equation system consists of a series of endogenous variables that are considered as a group because they bear a close conceptual relationship with each other. The application of ITSUR is appropriate when the error terms are correlated.

IV Empirical results

Structural stability

To test the hypothesis that the Brady-plan restructurings altered the relative price relationships between Latin American external-debt instruments, it is necessary to establish that the secondary market for developing-country debt underwent structural change. Equations (13a-e) suggest that portfolio shares are simultaneously determined. It is, therefore, only necessary to demonstrate that at least one of the estimated equations exhibited structural change between the two sampling sub-periods considered in this study. Equation 13(e) was eliminated and efficient parameters were estimated for Equations (13a-e).

The choice of the sub-periods chosen for estimation purposes was somewhat arbitrary, and largely was dictated by data considerations. Although the Brady Plan was announced in March 1989, the first Brady bonds (on behalf of Mexico) were not issued until a year later. Although it is very likely that investors altered their portfolio decisions sometime before then, January 1986 to February 1990 nonetheless was chosen as the initial sampling period.

While it would have been preferable to re-estimate the model following each new Brady bond restructuring, this approach was rejected because of statistical difficulties associated with reduced degrees of freedom. In spite of this, March 1990 to December 1993 was chosen as the second sampling sub-period, although further research in this area is clearly suggested.

The Chow test is a popular test of structural stability.[5] This statistic tests the null hypothesis of structural stability against the alternative hypothesis of no structural stability. If the measured F-statistic (F_m) is greater than its critical value (F_c) at k and n_1+n_2-2k degrees of freedom then we reject the null hypothesis in favor of its alternative. The critical F-value for 18 and 60 degrees of freedom at the 95 percent and 99 percent confidence levels are 1.8 and 2.3, respectively. Table 2 summarizes the measured F statistics for equations 7(a)-7(d).

---

5 The Chow test is given by the expression:

$$F_{(k,\ n1+n2-2k)}=\{(S_i \quad S_i')/k\}\{S_i'/(n_1+n_2-2k)\}^{-1}$$

where n_1 is the number of observations in the pre-Brady Plan period (January 1986 to February 1989), n_2 is the number of observations in the post-Brady Plan period (March 1989 to December 1992), k is the number of parameter estimates, S_i is the error variations for the entire sampling period and S_i' is the combined error variation for the two sub-periods.

The results presented in Table 2 would lead us to reject the null hypothesis of structural stability at traditional confidence levels for S_A and S_M. The estimated equation explaining shares of Chilean debt as a function of external debt prices appears to have been unaffected by the Brady-plan restructurings, perhaps because only Chilean debt traded at or near par value during the entire sampling period.

Table 2
Chow Test of Structural Stability

Equation	F_m
S_A	4.58
S_B	2.00
S_C	0.85
S_M	8.63

Parameter estimates

Table 3 represents the final ITSUR parameter estimates for the two sampling periods. The *t*-statistics (in parentheses), root mean squared errors (*RMSE*), and the adjusted coefficients of determination (*Adj.* R^2) for each equation are also presented. The results presented in Table 3 support the hypothesis that the demand for Latin American external-debt assets was functionally related to all secondary-market external-debt prices. The only exception appears to be the statistically insignificant relationship between Brazilian portfolio shares and Venezuelan external-debt prices for the period March 1990 to December 1993.

Table 3
ITSUR Parameter Estimates of the Indirect Utility Function; Total Outstanding External Debt Shares: January 1986-February 1990 and March 1990-December 1993

Parameter	January 1986-February 1990	March 1990-December 1993
α_A	0.191 (7.71)	0.300 (12.38)
α_B	0.329 (7.70)	0.152 (1.95)
α_C	-0.001 (-0.41)	0.159 (4.39)
α_M	0.177 (3.34)	0.199 (3.88)
β_{AA}	0.092 (26.30)	0.106 (52.72)
β_{AB}	-0.054 (-9.75)	-0.031 (-13.49)
β_{AC}	0.003 (1.67)	-0.004 (-8.72)
β_{AM}	-0.030 (-5.71)	-0.053 (-19.71)
β_{AV}	-0.019 (-4.38)	-0.045 (-7.66)
β_{BB}	0.246 (16.85)	0.179 (22.61)
β_{BC}	-0.020 (-6.27)	-0.012 (-6.52)
β_{BM}	-0.116 (-11.40)	-0.091 (-15.17)
β_{BV}	-0.059 (-6.48)	-0.004 (-0.22)
β_{CC}	0.070 (13.39)	0.017 (21.06)
β_{CM}	-0.19 (-3.80)	-0.002 (-1.65)
β_{CV}	-0.016 (-3.27)	-0.019 (-2.20)
β_{MM}	0.231 (17.24)	0.214 (31.86)
β_{MV}	-0.028 (-2.96)	-0.046 (-3.76)
RMSE (S_A)	0.0043	0.0037
RMSE (S_B)	0.0001	0.0164
RMSE (S_C)	0.0023	0.0076
RMSE (S_M)	0.0076	0.0099
Adj. R^2 (S_A)	0.9782	0.9887
Adj. R^2 (S_B)	0.9053	0.9389
Adj. R^2 (S_C)	0.9638	0.9293
Adj. R^2 (S_M)	0.9556	0.9286

Partial elasticities of substitution

The estimated partial elasticities of substitution for the periods January 1986-February 1990 to March 1989-December 1993 are presented in Table 4. A positively (negatively) signed partial elasticity of substitution suggests that the specified assets were substitutes (complements).

Table 4
ITSUR Estimated Allen-Uzawa Partial Elasticities of Substitution via the Translog Indirect Utility Function: January 1986-February 1990 and March 1990-December 1993

Month	ε_{AB}	ε_{AC}	ε_{AM}	ε_{AV}	ε_{BC}	ε_{BM}	ε_{BV}	ε_{CM}	ε_{CV}	ε_{MV}
Jun 1986	-0.02	1.34	0.34	0.15	0.07	-0.14	-0.18	-0.04	-0.80	0.32
Dec 1986	0.05	1.33	0.31	0.15	0.14	-0.16	-0.16	-0.09	-0.80	0.26
Jun 1987	-0.17	1.40	0.43	0.11	-0.18	-0.09	-0.36	-0.01	-1.09	0.41
Dec 1987	-0.25	1.39	0.35	0.01	-0.00	-0.06	-0.30	0.10	-0.84	0.41
Jun 1988	-0.47	1.45	0.18	-0.22	0.14	0.00	-0.21	0.17	-0.66	0.41
Dec 1988	-0.60	1.46	0.11	-0.37	0.21	0.02	-0.22	0.24	-0.59	0.40
Jun 1989	-0.83	1.45	0.07	-0.55	0.26	0.03	-0.30	0.35	-0.46	0.42
Dec 1989	-0.96	1.31	0.30	-0.01	0.13	-0.25	-0.42	0.46	-0.02	0.55
Feb 1990	-1.67	1.57	-0.28	-1.00	0.33	0.03	-0.22	0.44	-0.17	0.49
Mar 1990	-0.57	0.44	-0.77	-2.39	0.56	0.09	0.91	0.95	-0.08	0.31
Jun 1990	-1.01	0.40	-0.59	-2.55	0.44	0.02	0.88	0.95	-0.14	0.39
Dec 1990	-0.20	0.62	-0.16	-1.05	0.45	-0.10	0.89	0.95	-0.08	0.31
Jun 1991	-0.09	0.58	-0.23	-1.24	0.49	0.01	0.90	0.94	-0.21	0.28
Dec 1991	-0.01	0.66	0.05	-0.74	0.38	-0.15	0.89	0.94	-0.23	0.30
Jun 1992	0.20	0.71	0.16	-0.69	0.41	-0.13	0.88	0.94	-0.45	0.16
Dec 1992	0.04	0.71	0.20	-0.75	0.35	-0.20	0.86	0.94	-0.37	0.23
Jun 1993	0.37	0.61	-0.13	-1.52	0.56	0.14	0.90	0.92	-1.04	-0.22
Dec 1993	0.55	7.69	0.10	-1.31	9.05	0.28	0.90	2.69	-48.86	-0.31

The results presented in Table 4 suggests that by December 1993 seven of ten asset pairs examined (Argentina-Brazil, Argentina-Chile, Argentina-Mexico, Brazil-Chile, Brazil-Mexico, Brazil-Venezuela, and Chile-Mexico) could be characterized as substitutes, as compared with five of ten in the months preceding the issuance of the first Brady bonds for Mexico in March 1990. In fact, Mexican and Venezuelan external debt instruments could also be characterized as substitutes until year-end 1992 when investor attitudes towards Venezuela were negatively influenced by domestic political instability. Of these seven pairs, Argentina-Chile (7.69), Brazil-Chile (9.05), and Chile-Mexico (2.69) appear to be the most highly substitutable, suggesting that Argentine, Brazilian, and Mexican debt moved closer to investment grade status in the period following the announcement of the Brady Plan.

Secondary market structural changes also may be examined more closely by simulating partial elasticities of substitution in the period March 1990-December 1993 using parameter estimates for the period January 1986-February 1990. The simulated partial elasticities of substitution presented in Table 5 suggest that the trend towards increasing substitutability between individual Latin American debt instruments (and also the return to international creditworthiness of individual assets held in isolation) probably would have proceeded in spite of the Brady Plan. In fact, the results presented in Table 5 appear to support the earlier contention that Mexican and Venezuelan debt instruments probably would have been substitutes for each other had domestic Venezuelan politics not been disrupted by a coup attempt.

The results presented in Table 5 appear to support the observation that Brady-plan restructurings accelerated the rate of return to credit worthiness of Argentina, Brazil, and Mexico, which is evidenced by larger estimated partial elasticities of substitution with respect to Chilean external-debt instruments. Once again, it is important to underscore the fact that only Chilean debt traded at or near par value during the entire sampling period.

Table 5
Simulated Allen-Uzawa Partial Elasticities of Substitution via the Translog Indirect Utility Function: March 1990-December 1993

Month	ε_{AB}	ε_{AC}	ε_{AM}	ε_{AV}	ε_{BC}	ε_{BM}	ε_{BV}	ε_{CM}	ε_{CV}	ε_{MV}
Mar 1990	0.06	1.15	0.65	-2.80	0.24	-0.08	-8.17	0.51	-5.96	-1.97
Jun 1990	-0.23	1.15	0.73	-3.40	-0.15	-0.27	-14.96	0.55	-8.29	-2.11
Dec 1990	-0.04	1.11	0.74	-1.65	-0.02	-0.45	-10.24	0.54	-4.92	-1.54
Jun 1991	0.11	1.11	0.73	-24.09	0.12	-0.29	-93.28	0.53	-55.63	-24.00
Dec 1991	-0.06	1.10	0.78	-10.36	-0.21	-0.67	-64.93	0.55	-28.33	-11.23
Jun 1992	0.10	1.09	0.78	4.61	-0.29	-0.54	20.79	0.53	10.91	5.24
Dec 1992	-0.14	1.09	0.79	5.68	-0.28	-0.78	32.33	0.59	12.97	6.02
Jun 1993	0.44	1.12	0.71	2.14	0.30	-0.01	4.01	0.35	4.27	2.39
Dec 1993	0.56	0.96	0.77	0.23	1.20	0.38	-0.62	1.18	1.79	0.26

A comparison of Tables 4 and 5 appear to suggest, however, that the beneficial impact of the Brady Plan was not universal. Venezuelan-Argentine and Venezuelan-Mexican asset pairings became more complementary by the end of the March 1989-December 1993 sampling period, which suggest that the return to credit worthiness may have been adversely affected by the announcement of the Brady Plan. Trebat (1993) has noted that secondary-market external-debt prices ultimately are a function of a country's underlying economic fundamentals, its ability to generate foreign exchange, and its willingness to nominally service its external debt obligations. Debtor countries that entered into a Brady-plan restructuring and that adopted IMF economic reform programs generally are viewed as more credit-worthy by potential investors. Although this tends to discourage speculators seeking high returns, these assets become more attractive to pension fund and large mutual fund managers.

By early-1993, investors were increasingly moving past debt deal questions and assessing developing debtor countries political and economic risk. Trebat has noted that when Venezuela successfully negotiated a Brady deal in 1992 debt prices actually fell, which mirrored two coup attempts. According to Trebat, the most pertinent consideration for investors was a country's

projected economic growth, along with an accurate reading of the government's commitment to a reasonable economic policy.

Although it has been argued that external-debt instruments tended to become more substitutable as a result of the newly guaranteed debt instruments, the trend towards increased substitutability may also have been the result of enhanced liquidity. Because the creditworthiness of the sovereign nation became secondary to that of the guarantor, interest in these instruments, and therefore trading volume, increased. Bonds that were once traded infrequently are now being traded more or less continuously. Greater substitutability may thus be a reflection of increased liquidity, rather than being directly the result of improved risk-return characteristics.[6]

Own-price elasticities of demand

The estimated own-price elasticities of demand for each of the assets in the Latin American external debt portfolio for the periods January 1986-February 1990 and March 1990-December 1993 are presented in Table 6. These results suggest that the demand for Latin American external sovereign debt instruments became more "normal" in the period following issuance of the first Brady bonds. Prior to that time, structural rigidities and the presence of complementarities appear to have overwhelmed negative price effects. After the Mexican restructuring, however, this pattern was partly reversed. The only exception by the end of the second sampling appears to be Venezuelan debt, which seemed to become more attractive to investors with higher relative risk-return preferences.

---

6 The authors would like to thank Dr. Paul Bolster, College of Business Administration, Finance and Insurance Group, Northeastern University for these interesting insights.

Table 6
ITSUR Estimated Allen-Uzawa Own-Price Elasticities of Demand via the Translog Indirect Utility Function; Total Outstanding External Debt Shares: January 1986-February 1990 and March 1990-December 1993

Month	η_{AA}	η_{BB}	η_{CC}	η_{MM}	η_{VV}
Jun 1986	-0.25	0.06	0.18	0.08	-0.00
Dec 1986	-0.26	0.04	0.16	0.12	0.01
Jun 1987	-0.24	0.10	0.33	0.02	0.01
Dec 1987	-0.18	0.09	0.19	0.02	0.01
Jun 1988	-0.04	0.06	0.10	0.02	0.00
Dec 1988	0.04	0.06	0.03	0.02	0.02
Jun 1989	0.13	0.07	-0.06	0.00	0.04
Dec 1989	-0.07	0.24	-0.16	-0.01	-0.11
Feb 1990	0.53	0.08	-0.15	-0.01	-0.03
Mar 1990	0.45	-0.05	-0.73	-0.06	-0.16
Jun 1990	0.49	0.06	-0.73	-0.07	-0.16
Dec 1990	0.00	0.04	-0.73	-0.05	-0.19
Jun 1991	0.29	-0.03	-0.72	-0.05	-0.17
Dec 1991	-0.14	0.06	-0.71	-0.05	-0.17
Jun 1992	-0.22	0.02	-0.72	-0.04	-0.09
Dec 1992	-0.21	0.12	-0.72	-0.06	-0.09
Jun 1993	-0.14	-0.13	-0.71	-0.00	0.07
Dec 1993	-0.23	-0.15	-7.50	-0.01	0.17

V Summary

This paper examined changes in the relative price relationships between Latin American external debt instruments with the use of a translogarithmic utility function. An examination of

price and external debt data for five heavily indebted Latin American countries over the period January 1986 to December 1993 suggests that the Brady Plan, and the subsequent issuance of Brady bonds, probably had significant effects on the portfolio diversification decisions of investors in debt instruments.

Brady-plan restructurings appear to have provided official Latin American debtors with the "breathing space" necessary to adopt economic reform programs to foreign capital to fuel long-term economic growth. This study found that Brady Plan restructurings resulted in a structural change in the secondary market for developing country debt and appears to have accelerated the return of Argentina, Brazil, and Mexico to international credit worthiness. As a consequence of this improved credit-worthiness, the external-debt instruments of Argentina, Brazil, Chile, and Mexico tended to become more substitutable with each other when held in a weakly separable portfolio. Only Venezuela's credit worthiness appears to have suffered in the period following the Brady-plan, perhaps due to political instability and/or complacency on the part of domestic economic policy-makers.

References

Christensen, L. R., Jorgenson, D. W. & Lau, L. J. Conjugate duality and the transcendental logarithmic function. *Econometrica*, v. 39, p. 255-256, 1971.

_____ Transcendental logarithmic utility function. *American Economic Review*. v. 65, p. 367-383, 1975.

Shephard, R. W. *Cost and production functions.* Princeton, NJ: Princeton University Press, 1953.

_____ *The theory of cost and production functions.* Princeton, NJ: Princeton University Press, 1970.

Trebat, Thomas. Buyers downplay Brady deals, key on country fundamentals. *LDC Debt Report/ Latin American Markets, American Banker—Bond Buyer* v. 6, n. 12 March 29, 1993, p. 1

Weston, Fred J. & Brigham, Eugene F. *Essentials of managerial finance*. New York: The Dryden Press, 1993.

Zellner, A. An efficient method for estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, v. 57, p. 348-368, 1962.