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Permit Market Inefficiency/Liability [Global Climate Change]

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Causes of Permit Market Inefficiencies and Failures

Most of the permit market failure articles discuss the Clean Air Act and overall EPA legislation exclusively and interchangeably. There is significant overlap in the stated causes of market failure, so for clarity the causes are listed by category rather than by source. The unique causes of only other detailed market failure, that of the Federal Water Pollution Control Act, are identified as such on the list.

Transaction Costs

--Monitoring, bargaining, decision-making, and paperwork costs reduced gains from permit trades. When monitoring was unsuccessful, evasion through false reductions also hampered efficiency.
--Review and certification processes for trading increased the time, difficulty and expense of trading, and put important projects on hold for long periods of time.
--In certain areas, potential buyers or sellers of permits were nonexistent or difficult to identify. Subsequent identification required high costs which reduced the profitability of trade.
--Sunk costs in older pollution control equipment reduced the ability of firms to adjust pollution reduction strategy to the most up-to-date and cost-effective alternative.
--The processes of determining how regulators calculate a firm's emissions, and bringing the regulators' attention to the firm's pollution control activities, produced additional costs.
--Offset ratios greater than unity for permits forced higher abatements for a given amount of emission reduction credits, creating a difference in value of the permit to the buyer and to the seller.
--When initial permit allocations were based on the status quo, new firms faced costly hurdles and more stringent requirements than did older firms.
--The presence of transaction costs precluded many mutually-beneficial trades, thus preventing the original allocation of permits from shifting to the most cost-effective allocation.

Conflicts with Other Programs and Regulations

--Required emission reductions for bubble trading may have prevented firms from trading altogether by significantly reducing gains from trade.
--Informal banks and internal trading, which were often less cost-effective than external trading, nevertheless impeded external markets by offering a much safer alternative.
--"Netting" emissions and reductions within a firm discouraged trading because firms saved their emissions reduction surpluses for their own use, rather than selling them to other firms.
--Regulatory agencies for municipal utilities may have confiscated money received through the sale of a permit, eliminating incentives to trade.
--Emissions programs were sometimes simply added on top of existing command and control regulation, making efficient market creation difficult.

Excessive Market Power

--When permits were auctioned, firms with "deep pockets" might have been able to buy all or most credits.
--Certain industries (pulp and paper) were oligopolistic, and thus did not act competitively in a permit market (Federal Water Pollution Control Act).

Legal Limitations on Permit Trading

--Some permit regulations required a clear "need" for the permit trade (Federal Water Pollution Control Act).
--Certain regulations prevented secondary transfers of permits for at least a year, and prevented trades used for the purpose of reducing operating costs (Federal Water Pollution Control Act).
--Regulation dictating that certain technological standards must be met before a firm is allowed to trade lessened the likelihood that the firm would trade at all.

--Certain emission credits were limited to offsets or internal use only.

Risks Preventing Industry Confidence

--Difficulties in data collection prevented firms from knowing how regulators calculated their baselines, actual emissions, and emissions surpluses.
--Certain transfer programs not explicitly authorized by EPA regulation could have been canceled without notice, causing all banked or traded permits to become worthless (Federal Water Pollution Control Act).
--The emissions limits might not have been stringent enough to meet ambient air quality standards, requiring reductions in the stock of emissions credits and thus major fluctuations in permit prices.
--Changes to stricter regulation could have resulted in confiscation or elimination of surplus emission credits, thus reducing the durability and economic value of the credits.
--Controversy over shutdown credits prevented firms from using them, for fear that they might be invalidated.
--Expiration dates on banked emission credits created risks of not using the credit before it expires, or not being able to sell the credit before it expires, which reduced the incentive to bank credits.
--Permit-buying firms had no guarantee that the potential sellers could actually make the emission reductions necessary to create the credits.
--Firms searching for credits often had no market information to anticipate the future price of credits.

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Selected Causes of Permit Market Failure

From Hahn, R.W. and G.L. Hester. "Where did all the markets go? An analysis of EPA's emissions trading program." *Yale J. Reg.* 6, 109-153 (1989):

- Uncertainty: "...firms face considerable uncertainty in anticipating how regulators will determine their baseline emission levels and emission reductions for emissions treading purposes. In making an external trade, firms face the even greater uncertainty associated with calculating these factors for another firm. If credits are to be obtained by external trading, firms must know whether the potential seller is really going to be able to make the emission reductions necessary to create the credits. If so, the firm must know whether regulators will officially recognize the creation of the credits and the right of the seller to transfer them to the buyer."

- Uncertainty: "...a firm searching for credits has no market information from which it can anticipate the future price of credits. If a firm has the option of generating credits internally, it may choose to do so rather than incure the expense of a search for credits when the outcome of the search is unpredictable."

- Legal trade limitations: "...because [Rhode Island] is an attainment area, there is no need for firms to use offsets...restrictions placed on the use of emission credits, such as limiting their use to offsets or to internal use, make them even less useful."

From Hahn, R.W. "Economic prescriptions for environmental problems: How the patient followed the doctor's orders." *J. Econom. Perspect.* 3, 95-114 (1989).

- "...several restrictions on transfers may have had a negative impact on potential trading. Any transaction between firms requires modifying or reissuing permits. Transfers must be for at least a year; however, the life of a permit is only five years. Moreover, parties must waive any rights to the permit after it expires...firms are required to justify the "need" for permits. This effectively limits transfers to new dischargers, plants which are expanding, and treatment plants that cannot meet the requirements, despite their best efforts. Trades that only reduce operating costs are not allowed."

On these points, the author makes reference to a paper by G. Novotny for the Wisconsin Department of Natural Resources. If you want this paper, I can put in a request at the library.

From Hahn, R.W. "Regulatory constraints on environmental markets." *J. Public Econom.* 42, 149-175 (1990).

- Legal trade limitations: "...potential gains from trade will be constrained by the requirement that new sources meet a specific emission standard prior to being allowed to buy offsets for their remaining emissions." There's a lot more written on this, from pp. 160-170 in this article. I'm not exactly sure what you'd be interested in, so I'd suggest that you read this section and see if it contains any helpful information.

Selected Causes of Permit Market Failure

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Fischer

Indexed bonds: intergenerational trading - intergenerational smoothing function: needs taxes / transfers. Need govt. operation.

- Issuance of new product: like innovation, we need presumption that private sector will intervene at right time.

Cat Bonds.

- also publicize of private insurance for hurricane & FEMA program

- Brady bonds: debt crisis 1980

debt service Bank loans ⇒ securities.

LDC

Started * Credit Enhancements. US govt. bonds. collateral.

Special. partial interest: collateral.

⇒ Facilitator role.

Key role Credit risk - can't opt out.

FDIC's market always non-existent.

Brady bonds: quite liquid

Buyer.

10 On the Nonexistence of Privately Issued Index Bonds in the U.S. Capital Market

Stanley Fischer

10.1 Introduction

"Why, if both borrower and lender benefit from them, [does] an index loan market . . . not develop spontaneously and without any government initiative?" This question, asked by Professor Arvidsson at the IEA conference on inflation in 1962, provides the major theme for the present chapter which pursues in some detail possible reasons for the nonexistence of privately issued index bonds in the United States.[1]

In an earlier paper, I used portfolio theory and the capital asset pricing model to study the demand for index bonds and some properties of equilibrium in a capital market with equity assets as well as indexed and nominal bonds [7], and in which individuals may also own (but not sell) human capital. The major conclusions of that paper are that the equilibrium relationship between the real yields on indexed and nominal bonds depends on the extent to which equity and human capital are hedges against inflation[2]—the real yield on index bonds tends to be below that on nominal bonds to the extent that real returns on equity and human capital are negatively correlated with inflation; that, in the absence of human capital and with no relative price uncertainty, all private lending and borrowing would take place through indexed bonds; and that, with human capital, both types of bonds would in general be expected to exist. I noted that the analysis did not throw much light on the nonexistence of indexed bonds in most major capital markets.

The nonexistence of privately issued index bonds in the United States is a phenomenon requiring explanation for two main reasons. First, the tying of contracts to the price level is not unknown nor even especially unusual in the United States: labor contracts, certain aspects of insurance contracts, and the prices to be paid for future delivery of manufactured products have all been tied to the price level.[3] Second, there has been no dearth of innovation in the financial area over the years, although those innovations taking the form of the issue of new types of securities by existing firms—such as the certificate of deposit and the floating rate note—have been undertaken mainly by banks.

Originally published in *Inflation Theory and Anti-Inflation Policy*, Erik Lundberg, ed. (Boulder, Colo.: Westview Press, 1977), pp. 502–518. The paper appears in its original form.

The previous paper concentrated on the demand for index bonds and equilibrium in a market composed of lifetime-utility-maximizing households. However, the most likely private issuers of index bonds are corporations. Accordingly, the emphasis in this chapter is on the supply of index bonds by firms, whose assumed motivation is the maximization of their stock market value.

It is well known that in the absence of bankruptcy and the differential tax treatment of equity returns and interest and under certain other assumptions, the Modigliani-Miller theorem [16] establishes that the value of the firm is independent of its debt structure—that is, that under the postulated conditions, there is no good reason for firms to issue one sort of debt rather than another. It is accordingly necessary to develop a rationale for the type of debt issued by a firm. Section 10.2 outlines a simple theory of the supply of bonds, based on the existence of bankruptcy costs and the tax treatment of interest as a business expense, which is used in parts of the remainder of the chapter to evaluate some arguments typically advanced to explain the nonissuance of indexed bonds by private firms [1] and [10].[4]

Section 10.3 examines the view that firms should be more willing to issue index bonds the greater the (positive) correlation of their profits with the price level and also presents evidence on the correlation of the real profits of some American corporations with the price level. Because the theory makes clear the crucial role of the tax treatment of indexed payments, section 10.4 very briefly examines the ambiguous tax status of such payments in the United States. Section 10.5 considers the argument that systematic underestimation of inflation is responsible for the nonappearance of indexed bonds. Section 10.6 reviews the argument that index bonds have not been issued because such bonds would saddle firms with open-ended obligations which nominal bonds with call-clause protection do not. Two further explanations for nonissuance of index bonds are considered: section 10.7 examines the variability of the rate of inflation over the past twenty years; section 10.8 discusses the costs of innovation and the possibility that a large-scale change in the form of debt issues would be easier to accomplish than piecemeal changes. Conclusions are contained in section 10.9. An appendix compares the variability of hypothetical profit streams for sixteen U.S. firms, constructed on the assumption that all their long-term debt issues over the period were indexed, with the variability of their actual profit streams.

10.2 The Supply of Index Bonds

The theory developed in Fischer [8] uses the capital asset pricing model [12] to examine the financing decision of a firm that has made an investment decision in period one that will produce (uncertain) real profits in period two. Real profits are assumed to have a random component that is uniformly distributed and independent of the price level and also to have a component that is correlated with the purchasing power of money (the inverse of the general price level) in period two. The purchasing power of money in turn has a simple two-point symmetric distribution and its expectation for period two is the same as its value in period one.[5]

The firm is assumed to sell claims on its second-period profits in the capital market. Two possible combinations of asset supplies by the firm are examined. In the first the firm can sell indexed bonds and equity. It promises to pay an amount W in real terms to holders of index bonds, provided its profits are at least W. Such payments are treated as business expenses. Any amount of profits not paid out to index bond holders is distributed to equity holders, after payment of taxes at rate τ. If the firm's profits are less than W, it is bankrupt. In such a case equity holders receive no payments. Certain fixed real bankruptcy costs are assumed to be incurred, and bondholders receive either zero or profits minus the bankruptcy costs, whichever is greater, in the event of bankruptcy.

The elements of the theory of the supply of index bonds are accordingly simple. The issue of bonds produces a tax advantage, but the more bonds are issued, the greater the probability of bankruptcy. Thus bonds will be issued to the point at which the tax benefit balances the expected bankruptcy costs.[6] It should be noted that in the absence of differential tax treatment of interest and profit distributions, no bonds would be issued by this firm.

In the capital asset pricing model assets issued by the firm are valued by the market on the basis of their expected return and the covariance of their returns with the market return. The market rate of return is assumed to have a random component that is distributed independently of the behavior of the firm's profits except that the market rate of return is correlated with the purchasing power of money. Empirical evidence suggests that the market rate of return in the United States is negatively correlated with unexpected changes in the price level, and it is accordingly assumed that the market return is positively correlated with the purchasing power of money [3].

The result of the optimization of stock market value by the firm is a supply function for index bonds: the supply of index bonds is positively related to the maximum profits the firm expects to earn and to the tax rate on corporate profits, and negatively related to the cost of bankruptcy. The effects of price-level uncertainty on the issue of index bonds depends on the relationship between the firm's profits and the price level on the one hand, and the market rate of return and the price level on the other; if the firm's profits are related to the price level in the opposite direction to which the market's return is related to the price level, price uncertainty increases the firm's issue of index bonds; if the correlation between the firm's profits and the price level is of the same sign as the correlation of the market return with the price level, then the firm's issue of index bonds is reduced by price-level uncertainty. Under the empirically justifiable assumption that the market return is inversely correlated with the price level [3], the firm's supply of index bonds is greater, the greater the variance of the price level, and also the greater the correlation of its profits with the price level.

In the second situation the firm is assumed to issue nominal bonds and equity, again with the aim of maximising its stock market value. A supply function for nominal bonds by the firm is derived and the optimised value of the firm when it can issue nominal bonds and equity is calculated. The optimised values of the firm under the two combinations of asset issues are compared and the following results obtained:

1. Neither type of bond—indexed or nominal—dominates the other from the viewpoint of the maximization of the firm's stock market value. There are situations where a firm issuing nominal bonds will command a greater stock market value than one issuing indexed bonds; such situations seem to require that both the market return and the firm's profits be inversely correlated with the price level. There are also situations in which stock market value is higher if the firm issues indexed rather than nominal bonds.[7]

2. Given the empirically negative relationship between the market rate of return and the price level, the greater the correlation of a firm's profits with the price level, the more likely its stock market value will be higher if it issues indexed rather than nominal bonds.

3. Increases in the variance of the price level tend to increase the relative attractiveness of issuing index bonds, at least if the effect of the price level on the market rate of return is small.

Table 10.1
Correlations of after tax interest-adjusted real profits with the price level, 1954–1973

Firm	Correlation coefficient		Total long-term debt outstanding 1973 ($ millions)
	Price level residuals from (10.3)	Price level residuals from (10.4) (simple time trend)	
1. US Steel	−0.06	0.08	1,464
2. Mobil Oil	0.27	0.50	1,052
3. Union Carbide	−0.29	−0.49	940
4. Bethlehem Steel	−0.11	0.15	670
5. IBM	0.32	0.65	652
6. AT & T	−0.64	−0.83	7,594
7. Consolidated Edison	0.08	−0.01	2,843
8. Pacific G & E	−0.36	−0.30	2,677
9. Public Service G & E	0.18	−0.04	1,658
10. Tennessee Gas Transmission	−0.45	−0.12	882
11. Eastern Airlines	−0.31	−0.06	785
12. American Airlines	−0.88	−0.80	692
13. Baltimore and Ohio RR	−0.12	0.03	361
14. Sears	0.30	0.46	956
15. May Co.	−0.24	−0.51	317
16. Woolworth	−0.44	−0.62	295

Data Sources: 1. Profits: *Moody's* industrial manual
2. Debt position: *Moody's* transportation manual; *Moody's* public utility manual
3. CPI: BLS, unpublished data series, monthly seasonally adjusted OPI.

4. Differences in tax treatment obviously affect the type of securities issued. In particular, if indexed bond interest payments are not treated as a business expense whereas nominal bond interest payments are treated as a business expense, the latter will dominate the former which will not be issued.

10.3 The Correlation of Profits with the Price Level

The analysis outlined above established that firms are more likely to have a higher stock market value by issuing indexed rather than nominal bonds if their profits are positively correlated with the price level.

In table 10.1 we present correlation coefficients between aftertax profits with an adjustment for interest payments and the consumer price index for sixteen firms. These firms were chosen from the industrial, public

utilities, transportation, and merchandising categories of the *Fortune* 500 firms for 1964. The criterion of selection was originally to be the largest five firms on the basis of long-term debt outstanding in 1964 in each category, subject to the firms existing in both 1954 and 1973. There are only three transportation firms because debt issues of many of the largest transportation firms were so numerous that the analysis of section 10.5 became too costly, and there are only three merchandising firms because these firms tended to have very little debt outstanding.

Profits for each firm were adjusted by adding back to reported net profits the computed amount of interest paid on long-term debt multiplied by one minus the corporate tax rate (state plus federal) in each year. Thus we obtained a series for each firm:

$$\pi_{it} = \pi_{it}^R + (1 - \tau_t)R_{it}, \quad i = 1, \ldots, 16, \quad t = 1954, \ldots, 1973, \tag{10.1}$$

where π_{it} will henceforth be called aftertax profits, π_{it}^R is reported net income, and R_t is reported interest payments on long-term debt. We chose to work with aftertax profits because it was simpler to make the tax adjustment to interest than to compute comparable pre-tax profits for each firm.

Nominal aftertax profits, π_{it}, were then deflated by the consumer price index for each year, a linear time trend was fitted to the real profit series, and the deviations of real profits from the trend values were calculated.[8] Similarly, an exponential time trend was fitted to the annual average of the CPI for each of the twenty years, with a dummy being included for the low inflation years, 1959 to 1965, and the residuals from that regression were calculated. The price level regression was

$$\ln(CPI_t) = \alpha_0 + \beta_1 t + \beta_2 Dt, \tag{10.2}$$

where

$D = 1$, for $t = 1959, \ldots, 1965$,

$= 0$, otherwise.

Equation (10.2) represents a crude estimate of the predicted path of the price level. The regression, with standard errors in parentheses, was

$$\ln(CPI_t) = \underset{(0.0185)}{4.3330} + \underset{(0.0014)}{0.0242}t - \underset{(0.0018)}{0.0051}Dt. \tag{10.3}$$

In addition the regression was run without the dummy variable, yielding

$$\ln(CPI_t) = 4.3116 + 0.0247t. \quad (10.4)$$
$$(0.0197)\ (0.0016)$$

Table 10.1 presents the correlations of the deviations of real aftertax profits from their trend values with the deviations of the price level from its trend value, for equations (10.3) and (10.4) respectively. In each case most of the correlations are negative. The correlations for the largest debt-issuing category—the utilities—are all either negative or close to zero, with the correlation for AT&T, the largest individual borrower, being strongly negative. Table 10.1 suggests that the most likely issuers of index bonds would be Mobil Oil, IBM and Sears.

While it may be surprising that the correlation of deviations of real profits with deviations of the price level from their respective trends is negative for so many firms, the major lessons of table 10.1 are that there exists a wide diversity of behavior of profits with respect to the price level and that there are indeed firms that have a positive correlation of detrended profits with the detrended price level and that, according to the theory, might have been expected to issue index bonds.[9] We conclude that the failure of indexed bonds to appear is not due to the fact that there are no firms whose profits are positively correlated with the price level.[10]

10.4 The Tax Treatment of Interest, and Indexing to the Price of the Firm's Output

The analysis outlined in section 10.2 points to the tax treatment of interest as a major determinant of the type of security issued.[11] There is also some uncertainty about the tax treatment of indexed interest payments in the United States.[12] The ambiguity stems from the fact that the courts have used fixity of the interest rate as one criterion for justifying the deductibility of interest payments [19]. There are a number of other criteria, such as fixity of the maturity date and negotiability, all of which an indexed bond would satisfy. Since the only criterion that puts the deductibility of indexed interest in question is fixity of the interest rate, and since interest paid on floating rate notes is deductible, it would now appear that in fact a very strong case could be made that indexed interest should be

treated as deductible, and that there is probably no tax obstacle to the issue of indexed interest bonds. However, it should be noted that there does not appear to be any precedent precisely covering the indexed interest case, and that the issue could only be finally resolved by rulings applied to a proposed and not a hypothetical bond issue, so that some uncertainty remains.

It is also appropriate here to consider a suggestion which has been made that firms would be more willing to issue bonds indexed to their own output price than bonds linked to the general price level. If their own output price were perfectly correlated with their profits (which is the reasoning behind the suggestion), it is easy to see that the model outlined in section 10.2 would support this argument. However, it should be noted that a firm's prices can rise because of cost increases as well as demand shifts, and thus that the correlation of a firm's prices with its profits is not likely to be perfect. Further the greater the correlation of price with profits, the more likely would it seem to be that the indexed payment on such bonds would be treated as a profit distribution. It should also be noted that, in the case of the issues of such bonds by French firms in the 1950s, indexing to the own price was a device used to circumvent a series of interpretations of a law of 1895 which was taken to forbid indexation to gold or the general price level [11] and which accordingly should not be treated as evidence confirming the view that firms would prefer to issue bonds tied to their own output price.

In brief, then, it appears that the tax treatment of indexed bonds, at least in the United States, should not deter their issue. The general uncertainty concerning the tax treatment of indexed bonds suggests that there has been little effort made to clarify their tax status. Thus it is unlikely that the tax treatment of index bonds has held back potential issues.

10.5 Expectations of Inflation and Index Bonds

The experience of the last decade has been of increasing inflation. The experience of the last two decades has also been of low real yields on bonds. It is by now well known that the average pre-tax real rate of return to the holding of United States treasury bills for the period 1954 to 1973 was 1 percent [6].

The average real yield on long-term corporate debt for our sample of sixteen firms for 1954 to 1973 was less than 2 percent. Table 10.2 presents

Table 10.2
Ratio of mean real profits with indexed interest payment to actual mean real profits, 1954–1973

Firm	Real rate	
	1 percent	2 percent
1. US Steel	1.003	0.988
2. Mobil Oil	1.001	0.995
3. Union Carbide	0.997	0.980
4. Bethlehem Steel	1.000	0.991
5. IBM	1.003	0.999
6. AT & T	0.998	0.987
7. Consolidated Edison	0.983	0.919
8. Pacific G & E	0.993	0.943
9. Public Service G & E	1.010	0.954
10. Tennessee Gas Transmission	1.027	0.982
11. Eastern Airlines	1.392	0.717
12. American Airlines	1.047	0.951
13. Baltimore and Ohio RR	1.101	0.982
14. Sears	1.005	1.000
15. May Co.	1.013	0.991
16. Woolworth	1.010	0.998

Note: Actual mean real profits for Eastern Airlines is close to zero.

the results of a calculation in which hypothetical indexed bonds were issued by the sixteen firms of the sample described in section 10.3. The long-term debt outstanding at the end of each half-year for each firm was calculated, and it was then assumed that each firm paid interest on outstanding debt equal to, in one case, 1 percent at an annual rate and, in the other, 2 percent annual, plus the realized rate of inflation over the preceding six months. Profits were calculated for each firm for each year on the basis of the hypothetical interest payments and then deflated by the CPI to yield a hypothetical real profit series. Table 10.2 shows the ratio of the mean of the calculated real profit series to the mean of actual real profits over the period 1954 to 1973. The ratios are not identical for all firms, both because the share of interest payments in profits varies among firms and because dates of debt issues vary among firms. Table 10.2 demonstrates that every firm effectively obtained bond financing at less than a 2 percent real rate over the period, and that some, including AT&T, paid less than 1 percent real.

It is tempting to conclude that the low real rate is a result of rising and

therefore unexpected inflation and that, if inflation had been accurately foreseen, the real rate of interest on bonds would have exceeded 2 percent. Thus it is argued, firms have had little incentive to issue index bonds because real rates on nominal bonds have been low [10]. This argument obviously requires borrowers to have had systematically higher expectations of inflation than lenders. This argument is difficult to confirm or refute. It should, however, be recognized that expectations of inflation among lenders are not homogeneous: it is possible that there are enough lenders in the American economy who are sufficiently pessimistic about inflation to make it worthwhile for some corporation to issue an indexed bond at a low real rate [1]. Thus the expectations explanation, too, should be treated with suspicion.

10.6 The Call Provision

Corporate bonds issued in the United States typically carry a call provision by which the corporation can repay the debt on specified terms before maturity, generally after five years of its existence but ten years for utilities. Thus corporations issuing nominal bonds appear to be covered against the possibility that the nominal interest rate will fall after their debt is issued, and they are of course covered against increases in the nominal rate by virtue of the fixity of the coupon rate. Accordingly, the call clause protects the corporation from the risk that the interest rate and rate of inflation will fall.

There are three points to be made in connection with the argument that the call provision has precluded the issuance of index bonds because the corporation is covered against increases in nominal interest rates by a fixed nominal rate on its debt and decreases in nominal rates by the call clause. First, the call clause is not free [4]. It could be, though, that the issue of call-protected nominal bonds dominates index bonds from the viewpoint of the firm; the model of section 10.2 is not equipped to analyze that issue. Second, the call clause provides protection only after five or ten years, and interest rates can change a great deal in that period. Third, there is no reason why index bonds should not have similar clauses creating minimum and maximum nominal payments.

The last two points suggest strongly that the call provision is not the explanation for the nonexistence of indexed bonds.

Table 10.3
Variance of rate of inflation

Period	Inflation rate variance	Variance of inflation calculated at annual % rate
1954–73	0.3771	6.0336
1954–58	0.3346	5.3536
1959–63	0.0979	1.5664
1964–68	0.1563	2.5008
1969–73	0.2892	4.6272

10.7 The Variance of the Rate of Inflation

The analysis of section 16.2 suggested that indexed bonds would be more likely to be issued, the greater the variance of the price level. Figure 10.1 shows the time path of the CPI in the United States for 1954 to 1974 (quarterly observations) and also the inflation rate, which is defined as

$$\frac{P_t}{P_{t-1}} - 1,$$

where t = 1953 II to 1974 IV.

Table 10.3 presents data for the variance of the quarterly inflation rate for the four five-year subperiods of 1954 to 1973. Although it is difficult to establish an absolute measure of variability, the second column of table 10.3 provides some notion of absolute variation; it presents the variance of the rate of inflation calculated at an annual percentage rate and is generally of the same order of magnitude as the mean rates of inflation for the subperiods, except for 1954 to 1958. This variance falls as the time interval over which the inflation rate is calculated is increased.

Perhaps the best notion of the relative variability of the inflation rate is obtained by comparing its variance with that of the stock market rate of return: the variance of the inflation rate is lower by a factor of the order of one hundred than the variance of the stock market rate of return.[13] It thus appears that in terms of the uncertainties portfolio holders are accustomed to facing, inflation uncertainty is relatively trivial and insufficient to make the introduction of a new financial asset worthwhile. The costs of innovation are discussed in section 10.8.

Whatever the absolute magnitude of the variance of inflation, it is clear that the periods most favorable to the issue of index bonds were 1954 to

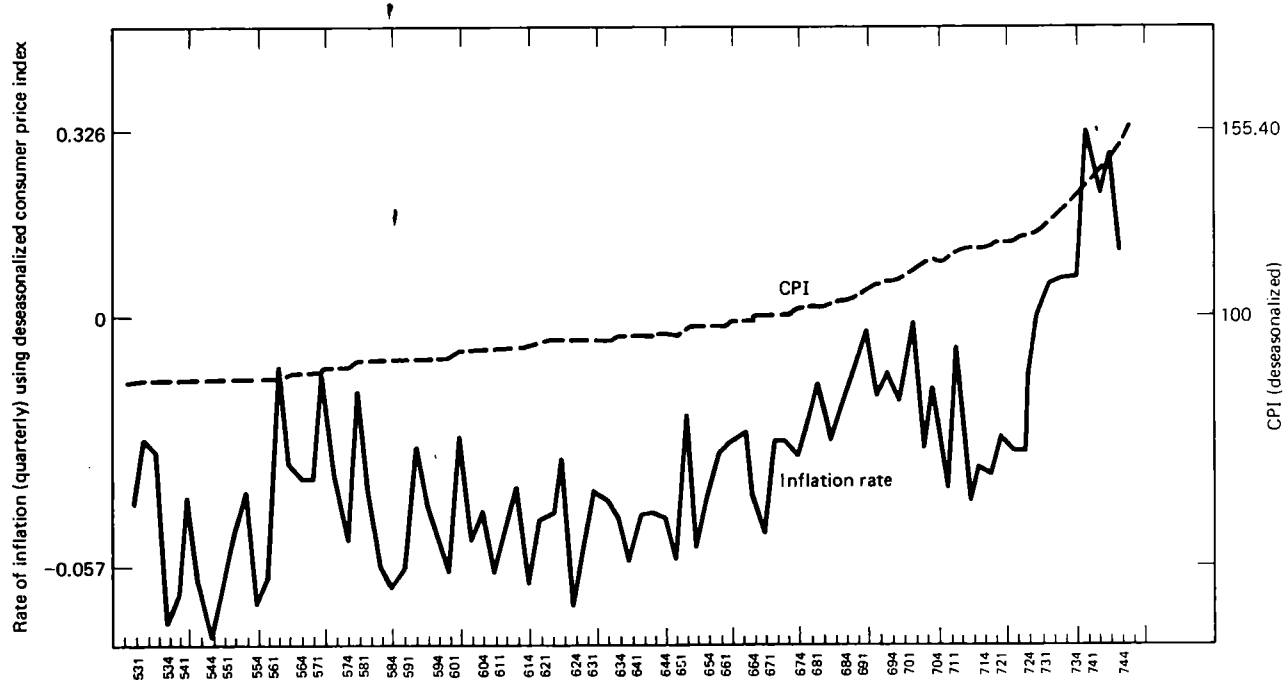

Figure 10.1
Variations of the inflation rate

1958 and 1969 to 1973. These are also of course the periods in which economists were most actively discussing indexing. Further the variance for 1970 to 1974 (11.792) considerably exceeds that for 1969 to 1973 (4.2672). Thus the recent instability of the inflation rate has created conditions substantially more favorable to the issue of index bonds than existed in the previous ten years.

10.8 The Costs of Innovation

The introduction of the floating rate note involved the issuer of the first such note in discussion and negotiation with the Federal Reserve System.[14] This resulted in modification of the terms of the note.[15] Such negotiation is an obvious cost of financial innovation. There are other costs of innovation such as the education of the public to the advantages and disadvantages of the new instrument. (Irving Fisher [9] attributed the failure of the Rand Kardex index bond to the unfamiliarity of the market with the instrument.) These costs are borne by the innovator and not by subsequent issuers.

The fact is, however, that the innovation was carried out in the case of the floating rate note. The note was aimed at the small borrower and thus the educational costs could be expected to be relatively high. Further the difficulties Citicorp encountered with the Federal Reserve System stemmed largely from the fact that the issue was regarded by financial intermediaries such as savings banks as aimed directly at their depositors.[16] It is not certain that similar interests would be affected if an indexed bond were to be issued.

In discussing innovation, it is worthwhile distinguishing financial institutions from other corporations. Financial institutions tend to carry hedged portfolios, and it is probable that they would want to innovate on both sides of their balance sheet if they innovated by issuing an indexed bond (see the model of hedging behavior by a financial intermediary in [5]). Citicorp presumably found the floating rate note more attractive than an indexed bond because its liabilities are nominal. The desire of financial intermediaries for hedging even makes a large-scale transition to indexation as feasible as the piecemeal introduction of indexation by financial intermediaries.

Nonfinancial corporations have not been particularly innovative in the

types of securities they issue, and it may be that the costs of innovation for them are high. However, it is difficult to believe that the costs of educating a public, by now well aware of inflation, to understand the features of an indexed bond can be very high. Accordingly, continuance of the current levels and variability of inflation will likely make the costs of innovation for some nonfinancial corporation low enough to result in the issue of an indexed bond. Similarly, if proposals for reform of the mortgage system [15] lead to the introduction of indexed mortgages, the spread of indexation could be rapid.

10.9 Conclusions

Most of the usual explanations for the nonissuance of private indexed bonds do not in fact explain the phenomenon. There are firms whose profits are positively correlated with the price level; the tax treatment of indexed interest would probably not be adverse; the call clause provides protection to the borrower only after a lengthy period and a similar provision could in any case be applied in the case of index bonds; the costs of innovations have not prevented sophisticated innovation aimed at small lenders. There are two arguments that may have some merit. The first is that expectations of inflation by borrowers have been systematically higher than those of lenders. However, it is difficult to believe that borrowers will always expect more inflation than lenders or, for that matter, that there are not now lenders who would accept a low real rate of interest in exchange for protection against inflation. Thus this factor would not prevent the future emergence of index bonds. The second is that the variance of inflation has been low, particularly relative to the other risks incurred in the capital markets. However, this variance is now higher than it was in the 1960s, and increased instability of the inflation rate, if maintained, may well lead to the emergence of privately issued index bonds.

Appendix: The Variability of Hypothetical Profit Series for Sixteen Firms Issuing Indexed Bonds

Closely related to the question examined in section 10.3 of the correlation of a firm's detrended profits with the detrended price level, is an issue of independent interest—the stability of after-interest profits if firms were

Table 10.4
Ratio of variability of real profits with indexed interest payments to variability with actual interest payments, 1954–1973

Firm	Rates
1. US Steel	0.918
2. Mobil Oil	0.938
3. Union Carbide	1.033
4. Bethlehem Steel	0.969
5. IBM	0.974
6. AT & T	1.050
7. Consolidated Edison	2.322
8. Pacific G & E	2.589
9. Public Service G & E	2.268
10. Tennessee Gas Transmission	0.893
11. Eastern Airlines	0.567
12. American Airlines	1.011
13. Baltimore-Ohio RR	0.721
14. Sears	0.976
15. May Co.	1.128
16. Woolworth	1.011

Note: Eastern Airlines has mean profits close to zero's, and ratio is accordingly suspect as a measure of variability.

to issue indexed rather than nominal bonds. Table 10.4 presents the results of comparisons of the variability of hypothetical real profit streams where firms issued index bonds with the variability of their actual real profit streams. The construction of the hypothetical profit series is described in section 10.5 (the real interest rate used for the construction of the appendix was 1 percent). Each nominal profit series was deflated by the CPI to give a real profit series.

A linear trend was then fitted to each hypothetical real profit series, and the sum of squared residuals from that series was calculated and divided by the square of the mean of the series to give a "coefficient of variation" of hypothetical real profits around its trend line. An identical procedure was applied to the time series for actual real profits, and the corresponding "coefficient of variation" calculated.

Table 10.4 presents the ratio of the "coefficient of variation" for the hypothetical real profit series to that for the actual real profit series. It is seen from table 10.4 that, given the actual debt issues of firms, the profits of the industrial firms would on the whole have been more stable had they issued indexed debt rather than nominal debt, while profits for the utilities would on the whole have been less stable. The reasons the

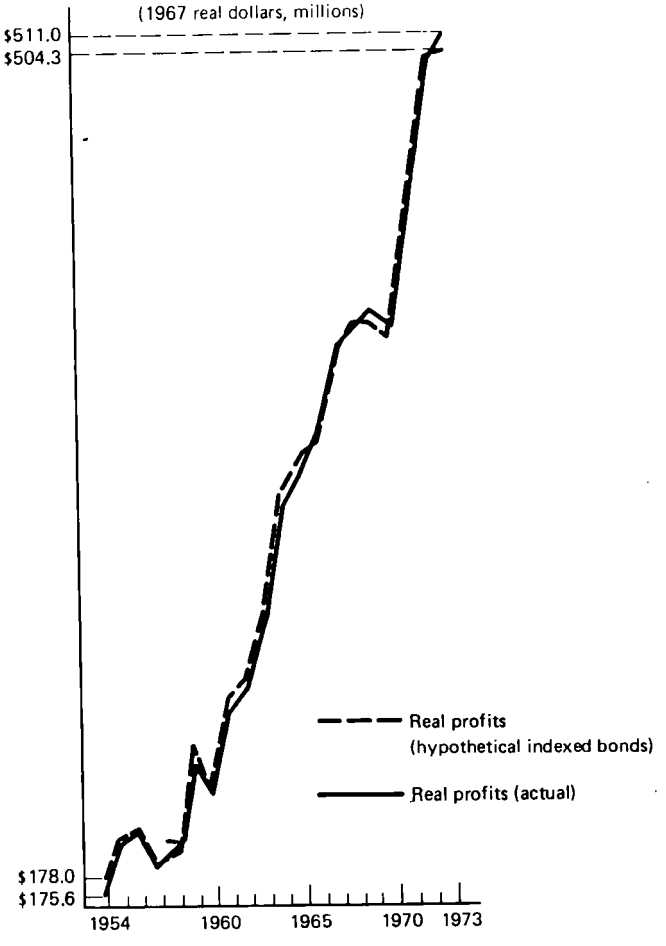

Figure 10.2
Hypothetical and actual profits, Sears, Roebuck & Co.

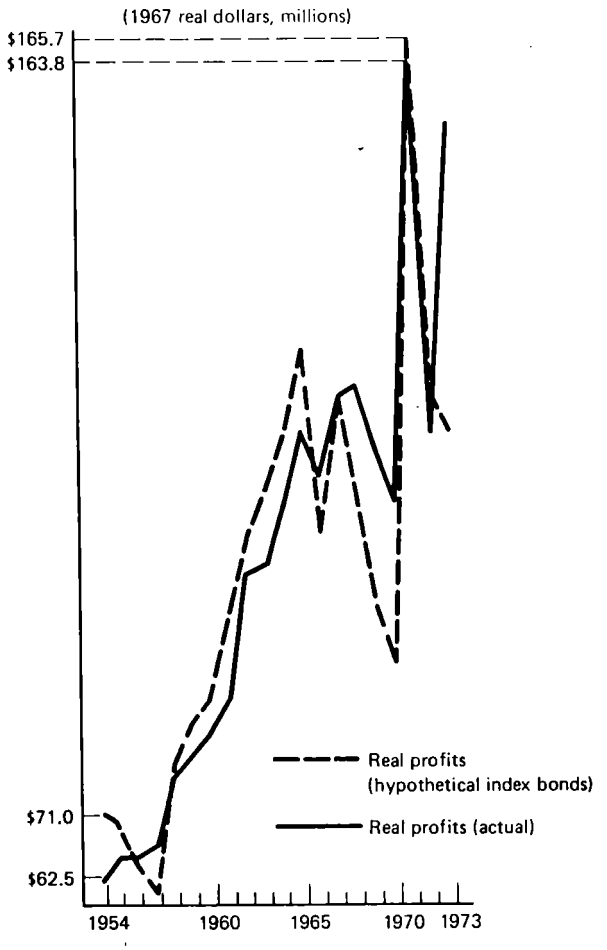

Figure 10.3
Hypothetical and actual profits, Consolidated Edison

ratios in table 10.4 are not uniformly greater (less) than unity if the corresponding correlation of table 10.1 is negative (positive) is that the variability measure is affected by the dates of issue of securities. Table 10.4 shows that a number of firms, including Mobil, IBM and Sears, would have had slightly more stable aftertax profit streams over the last twenty years had they issued index bonds rather than nominal bonds on every occasion on which they issued debt. Figures 10.2 and 10.3 show hypothetical and actual real profits for Sears and Consolidated Edison for the twenty-year period.

Notes

I am indebted to Richard Cohn, Martin Feldstein, Benjamin Friedman, Robert Merton and Stewart Myers for helpful discussions and to Olivier Blanchard and Mary Kay Plantes for excellent research assistance. Financial support from the National Science Foundation is acknowledged with thanks.

1. Arvidsson [1], p. 113. I should note that Professor Mossé, the discussant of Arvidsson's paper, was unimpressed by the question. "Opponents of index loans said that, if borrowers and lenders both wanted them, an index loan market would spring up spontaneously. This was a false argument, and needed refuting much more strongly than Professor Arvidsson had done. One might as well say that, because the government built schools for children, people did not really want their children to have schools, or they would have built schools for themselves." (From the Summary Record of the Debate, p. 402, in Hague 1962).

2. In the sense that their real returns are positively correlated with inflation.

3. The indexation of labor contracts is well documented (see, for example, Sparrough and Bolton [18]). The existence of indexation in other types of contracts is known from anecdote and personal knowledge, but the extent of such indexation has apparently not been documented.

4. The theory is developed in greater detail in Fischer [8]; the two elements of differential tax treatment of interest and dividends and bankruptcy costs are used by Kraus and Litzenberger [14] to develop a theory of optimal financial leverage in a model where there is a full set of contingent commodities. The theory developed in Fischer [8] uses the mean variance version of the capital asset pricing model to avoid assuming a full set of contingent commodities, in which case the consumer or a mutual fund could construct an index bond.

5. Since it is only uncertainty about price level that matters for the analysis, no substantive results depend on the assumption that the average purchasing power of money is not expected to change.

6. This is the essence of the view advanced by Kraus and Litzenberger [14]. This theory fails to explain the existence of bonds before the corporate income tax. Interesting papers by Jensen and Meckling [13] and Myers [17] explore the determinants of debt capacity in a longer-run perspective.

7. It should be noted that we are not here allowing the firm to issue both types of bonds simultaneously, though it is quite likely that such an option would generate a greater stock market value for the firm than the issue of only one type of bond. Our major concern, however, is to show that neither type of bond dominates the other.

8. An exponential could not be used because profits were negative for some firms in some years.

9. It is beyond the scope of this chapter to speculate on reasons for this negative correlation. One obvious "explanation" which may be forthcoming is that all the results tell us is that profits fell over the late 1960s and early 1970s when the rate of inflation was high. Since both regressions treat the inflation rate as essentially constant over specified periods, residuals will be positive in the late 1960s and early 1970s. This explanation is probably statistically correct for the cases it fits but leaves open the question of why profits fell as the rate of inflation rose.

10. Of course it is possible that the financial officers of all firms believe, despite the evidence, that their real profits are negatively correlated with the price level. Presumably, though, the evidence, if it stays firm, will eventually change such beliefs.

11. We shall not discuss the important issue of how the tax system should be adjusted for inflation but rather remain within the confines of the present U.S. tax structure.

12. In my previous paper on index bonds I stated that indexed payments would be treated as dividends, this on the basis of verbal discussion with students of the question. On further examination I now believe that indexed interest payments would be treated as interest (see Fischer [8]).

13. This point was suggested to me by Eugene Fama. See Black, Jensen, and Scholes [2] for estimates of the variance of stock market returns.

14. See Listing Application to the New York Stock Exchange, Inc., B–4337–D, July 24, 1974, by Citicorp.

15. *Wall Street Journal*, July 15, 1974, p. 4.

16. *New York Times*, July 6, 1974, p. 25.

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Special Analyses

It has been determined that this notice of proposed rulemaking (i) is not subject to the "budgetary impact statement" requirement of section 202 of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) and (ii) is not a significant regulatory action as defined in Executive Order 12866. It is not anticipated that this proposed rule, if adopted as a final rule, will have an annual effect on the economy of $100 million or more. Nor will it, if so adopted, affect adversely in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local or tribal governments or communities. The proposed rule is neither inconsistent with, nor does it interfere with, actions taken or planned by other agencies. Finally, it raises no novel legal or policy issues.

Because this rule affects Indian gaming establishments with gross annual gaming revenues in excess of $1 million, it is hereby certified that this proposed rule is not likely to have a significant economic impact on a substantial number of small entities.

Drafting Information

Several individuals in FinCEN's Office of Legal Counsel and its Office of Regulatory Policy and Enforcement participated in the development of these regulations.

List of Subjects in 31 CFR Part 103

Authority delegations (Government agencies), Banks and banking, Currency, Foreign banking, Investigations, Law enforcement, Reporting and recordkeeping requirements, Taxes.

Proposed Amendments to the Regulations

Accordingly, 31 CFR Part 103 is proposed to be amended as follows:

PART 103—FINANCIAL RECORDKEEPING AND REPORTING OF CURRENCY AND FOREIGN TRANSACTIONS

1. The authority citation for Part 103 continues to read as follows:

Authority: Pub. L. No. 91–508, Title I, 84 Stat. 1114 (12 U.S.C. 1829b, 1951–1959); and the Currency and Foreign Transactions Reporting Act, Pub. L. No. 91–508, Title II, 84 Stat. 1118, as amended (31 U.S.C. 5311–5330).

2. Section 103.11 is amended by revising paragraphs (i)(7)(i), (n), and (s), and adding paragraphs (v), (w), and (x) to read as follows:

§ 103.11 Meaning of terms.

* * * * *

(i) * * *

(7) (i) *Casino.* A casino or gambling casino that (A) is duly licensed or authorized to do business as such in the United States, whether under the laws of a State or of a Territory or Insular Possession of the United States, or under the Indian Gaming Regulatory Act or other federal, state, or tribal law or arrangement affecting Indian lands (including, without limitation, a casino operating on the assumption or under the view that no such authorization is required for casino operation on Indian lands) and that (B) has gross annual gaming revenue in excess of $1 million. The term includes the principal headquarters and every domestic branch or place of business of the casino.

* * * * *

(n) *Person.* An individual, a corporation, a partnership, a trust or estate, a joint stock company, an association, a syndicate, joint venture, or other unincorporated organization or group, an Indian Tribe (as that term is defined in the Indian Gaming Regulatory Act), and all entities cognizable as legal personalities.

* * * * *

(s) *United States.* The States of the United States, the District of Columbia, the Indian lands (as that term is defined in the Indian Gaming Regulatory Act), and the Territories and Insular Possessions of the United States.

* * * * *

(v) *Indian Gaming Regulatory Act.* The Indian Gaming Regulatory Act of 1988, codified at 25 U.S.C. 2701 *et seq.*

(w) *State.* The States of the United States and, wherever necessary to carry out the provisions of this Part, the District of Columbia.

(x) *Territories and Insular Possessions.* The Commonwealth of Puerto Rico, the United States Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, and all other territories and possessions of the United States other than the Indian lands and the District of Columbia.

§ 103.36 [Amended]

3. Section 103.36(b)(7) is amended by adding after the words "state and local laws or regulations" the words ", regulations of any governing Indian tribe or tribal government, or terms of (or any regulations issued under) any Tribal-State compacts entered into pursuant to the Indian Gaming Regulatory Act, with respect to the casino in question".

Dated: July 26, 1995.

Stanley E. Morris,

Director, Financial Crimes Enforcement Network.

[FR Doc. 95–19137 Filed 7–31–95; 3:30 pm]

BILLING CODE 4820–03–P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Ch. I

[FRL–5267–9]

Open Market Trading Rule for Ozone Smog Precursors

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed policy statement and model rule; Notice of public hearing.

SUMMARY: This notice conveys EPA's strong support for an innovative approach in emissions trading that would bring better, faster, and less expensive progress towards our nation's air quality goals. This innovative approach, known as open market trading, would allow all types of sources to trade emissions of pollutants that cause ground-level ozone and significantly reduce the overall cost of meeting the public health and environmental goals of the national ambient air quality standards (NAAQS) for ozone. An important feature of this approach is that individual trades would not have to be processed as separate State implementation plan (SIP) revisions. Rather, open market trades would provide sources with an alternative means of compliance, and they would be reviewed by State and Federal authorities predominantly during compliance determinations. The EPA believes this open market approach can provide important emissions reduction benefits. It can be put into operation immediately in places where area-wide emissions budgets and source allocations needed to meet the ozone standard have yet to be determined. The unique character of this approach encourages and permits market participation and innovation by smaller stationary sources and mobile sources. It also encourages sources to make reductions early; these reductions can provide immediate public health benefits. By providing a lower cost compliance alternative, the open market approach can make it easier for States to adopt additional control measures where needed to achieve attainment.

The EPA has developed today's proposed open market trading rule (OMTR) as a new approach that would supplement, and would not modify or

limit the adoption by States of other emissions trading approaches available under the Clean Air Act (Act) and existing EPA rules and policies. Today's proposal is in the form of a model rule; any State which adopts the final version of this rule could expect its rule to be immediately approved by EPA. This feature would enable States to begin operation of an open market trading program without delay. The EPA continues to encourage States to take advantage of all market-based programs available to them, including emissions budget (cap and trade) programs and emissions offsets, as well as emissions averaging programs.

DATES: *Comments.* Comments must be received on or before October 2, 1995. *Public Hearing.* A public hearing will be held August 31, 1995, beginning at 9 a.m. Persons wishing to present testimony must contact Ms. Shelby Journigan at (919) 541–5543 by August 24, 1995. Persons wishing to attend the hearing should contact Ms. Journigan to obtain the location of the hearing.

ADDRESSES: Comments should be submitted (in duplicate, if possible) to Air and Radiation Docket and Information Center (6102), ATTN: Docket No. A–95–21, Room M1500, U.S. EPA, 401 M Street, SW., Washington, DC 20460; Phone 202–260–7548 or 202–260–7549. Fax 202–260–4400. Docket No. A–95–21, containing information supporting the development of today's proposal, is available for public inspection and copying between 8 a.m. and 5:30 p.m., Monday through Friday, at the address listed below. A reasonable fee for copying may be charged.

FOR FURTHER INFORMATION CONTACT: Nancy A. Mayer, U.S. EPA, MD–15, Research Triangle Park, North Carolina 27711, telephone 919–541–5390, fax 919–541–0839; or Scott L. Mathias, U.S. EPA, MD–15, Research Triangle Park, North Carolina 27711, telephone 919–541–5310, fax 919–541–0839.

SUPPLEMENTARY INFORMATION: The contents of today's preamble are listed in the following outline:

I. Introduction and Overview

On March 16, 1995, President Clinton and Vice President Gore announced 25 major initiatives for regulatory reinvention at EPA. The number one initiative was an "open market" air emissions trading rule to achieve the public health standard for ozone faster and at lower cost. The Presidential announcement said:

> EPA will issue an emissions trading rule for smog-creating pollutants that will allow States to obtain automatic approval for open market trading of emissions credits with accountability for quantified results. Expanding use of market trading on a local and regional level will give companies broad flexibility to find lowest cost approaches to emissions reductions. The rule will encourage experimentation with new trading options, while enabling States to pursue more quickly allowance-based cap systems, which are already under development in some areas. (Reinventing Environmental Regulations; Clinton/Gore, March 16, 1995)

Today's proposal of a model rule for open market trading fulfills this commitment. It would provide an expedited path by which States, with EPA's cooperation, could quickly implement this new approach.

Together with ongoing initiatives to promote emissions budget (cap and trade) programs, the open market rule signifies a major push to introduce market-based approaches to cleaning up the air: Reducing costs, increasing innovation, enhancing flexibility, and accelerating attainment of health standards.

Ground level ozone, the primary constituent of smog, continues to be one of the most pervasive pollution problems in the United States. Exposure to ozone may cause serious respiratory health problems, such as chest pain, coughing, nausea, and congestion.

Elevated ozone levels have been associated with observed increases of hospital admissions for respiratory diseases such as asthma and decreased lung function of children attending summer camp. It is estimated that ozone damage to crops, forests, natural systems and synthetic materials is significant and exceeds $2 billion per year lost to crops alone. Ozone is not directly emitted into the air, but instead is formed in the atmosphere from reactions of "precursor" pollutants in the presence of sunlight and warm conditions. The major ozone precursor emissions are oxides of nitrogen (NO_X) and volatile organic compounds (VOC).

In the last 25 years great progress has been made toward achieving healthy air quality under the Act. However, over 100 million people still live in areas that do not meet the ozone health standard. Continued reductions in ozone precursor emissions are important to protect public health, and represent a tremendous challenge for our nation's citizens and industries.

The 1990 Amendments to the Act established new deadlines for meeting the health standard for ozone and substantially increased EPA, State and industry attainment efforts. All areas that have not yet attained and maintained the ozone standard are categorized as marginal, moderate, serious, severe, or extreme areas. Each category has a compliance deadline, ranging from 3 years (for marginal areas) to 20 years (for extreme areas; e.g., Los Angeles). All such areas have requirements for reasonably available control technology (RACT) for major stationary sources of VOC and NO_X and with the exception of marginal areas have defined rates of progress (ROP) for reducing ozone precursor emissions.

The smog reduction programs in the U.S. are typically based on traditional forms of environmental regulation: source-specific emissions standards (e.g., RACT) set on a uniform basis for categories of similar sources. Even though set as performance standards, these regulations have a tendency to treat all sources within a category the same and to be oriented toward the lowest common denominator, that is, toward sources within the class that have the greatest difficulty and/or greatest cost of control. Such standards simultaneously miss substantial opportunities for cheap emissions controls by "better" sources, and impose a disproportionately high cost (per ton of pollutant reduced) on a smaller group of sources. Government frequently lacks information on untapped but cost-effective control options, and sources have no incentive to be forthcoming. Government also tends to overlook smaller or unconventional sources.

Recognizing some of these problems in traditional regulations, EPA has developed policies permitting an increasing variety of "emissions trading" approaches since the late 1970's. The EPA "bubble," "netting," and "offset" programs allow certain kinds of trading of emissions reduction obligations within the pre-existing regulatory structure. These programs use the existing command and control regulations as a baseline for trading.

The results of these existing programs have been mixed. Overall, the volume of existing source trading has been small, perhaps due to high transaction costs associated with the bubble policies. New sources have found it possible through netting to avoid both time- and resource-consuming Government review processes. Bubbles, netting and offsets have reduced sources' overall compliance costs. However, there have been significant problems of quality control, reducing the environmental effectiveness of the programs.

A. Emerging Market-Based Approaches for Ozone Control

The 1990 Act Amendments recognized the merit of market-based solutions to pollution control. The Amendments introduced a market-based allowance trading system for sulfur dioxide to control acid rain. The Amendments also included a requirement, in certain cases, for economic incentive programs (EIP's) to be used as part of States' plans to meet the ozone and carbon monoxide standards in designated nonattainment areas. In 1994, EPA issued the EIP rule, which provided rules and guidance for establishing EIP's. Two market-based approaches have emerged that show particular promise for EIP's or other ozone related trading systems: emissions budget programs and, more recently, the open market approach.

1. Emissions Budgets: ("Cap and Trade")

Emissions budget programs have been highly successful where they have been implemented to date and offer the potential for high integrity achievement of environmental goals and considerable cost savings. Emissions budgets programs are predictable, flexible, offer low transaction costs, and in practice have yielded both unexpectedly high rates of innovation and unexpectedly lower costs. The cost of the acid rain program is proving to be considerably lower than expected—in large part because of the flexibility and innovation allowed under an emissions budget program. Estimated national annualized cost of the program at the time of enactment (1990) was $4 billion; the current (December 1994) estimate from the General Accounting Office is $2 billion (Market-Based Pollution Control Programs, ICF Kaiser, Inc. May 11, 1995). Recent scrubber costs are about half of their historic level and their removal efficiency has increased. Prices for low sulfur coal are also lower than expected because of increased production, increased use of low expense coal cleaning, bundling of allowances with fuel sales, and competition in transportation. The Regional Clean Air Incentives Market (RECLAIM) program is expected to cut Southern California NO_X emissions by 80 percent over 10 years while saving about $58 million annually compared to traditional regulations (ICF Kaiser, 1995). Well-designed emissions budget proposals offer the highest degree of certainty for the environment and sources alike, and EPA wants to do everything possible to support and encourage them. The EPA is currently providing strong support for ongoing State development of emissions budget approaches for large-scale regional control of NO_X in the Northeast Ozone Transport Region (OTR), and for VOC emissions in Chicago and Los Angeles.

Notwithstanding their substantial benefits, emissions budget programs are unlikely to capture all of the market-based opportunities to achieve environmental results with reduced cost and greater flexibility. Emissions budget programs have required considerable start-up time and effort. They require agreement on (1) The universe of covered sources, (2) baseline emissions levels, (3) the emissions cap and its rate of decline, (4) the allocation of emissions allowances, and (5) standardized monitoring and measurement techniques for determining each source's emissions. Experience with RECLAIM and the acid rain program shows that obtaining agreement on these points can take several years. As a result, emissions budget programs have been applied to date mostly to well-measured pollutants from relatively uniform industrial sectors, e.g., oxides of sulfur (SO_X) and NO_X from utilities. Start-up time should decline, however, as experience is gained. The RECLAIM program and the Chicago program are making great strides in extending emissions budget programs to some categories of VOC sources.

The EPA is committed to continue providing financial and staff support to emissions budget development projects,

and the Agency will process emissions budget SIP revisions on an expedited basis. Nonetheless, opportunities remain for market-based solutions that emissions budgets are not likely to capture in the near term. The EPA is pursuing the open market approach, in addition to emissions budget approaches, to reach more of these opportunities for cost reduction and flexibility while meeting public health protection standards.

2. Open Market Trading

As stated, the open market approach has the potential to reach market-based opportunities that emissions budgets are not capturing, and to serve in some cases as a transitional stage until full emissions budget programs can be developed. Open market trading programs can begin operating without waiting for agreement on a cap, on allocations, or on pre-established emissions measurement methodologies.[1] They can be implemented before there is agreement on an area-wide or regional budget or other package of emissions reduction measures fully adequate to demonstrate attainment of the ozone smog health standard. They also have the potential to reach more diverse and numerous types of sources (including mobile sources) than have been covered to date by emissions budget programs.

The OMTR described today builds on the pioneering work done in a major demonstration project overseen by the Northeast States for Coordinated Air Use Management (NESCAUM) and the Mid Atlantic Regional Air Management Association (MARAMA) (Emissions Reduction Credit Demonstration Project, Phase II, Volume I Final Report, April 1995). This project was partially funded by EPA's market-based initiative grant program and has involved many State air pollution officials, EPA staff, environmentalists, and representatives of major corporations in the Northeast.

The open market system differs both in concept and execution from the traditional emissions reduction credit (ERC) programs, "bubbles," "netting," and "offsets.— These programs involve trading of contemporaneous emissions rates that extend indefinitely into the future. The open market, on the other hand involves trading of discrete quantities (tons) of emission reductions already made. The discrete reductions are measured from an emissions baseline that is generally defined as the lower of actual or legally allowable emissions at the source. Retrospective quantification of discrete reductions offers the potential for achieving greater certainty and verifiability for all parties regarding reductions already accomplished.

Administration of ERC programs under the 1986 Emissions Trading Policy Statement has required a heavy investment of State, Federal, and public resources in "up-front" review and clearance of specific trades. In the effort to avoid quality control problems ("paper trades") that existed at points in the past, States typically devote substantial resources and take considerable time to review individual trades. High governmental costs and delays for the private sector have kept the volume of emissions trades quite low.

The open market system would shift review and approval of individual trades from the front end as a SIP revision or a permit change, to the time of use as a compliance determination and enforcement matter. Instead of complying with an emissions limitation through control equipment or process changes on site, a source operating under the open market rule may comply by buying and using an appropriate number of tons of discrete emissions reductions (DER's). This system places responsibility for the quality of those DER's on the source that uses them for compliance. These features would reduce front-end costs and delays while harnessing private sector resources to assist government in assuring quality control. Responsibility for compliance would motivate arms-length users to inspect carefully and choose wisely among the DER's offered on the market, and to protect themselves through contract indemnification provisions with sellers of reductions, or with third party auditors, and through purchases of extra reductions as "insurance." Trades can take place before governmental review and approval, increasing flexibility and lowering costs.

The likely benefits of this system would be several. The fact that reductions are accomplished before they are traded and used, encourages earlier achievement of reductions. The private sector would be rewarded for revealing, rather than concealing, cost-effective pollution control opportunities. Lower cost curves would make it easier for States to deny variances and promulgate additional needed rules. The open market system would also expand the participating pool of sources beyond those currently subject to direct regulation.

The practical implementation of an open market trading system gives rise to many significant questions. These questions are identified here and addressed in Section III of the preamble to today's notice. How would open market trading be made consistent with air quality goals and legal requirements? What would be EPA's role in assuring market integrity? To promote certainty in the market as well as quality and enforceability of reductions, what level of EPA support for emissions reduction quantification protocols would be necessary? What would be the appropriate degree of compliance oversight?

B. Open Market and Emissions Budgets Can Work in Concert

The EPA believes open market and emissions budget systems can complement each other and even work together. Open market systems can be put into place more quickly because they do not require consensus-building on a budget, allocation disbursement and related infrastructure. Open market systems can involve different source sectors and smaller, more diverse sources that are not easily captured by budgets. Open market systems can operate in concert with budgets and positively affect areas outside the emissions budget domain.

Emissions budget systems would still offer substantial advantages over open market systems. Under emissions budgets, sources have greater certainty about future allowance allocations and thus greater flexibility and ability to plan operations and trading in the future. Reductions from shutdowns and curtailments, while not compatible with the open market system, can be accommodated under an emissions budget program. Thus, there will be continuing incentives to move from an open market to a budget system, which would allow increased flexibility and cost savings consistent with achieving health and environmental goals.

C. Rationale and Principles for Today's Proposal

The model State rule proposed in today's notice has several features that would clear the way for widespread application of open market trading programs. Today's proposal is designed to eliminate the bottleneck of the single-source SIP revisions for emissions trading. The adoption of the OMTR into the SIP would allow sources to legally substitute DER's for on-site compliance through pollution control equipment. Today's proposal is a model rule for incorporation into the SIP. Once this rule is made final, EPA proposes to automatically approve SIP revisions that adopt this rule.

[1] The name "open market" was coined to reflect the absence of an emissions budget or cap (so-called "closed market" systems).

The model rule would not displace any other trading rule or option currently approved or under development. It would open a new method of trading and a new route for adopting that method. The model rule describes a set of provisions that EPA has concluded are approvable in all circumstances and in any area of the country. Variations that are more expansive (e.g., trading over greater distances than provided in the model rule) may be approvable in specific areas or under the specific circumstances of a particular State. The EPA would evaluate SIP revisions containing variations of this model rule on a case-specific basis. The EPA is committed to working closely with any State interested in pursuing any such variation. The EPA is available to consult with States on the approvability of potential variations and to provide expeditious review and decisions on any such submissions.

In producing this proposed model rule, EPA has observed the following over-arching principles:

1. Do Not Interfere With Ongoing State Market-Based Programs

As mentioned above, one function of the OMTR is to encourage, enable, and support emerging State trading programs, whether they are classified as open market, emissions budget, or another trading approach. The proposed model rule is neither mandatory nor prescriptive. States would be free to tailor their own programs, which may or may not include an open market trading component, and EPA encourages States to harness compliance tools appropriate to their particular circumstances.

2. Reduce Compliance Costs Without Compromising Environmental Integrity

A key test for any market-based strategy, including the OMTR, is to lower the overall cost to the economy of clean air compliance, in a manner that has equivalent or better environmental integrity.

3. Provide for a Long-Term Benefit to the Environment

The open market rule should benefit the environment in a number of ways. Facilities may reduce emissions beyond their current levels in order to sell the reductions, and facilities purchasing the reductions would in turn have more flexibility to meeting their compliance obligations, often obviating the need for source-specific emissions limit modifications and exemptions. The open market program should encourage early reductions through banking. It also should create an incentive to try incremental and innovative emissions reduction strategies, as well as reward accurate emissions measurement procedures. To ensure an environmental benefit, the proposed rule requires 10 percent of every credit used to be retired for environmental benefit.

4. Maximize Flexibility and Minimize Transaction and Regulatory Costs

Reflecting one of the President's concerns with the role and effectiveness of the Government in his reinvention initiative, a major goal in this rule development is to improve upon the burdensome oversight, and reporting and recordkeeping requirements that currently exist in many pollution control programs. In this spirit, the rule proposes requirements that are less burdensome yet consistent with the level of quality necessary to maintain environmental integrity within the open market system.

5. Actively Involve the Public, Industry and States in the Process

The EPA has worked with States, industry, and the public in developing this model rule. This cooperative process will continue as the proposed rule emerges toward its final version.

II. Summary of Proposed Rule

A. Purpose

The purpose of the model open market trading rule is to allow sources to generate and use DER's for compliance with Title I and various Title II VOC and NO_X rules while complying with all other applicable requirements of the Act. The model rule would provide VOC and NO_X sources with a financial incentive to reduce emissions below levels required by applicable Federal and State requirements and below their actual emissions in the recent past. Sources would be permitted to make more economical decisions regarding how to comply with pollution control requirements applicable to them. These sources would be able to supplement or replace traditional compliance strategies with a strategy of purchasing and using DER's.

B. Applicability

Today's notice applies to any State that adopts and submits an identical rule to EPA as a SIP revision. The preamble to the proposed model rule serves as a policy statement on open market emissions trading, and explains how EPA would view specific deviations from the proposed model rule.

C. State Program Election and Submittal

The EPA would automatically and immediately approve any State submittal that revises that State's SIP to incorporate the identical language of the model rule. That does not imply, however, that a State could not develop variations on the model rule tailored to its particular needs. The EPA would review any such rule and judge its approvability in accordance with the adequacy and reasonableness of the justifications for any variations from the model rule. Variations could not be automatically approved, but EPA is committed to reviewing them expeditiously.

D. Rule and Program Summary

This section briefly describes, in nontechnical terms, how the open market trading system would work under the model rule proposed in today's notice. It serves as a brief summary of the steps a source would take to generate and/or use a DER, including any limitations. It also describes what, when and how the source would need to tell the State about their DER activity. A brief description of EPA's enforcement strategy is also included.

1. Generating DER's

Any NO_X or VOC source could generate DER's under the OMTR. In contrast with traditional trading programs, where a source must accept a permanent tightening of applicable emissions reduction requirements in order to generate a continuing stream of emissions reduction credits, in the open market program a generating source would not change its legal emissions limitations. The source could generate DER's by any action that reduces its emissions per unit of production or operation (e.g., install pollution controls, make process changes, switch fuels). Qualifying actions may even be temporary (e.g., a temporary fuel switch); after the discrete period in question, the source would have no obligation to continue emitting below its legal limitations.

To be valid, DER's must meet the requirements of the model rule and of guidance regarding emissions quantification that will be issued by EPA. The DER's must be real, surplus, and verifiably quantified. The DER's must represent real reductions in ozone-forming emissions. In addition, they must be surplus, that is, reductions that were not otherwise required by existing regulatory requirements or accounted for in attainment or maintenance plans. DER's are emission reductions generated

over a discrete period of time, measured in units of mass (usually tons). The generating source would be responsible for verifiably documenting the amount of DER's it had produced, and DER's would have to be measured through a valid quantification protocol.

To generate DER's, a source would first determine its baseline, which reflects what the source would have emitted during the generation period absent its DER generation strategy. In general, this would be determined by referring to either the emissions level that would be allowed by current law, or the facility's emissions that would have occurred based on recent actual emissions rates. After the baseline was ascertained, measurements would be taken and calculations would be made to determine the amount of DER's that resulted from the specific action taken to reduce emissions. This process must follow a valid quantification protocol developed in one of several ways as indicated below. The protocol would take into account an individual source's characteristics (e.g., rates of VOC and NO_X production, continuous or batch processes, etc.) and monitoring capabilities. A source could chose to follow a protocol that had been found to be previously acceptable, or it could forge a new protocol following criteria that EPA will issue in protocol guidance.

The generator would quantify its reduction by factoring relevant source-specific information into the quantification protocol to determine the amount of DER's generated. The generator must document DER's in a format that would allow enforcement authorities to verify them, to determine the user's compliance and, where necessary, to enforce in cases of invalid DER's. Once generated, DER's could be used at any later time for compliance with an eligible VOC or NO_X emissions reduction requirement. Like other emissions allowances recognized under the Act, they would not be the holder's property, but instead would be a limited authorization to emit the designated amount of emissions.

After a DER had been generated, the source generating the DER's would submit a Notice and Certification of Generation to the State where the generation had taken place. This notice must contain a certification, made under penalty of law, as to the accuracy of certain information, including:

(a) The name and location of the source that reduced emissions;

(b) The discrete time period over which the emissions reductions occurred;

(c) The amount of emissions reductions that occurred during the ozone season and the amount of reductions that occurred during other parts of the year;

(d) The unique identification number for each ton of DER's created;

(e) The emissions quantification protocols that were used to calculate and document the emissions reductions;

(f) Information on existing requirements, if any, to which the generator source is subject; and

(g) A signature of an authorized individual who is certifying under penalty of law that the above information is accurate and complete.

Certain actions described in the rule would not create DER's, such as:

(a) Facility shutdowns;

(b) Temporary or permanent production curtailments;

(c) Emissions reductions resulting from modifying or discontinuing any activity that is otherwise illegal;

(d) Emissions reductions that occur as the result of any applicable Federal or State requirement including compliance with MACT, BACT, LAER, and NSPS requirements, or emission reductions relied on by the State for meeting the ozone NAAQS; and

(e) Actions that occurred prior to the start of the relevant 1995 ozone season.

2. Using DER's for Compliance

Once DER's were generated, they could be transferred to any party for use to comply with eligible requirements. Anyone could hold, purchase and sell DER's. Intermediaries could act as DER brokers to further facilitate the market process. Any source could use DER's to cover eligible compliance obligations. Common uses for DER's might be: (a) To comply with specified NO_x and VOC emissions limits; (b) to cover emissions increases that currently are commonly legitimized by variances; or (c) as offsets under an EPA-approved major new source review regulation.

A source that desired to use DER's for compliance purposes over a specified period must determine the amount of DER's it would need. Thus, the source must estimate its DER requirement through a valid emission quantification protocol, similar to the process described for DER generation, except that the user source must project its underlying activity rate for the use period. The source must retire 10 percent of the DER's it uses; thus it must purchase a fraction more than it needed for compliance purposes in order to help ensure that the flexibility and economic benefits of the open market trading program would also produce a public health protection gain in each future year.

In order for a user source to use DER's for compliance purposes, that source must own such DER's before the applicable date for compliance. The user must notify its State at least 30 days prior to its first actual use of DER's of its intentions to use such DER's. This notice would not obligate the notifying source to use the specified DER's. The notice would give the State the opportunity, if it wished, to begin inspecting the validity of the DER's before they are used.

The source must "true-up" its original DER need estimate by using the appropriate protocol to determine its DER compliance requirement during or after the period in which DER's would be applied. When a source had actually used specific DER's, it must file a Notice and Certification of Use along with its regular compliance reports to the State no less often than once every year. This notice would become part of the documentation that the State would rely upon to verify that the user had met its compliance obligations.

The model OMTR would prohibit certain DER uses. Such prohibitions include: (a) To avoid penalties or enforcement actions by obtaining DER's after the fact of noncompliance; (b) for netting or other means to avoid NSR/PSD requirements; (c) to meet Act section 111 and 129 NSPS, LAER, BACT or MACT requirements; and (d) to meet requirements for motor vehicle emissions standards, reformulated gasoline, Reid vapor pressure standards, clean fueled fleets, employer trip reduction programs, or vehicle inspection and maintenance programs.

3. Time and Place Use Limitations

By definition, DER's must be used at a time after their generation. This is known as intertemporal trading. Intertemporal trading could occur, within the same ozone season, from one ozone season to a later one, or from the ozone season to a non-ozone season. However, DER's generated during a time outside of the ozone season could not be used to comply with any emission reduction obligations during the ozone season.

User sources must also comply with certain geographic restrictions to ensure that the new geographic distribution of emissions created by trading would not interfere with a State's obligation to maintain air quality or reach attainment of the ozone smog standard in a timely manner. Due to differences in the role of natural emissions and in how VOC and NO_x react to form ozone, the

proposed model rule places different geographic limitations on VOC and NO_x.

Under the model rule as proposed herein, VOC reductions generated outside any ozone nonattainment area may not be used for compliance inside any nonattainment area. NOx emissions generated outside a SIP's modeling domain (as defined by urban airshed modeling) may not be used for compliance inside the modeling domain. These limitations could be relaxed in some but not all State-specific OMTR applications due to an area's unique meteorology. If a State submitted appropriate justification, EPA would consider and expeditiously review any area-specific variations on the model rule's geographic limitations.

Consistent with these geographical limitations, interstate trading and use of DER's would be allowed and encouraged, so long as the relevant States had entered into agreements that allowed such transactions. Participating States must provide for an interstate DER tracking system so the States could protect against DER's being used more than once.

4. Reporting, Recordkeeping, and Public Availability

Sources must keep adequate and accurate records so as to ensure that the DER's are real, quantified, surplus and verifiable. In addition to the records they must create themselves, users would be expected to have pertinent records of DER generation from the generator to prove they held valid DER's. The user source then must hold such records for a minimum of 5 years after the DER's are used.

The notices that are submitted to the State must be made available to the public by the State under the appropriate State law regarding public access to such documentation. This requirement applies equally to both title V and non-title V sources. This will allow the public to monitor specific transactions and contribute to public confidence in the open market system.

5. Market Participants

Both sources that have and do not have title V operating permits could, and are encouraged to, participate in the open market trading program, especially as DER generators. One of the benefits of the open market program is that small stationary sources and mobile sources that are not subject to title V requirements could contribute to reducing overall pollution levels in an area. The Notice of Intent to Use and the Notice and Certification of Use must be filed with any applicable operating permit.

6. Protocol Development and Approval

One key to integrity in the operation of an open market system is accurate quantification of the amount of surplus DER's created, and accurate quantification of the amount of DER's needed to meet compliance obligations. For the program to be adequately enforceable by State and Federal authorities, these measurements or calculations require emissions quantification protocols that could be recognized by the State and the EPA for use in the open market program. All DER generation and use activities must be documented through the use of DER quantification protocols that either have been approved by EPA, or that correspond to EPA guidance on acceptable protocols. Typically, a protocol would specify the measurement methods, monitoring methods, calculation procedures, and documentation requirements for estimating or measuring emissions for both the source's discrete reduction strategy and its baseline. All protocols must include methods that are credible and replicable.

EPA-approved protocols could come into existence in two ways. First, EPA intends to issue EPA-approved protocols for a number of reduction strategies. Second, EPA would work together with States and industries to jointly review and approve quantification protocols for a variety of source types. As a separate action, EPA also plans to issue guidance on the development of an acceptable protocol. This guidance would lay out specific criteria that must be met by a protocol developed by a generator or user which had not already been approved by EPA. The EPA intends to issue this guidance by the time the model rule is finalized.

7. Enforcement

The user source would be responsible for complying with all applicable requirements, and therefore would bear the burden of demonstrating that the DER's it relied on were real, surplus, in sufficient quantity to meet its compliance obligation, came from an appropriate place and season, and met all other applicable requirements of the rule. The user would be subject to enforcement proceedings for insufficient or invalid DER holdings. The DER user, not the State, would bear the burden of proof that the amount of DER's purchased were sufficient to cover its compliance obligation including the environmental discount, and that the DER use met all applicable requirements of this rule.

From a compliance and enforcement standpoint, a lack of adequate and credible recordkeeping would be equivalent to a lack of creditable DER's. As stipulated in the Act, each violation (emissions limit or recordkeeping) would be subject to maximum penalty of $25,000 per day. Criminal sanctions could also apply as allowed under law. In assessing penalties, EPA enforcement policy does take into account the nature and degree of violation when determining what is an appropriate enforcement action.

8. Program Audit

At least once every 3 years, the State would be required to audit their open market trading program to evaluate the program's performance. The audit would include, but would not be limited to, an examination of the program's effects on requirements for rate of progress (ROP) and timely attainment (credits used compared to credits generated in a given year or ozone season), and the effects of reconciliation measures that might have been taken as a result of previous audit findings.

If the audit indicated a problem with implementing this rule, then the State must consider initiating measures to reconcile the problem. Possible reconciliation measures would include, but would not be limited to: (a) Enhancing monitoring requirements; (b) increasing the environmental benefit component of DER use, or limiting the use of DER's to compensate for the difference between actual emissions and the reductions needed to reach attainment; (c) implementing additional technology-specific emissions reductions; (d) increasing penalties, or (e) restricting trading.

The EPA would also perform a national audit based on the compilation of State audit reports and if necessary, would revise the open market program in accord with the audit's findings.

III. Discussion of Issues

This section provides more detail on the provisions of the OMTR and issues surrounding the development of an open market trading system and requests public comment on several issues. This section also discusses elements of the proposed model rule that States could modify to meet their unique needs. The EPA recognizes that States may develop variations on this rule that are better suited to specific local air pollution problems, and EPA will be flexible with respect to approving a variation to the model rule if the State provides an adequate and reasonable justification.

A. Regulatory and Contractual Liability in the Open Market

Currently, most emissions trades between existing sources are made through single-source SIP revisions that must be approved by both States and EPA. Pre-approval scrutiny of each trade is generally effective in ensuring that trading does not interfere with air quality requirements: For example, that the emission reductions and increases involved are calculated from appropriate baselines and are appropriately quantified. However, individual SIP revisions take considerable time and involve substantial costs for both the private sector and State and Federal governments. At least in part because of these transaction costs, the number of emissions trades between existing sources has been relatively low, and significant potential opportunities to meet air quality objectives at lower cost have not been realized.

The EPA's fundamental objectives in this proposal are to free up the market for a higher volume of cost-effective emissions trading while at the same time maintaining the relatively high level of quality assurance that the current system provides. To meet these objectives, EPA has used the following "design criteria" in designing the proposed open market trading rule. The proposed rule should:

(1) Support timely attainment and maintenance of the Clean Air Act's public health protection standards;

(2) Reduce private sector compliance costs, making it possible to better protect the environment at lower cost;

(3) Reduce governmental costs in administering an expanded emissions trading system;

(4) Make maximum use of private sector mechanisms for quality assurance (liability arrangements, contractual guarantees, insurance, third party services, etc.);

(5) Give potential market participants the ability to predict with reasonable certainty which emission reduction actions will be found valid and creditable by governmental authorities; and

(6) Provide the private sector with strong incentives to comply with all requirements while at the same time giving responsible ("good faith") market participants reasonable expectations on potential exposure to civil or criminal penalties.

The proposed rule, as already noted, is derived from the "open market" concept developed by the EPA-supported NESCAUM-MARAMA demonstration project and elaborated in a recent article.[2] This approach avoids the need for single-source SIP revisions by treating emissions trading as a compliance option, that is, as another means of compliance with applicable pollution control requirements contained in the State Implementation Plan (SIP).

At present, most SIP's establish emission limitations directly applicable to specific equipment and operations at facilities. Owners and operators of such facilities must comply with these emission limitations by installing emissions control equipment, making process changes, or changing fuels or other inputs. Failure to comply is a violation of State law and section 113 of the Clean Air Act and exposes the source to enforcement proceedings by the State and EPA. Citizens may also bring actions to enforce these obligations under section 304 of the Act.

Under the open market concept, sources would have the option of complying by purchasing appropriate amounts (tons) of discrete emission reductions (DER's) generated by others. The governmental role in reviewing emissions trades would be transformed from prior approval during SIP revisions to "post-hoc" scrutiny during compliance determinations. Eliminating pre-approval of reductions and shifting to review at the compliance stage would greatly free up the market and increase trading volume, thereby reducing compliance costs and benefitting the environment.

A key issue identified, however, in the NESCAUM-MARAMA demonstration project and in the above-cited article is how to maintain confidence that DER quality will remain high—that reductions will be taken only from appropriate baselines and rigorously quantified—as government involvement moves from prior approval to compliance auditing.

Maintaining confidence in the quality of DER's is critical from all perspectives. Regulatory authorities and the public need to know that pollution will actually be reduced as projected, and the private sector needs to know that the market will reward high quality reductions and reject defective ones. Yet detailed compliance audits are inherently conducted on only a fraction of sources each year, as limited governmental enforcement resources must be targeted at a range of high priority environmental problems.

In the stakeholder and interagency review processes conducted prior to this proposal, a number of options were put forward for maintaining DER quality assurance in an expanded emissions trading market. The proposal made today is a hybrid of these options that EPA has developed using the "design criteria" described above. The EPA believes this hybrid best serves the twin objectives of freeing up the market for a higher volume of emissions trading while maintaining sound quality assurance incentives.

1. Option 1: User Liability

The first option considered was put forth by the original developers of the open market concept. Building directly on the current regulatory structure, they contemplated that liability for deficiencies in DER's under the Clean Air Act and State air pollution laws would remain with the party who purchased and used the DER's as a compliance option, since that party had the original compliance obligation. The key concepts underlying this option are that (1) DER's are compliance products similar to pollution control equipment, and (2) as such the user source is responsible for compliance when using DER's just as it is when complying by use of control equipment.

Like sources using purchased control equipment or services, sources using DER's to meet their emission limits would be able to control their compliance risks by choosing carefully among vendors and by negotiating for appropriate guarantees, insurance, or indemnification provisions. Pollution control equipment and services purchased from vendors generally come with guarantees specified in contracts or implied under commercial law, or with specific insurance policies or indemnification agreements as negotiated by the parties. Pollution sources using purchased control equipment or services, however, remain responsible for their own compliance obligations with State and Federal pollution laws, and remain liable to enforcement authorities in cases of non-compliance, even if the non-compliance was caused by a shortcoming in the products or services purchased from a vendor. In that case, sources have recourse to contractual guarantees, insurance, or indemnification provisions. Through these provisions sources can return to compliance (e.g., obtain satisfactory equipment) and be compensated appropriately for damages.

Liability for compliance with State and Federal pollution laws and the

[2] Emissions Reduction Credit Demonstration Project, Phase II, Volume I Final Report, April 1995. Developing a Market in Emission Credits Incremental: An "Open Market" Paradigm for Market-Based Pollution Control; Richard Ayres, Bureau of National Affairs Environment Reporter, Current Affairs December 2, 1994.

prospect of enforcement for non-compliance encourage each source to pay attention to the quality of goods and services offered by prospective vendors of emission control equipment, fuels, and services. In the competition for sources' business, market forces favor vendors with great expertise, good track records for reliability, or the best guarantees. Less capable vendors, who expose their clients to greater risks of non-compliance, generally command lower prices—if they can get any business at all. Market forces would be expected to operate in the same way for DER's. In order to minimize risk, buyers would look for quality and favor DER's that present low risks of placing users in non-compliance. Users would remain responsible to enforcement authorities in cases of non-compliance, but would be able to use contractual provisions (guarantees, insurance, etc.) to shift the financial consequences to generators or intermediaries that sold them defective goods. The care users would take to reduce their compliance risks would help assure the quality of DER's for the benefit of both governmental authorities and the public.

Many participants in pre-proposal stakeholder discussions expressed support for this option of placing liability for DER validity on the buyer. Some participants, however, expressed concern that this option would not provide appropriate incentives for attention to DER quality if the seller and buyer are not in an independent, arms-length business relationship, such as when DER transactions are internal to a company or between companies that have close ties.

Still other participants expressed concern that buyer liability could create excessive uncertainties and risks for buyers. They predicted that buyer liability would reduce market activity and suggested other options.

2. Option 2: Retaining Pre-Approval Requirement

Several commentors recommended that EPA continue to allow trading only in reductions that have been pre-approved by governmental authorities. They contended that an active market could develop only if buyers have certainty that reductions offered on the market will be accepted by governmental authorities, and that this degree of certainty could be provided only by governmental pre-approval.

These commenters acknowledged, however, that the requirement for a source-specific SIP revision was an expensive and lengthy process for both industry and government and would remain a bottleneck preventing expansion of the market, especially given current governmental budgetary constraints. In response, these commenters suggested process changes such as limiting the time allowed for State review or dispensing with EPA review.

Other commenters, however, expressed concern that these process changes would present too high a risk of approving poor quality DER's. Governmental approval would be given despite reduced scrutiny of DER quality. Neither buyers nor any other party would have incentives to scrutinize the quality of DER's offered on the market once they were governmentally approved. These commenters expressed concern that this would lead to an influx of unsupported DER's, to the disadvantage of generators that were trying to follow the rules, and an increase in actual pollution levels.

3. Option 3: Splitting Regulatory Liability Between User and Generator

Other commenters suggested splitting liability for compliance under State laws and the Clean Air Act among the generators and users of DER's. Under this option, DER generators would bear full liability for the validity of the DER's they sold, and users' liability would be limited to deficiencies in how DER's were used (i.e., inaccurate calculation of a user's compliance "debit"). In other words, users could purchase and use DER's without any legal risk for deficiencies in the generation of those DER's. In a variation of this option, the user would have the limited obligation to make up shortfalls if compliance authorities discovered deficiencies in the DER's it relied on. Commenters stated that one of the advantages of this approach would be that each party would be held responsible for actions under its own control. The transaction costs associated with constructing legal arrangements to give the DER buyer information and certainty about DER generation activities (inspecting potential DER purchases and negotiating for guarantees or insurance) would be avoided, thereby expanding the volume of trading and the cost savings.

Proponents of this option acknowledged that buyers would have fewer incentives to inspect DER's offered to them, compared to the buyer liability option. They contended, however, that it would be possible to increase the frequency of governmental audits, and the size of penalties, enough to maintain DER quality assurance. Other commenters expressed concern that an increase in governmental auditing sufficient to preserve DER quality would be difficult in light of budgetary constraints, and that it would be difficult to convey appropriate market signals about potential penalties through case-by-case enforcement actions. Legal issues were also raised over whether State authorities could obtain jurisdiction over out-of-state generators, and on whether statutes of limitations with respect to generation violations would begin to run before the DER's are used.

4. Option 4: Reliance on Third Party Guarantors

Another suggested option is to allow independent third parties to guarantee the validity of DER generation and assume the compliance liability for invalid DER's. In this option, independent third parties would become subject to penalties under State laws and the Clean Air Act if DER's were deficient. This liability would give such third parties incentives similar to those of the buyer under Option 1 to inspect DER's carefully and choose those that are best supported. The user would remain liable for deficiencies in how DER's were used, as in the split liability option above.

Proponents indicated that this approach could be of special value when dealing with small sources that have the potential to generate cost-effective emission reductions, but that lack the knowledge or capacity to seize the opportunities on their own. Likewise, the availability of such third parties might be valuable to small sources that were potential users of DER's, but that lacked the necessary expertise to purchase high quality DER's on their own or the willingness to assume liability for defective DER's. Other commenters raised questions about the legal means by which such third parties would be made subject to regulatory liability, how to define an independent third party, and how to handle the potential bankruptcy of such a party.

5. Proposed Approach

The proposed open market trading rule adopts a hybrid of these options, as well as other measures to address concerns about incentives and uncertainties. The proposal is based largely on Options 1 and 4, while also requesting comment on the issues raised in Option 3. The EPA believes that the principle of buyer liability will work the best to assure DER quality. The EPA also believes that in addition to their major role through contractual mechanisms, third parties should be allowed to assume regulatory liability in certain circumstances. The proposal also reflects other significant features

intended to promote market activity by reducing the uncertainties associated with buyer liability.

Accordingly, under the proposed open market trading rule, sources may use DER's in lieu of direct pollution control measures to demonstrate compliance with their emission reduction obligations under State and Federal law. Today's rule proposes that the user source would be responsible to enforcement authorities for compliance. The EPA has taken four steps in this proposal to reduce the uncertainties and transaction costs associated with this liability structure. Included in these steps are provisions for third parties, in certain circumstances, to assume the legal responsibilities of a generator. In addition, EPA is considering and asking for comment on whether there are appropriate circumstances in which a third party could take on a portion of the legal liability of certain users, or liability could be divided between user and generator.

a. Generator Certification. First, the proposal would require generator sources to certify, under penalty of law, to the accuracy of the underlying factual information (e.g., the accuracy of monitoring and other data used to calculate the reductions), which supports DER's offered for sale. If subsequent investigation should demonstrate that such information was inaccurate, the generator would be subject to civil and, if appropriate, criminal enforcement. It should be noted that certification is a requirement to which pollution control equipment vendors are not subject, but EPA believes it is an appropriate requirement for DER generators in order to provide a significant added measure of DER quality assurance to prospective users, State and Federal authorities, and the public.

b. Guidance for Emissions Quantification Protocols. Second, EPA proposes to issue guidance containing criteria for emissions quantification protocols. Quantification of the emissions reductions that sources have generated and the amounts that are needed by users would have to meet the criteria in this guidance. In addition, working with the States, industry, and the environmental community, EPA proposes to create a mechanism for approving specific quantification protocols for priority types of generation and use activities. A number of such protocols would be drafted by industries, and others by EPA or States. They would be reviewed by a multi-stakeholder process prior to an EPA approval decision. The EPA believes these protocol guidance and specific protocols would give generators and users, as well as compliance authorities, a predictable "road map" for distinguishing DER's that have a high likelihood of being considered valid, from ones that are suspect or clearly inadequate.

c. Third-Party Relationships. Third, EPA proposes to encourage the emergence of a variety of third-party relationships that could help the market function. Within the context of Option 1, third parties could, through contractual arrangements, assume many important functions that would assist generators and users. Further, as suggested in Option 4 above, EPA proposes to allow third parties to assume the regulatory liability of generators in certain circumstances. Finally, EPA is considering and requesting comment on the possibility of allowing third parties to take on a portion of the regulatory liability of certain users.

(i) Third party contractual roles. Under the proposal, generators and users could enter contractual arrangements with third parties to perform a variety of important functions. For example, generators and users could hire technical and legal experts to improve their ability to create and purchase high quality DER's. Technical experts could help generators develop quantification protocols that conform to EPA guidance, and develop the data that plugs into such protocols. Lawyers could provide expert opinions on the applicable State and Federal requirements that determine a source's baseline. Similar technical and legal services could be performed for the user, both to determine the user's need for DER's and to pick the highest quality.

Third parties could also serve as brokers matching sellers and buyers. Some third parties may acquire their own portfolios of DER's and offer guarantees, insurance, or indemnification services to buyers.

Independent third parties could serve as a trusted source of expert opinions establishing the quality of DER's. Such opinions would not relieve the user of its regulatory liability under State law and the Clean Air Act, but they could serve to reduce uncertainty, distinguish high quality products, and build market confidence. The EPA specifically requests comment on whether an opinion by an independent third party should be required when the generator and the user are not in an "arms-length" relationship.

(ii) Third parties as generators. The EPA also proposes that, under defined circumstances, third parties could directly assume the regulatory liability of generators. Third parties could play an instrumental role when dealing with small batches of cost-effective emission reductions from smaller sources. The EPA recognizes that the requirement for generator certification could discourage participation by small sources with the potential to make highly cost-effective reductions. Buyers may also be reluctant to take on the task of inspecting numerous small DER offerings from such sources. Third parties may be more familiar with the emission reduction methods and the DER calculation protocols than the owners and operators of such generator sources. Third parties could offer the service of taking operational responsibility for performing and documenting emission reducing actions for such sources, thereby capturing inexpensive emission reductions opportunities that smaller sources would otherwise be unaware of, or that they would be unwilling to seize on their own given the requirement for generator certification. The third party could then take ownership or control of the reductions achieved, aggregate many small batches of DER's, and offer them for sale to users.

To promote such actions, EPA is proposing that third party aggregators of DER's from small sources could take on the responsibilities of generators under the rule in certain circumstances. Specifically, this could occur where the third party enters an agreement with the owner of the small source to take actual operational responsibility for performing and documenting the action that generates DER's. Under the rule, the third party would be considered an "operator" of the sources in question, for the purposes of the Clean Air Act. The third party, not the numerous smaller sources, would file the Notice and Certification of Generation and assume the legal risk associated with the generator's certification as to the accuracy of the information underlying its DER; the sources whose emissions the aggregator reduced would have no liability. The user would look to the third party operator, not the actual owners of those sources, for the necessary documentation and certification as to the validity of the DER's, and for appropriate guarantee or insurance provisions.

In order to qualify for this role, the third party also would need to demonstrate financial responsibility, in order to insure that it has an adequate stake in generating bona fide DER's, and that the neither subsequent users nor the environment bear an undue risk in case of fraud or bankruptcy. EPA solicits comment on what specific criteria for a

showing of financial responsibility should be set forth in the final rule, and whether any additional qualifications or requirements on such third parties would be appropriate.

(iii) Third parties as users. EPA is considering and requests comment on whether third parties could play a similar role on the user side. The EPA recognizes that, as on the generation side, some sources with the potential to reduce control costs by using DER's may nonetheless be unwilling to take on the regulatory liability associated with responsibility for the validity of the DER's. It has been suggested that the rule could allow a qualified third party, by agreement with the user source, to assume the user's liability under State law and the Clean Air Act for the validity of the DER's used. Under this suggested approach, the user would retain legal responsibility for the calculation of the amount of DER's needed for compliance, as well as all other aspects of how the user source is operated. The third party, however, would assume legal responsibility for the validity of the DER's acquired and used.

The EPA is considering and requests comment on this approach should be adopted, and if so, with what appropriate conditions. Specifically, EPA is considering and solicits comment on what conditions would be necessary to maintain DER quality assurance incentives and capabilities for compliance determinations and enforcement actions equal to those associated with user liability alone. For example, to ensure that the third party has the same motivation as would the otherwise liable user to review DER offerings with care and choose on the basis of quality, the third party would have to be functionally independent of the generator from which it acquired the DER's. The third party would also have to consent expressly to take on the legal responsibility of the user source for deficiencies in the DER's, and to being considered an "operator" of user source for that purpose. The user and third party would have to file a single, unified Notice of Intended Use. They would have to do likewise for the Notice and Certification of Use, which would have to include certifications under penalty of law by responsible corporate officers of both the user and the third party as well as to the accuracy of the facts underlying their respective portions of the documentation. The third party would have to acknowledge the jurisdiction of the user source's State, and that any statutes of limitations on DER validity run from the time DER's are used, regardless when they were generated. The third party would have to commit to be present and make records available, on the same basis as the user, present with the user itself, for any inspections or related interaction with compliance authorities. As on the generation side, a demonstration of the third party's financial responsibility would assure that it has a sufficient stake to motivate diligence in determining the validity of DER's, and would protect the environment from undue risks of fraud or bankruptcy. As above, EPA solicits comment on what specific criteria should govern a showing of financial responsibility. The EPA is also considering and requests comment on how this approach would affect compliance determinations and enforcement proceedings in terms of complexity, resource demands, and effectiveness.

d. "Good Faith" Purchasers. Fourth, EPA proposes to develop a penalty or enforcement response policy in conjunction with the final open market trading rule that would lay out in greater detail how EPA intends to respond when DER's are determined to be deficient, despite users' "good faith" efforts, and the criteria upon which good faith would be judged. Enforcement of the Clean Air Act has a number of objectives, including remediation of environmental harm and deterrence of further non-compliance. The penalty or enforcement response policy will address the case where a source has fully acted in good faith in the purchase of DER's, including exercising due diligence in the inspection and selection of those DER's, and yet the DER's are subsequently determined to be deficient by compliance authorities. The policy will make clear that EPA's focus would be on remedying the harm to the environment from deficiencies in the DER's (i.e., the harm from excess emissions). This could be accomplished by requiring the user only to purchase and retire a sufficient number of DER's (perhaps with a multiplier) to recoup the deficiencies in the DER's originally used. The EPA requests comments on the steps a purchaser might take to be considered a good faith purchaser and on the appropriate multiplier, if any, should be applied in cases where replacement DER's are to be acquired.

The EPA believes these four features of the proposal would provide generators, users, and government authorities with sufficient guidance and certainty so that an active market in high quality DER's would develop.

After careful consideration, EPA rejected Option 2 (pre-approval requirement). The EPA agrees with concerns expressed by some commenters that retaining prior approval would maintain the bottleneck in the current system, and that proposals to limit State governmental review time or dispense with Federal review would run too high a risk of giving governmental sanction to poor quality DER's.

It should be noted that nothing in the proposed model rule is intended to prevent a State or other authorities from examining the quality of a particular DER prior to the compliance determination phase. Indeed, the Notice and Certification of Generation and the Notice of Intent to Use would give a State the opportunity to review a particular DER at an earlier stage, if it so chooses. The EPA expects also that many sources may seek informal consultations with States or EPA on the appropriateness of an emissions quantification protocol, the correct application of a monitoring method, the applicable baseline requirements, or other issues. The availability of such informal consultations could play an important role in providing certainty and predictability to the market. The EPA intends to continue working with stakeholders to explore mechanisms for informal early review of particular DER's.

With respect to Option 3, eliminating the user's responsibility for the quality of the DER's it purchased would reduce transaction costs and thereby expand the scope of trading leading to economic and environmental benefits. It would also increase the importance of governmental scrutiny during compliance determinations as a check on DER validity and a means of ensuring achievement of the environmental benefits. Only a fraction of sources are subject to detailed compliance inspections each year. If users are responsible for making up deficiencies, they will have some incentive to inspect the DER's offered to them to assure that they are real, surplus, and appropriately quantified. Nevertheless, it is possible that more unsupported or invalid DER's would be sold. This would increase pollution, damage public health, and undermine confidence in the market. The EPA is also concerned that both of these approaches could put the most scrupulous DER generators at a competitive disadvantage as compared with others that may exercise less care in their DER generation activities, unless compliance determinations are an effective check on the supply of defective reductions. The EPA requests comment on these issues. The EPA also requests comment on how, under a split

liability approach, States would address jurisdictional issues over out-of-State generators, or issues of responsibility for DER's generated in the past by sources no longer in business.

The EPA requests comments on all aspects of its proposed approach to liability.

B. DER Generation

1. DER Formation and Baseline

Under the proposed OMTR, participating sources may create reductions by reducing their emissions for a specific period of time below levels allowed by the approved SIP, State adopted rules (if more stringent and not yet in the approved SIP), applicable Federal requirements (e.g., NSPS), or historical actual emissions, whichever is more stringent. The source would not be required to remain at that new lower level permanently, but instead could reduce for a discrete time period. During that period, reductions may be calculated by determining the difference between what the source's emissions would have been under the baseline emissions rate (actual or allowable emissions without the DER generation strategy) and the actual emissions for the discrete period of operation at the new lower emissions level, times a measure of the source's operational level. The source would calculate its DER's in one ton units.

The generation baseline establishes a benchmark for what is surplus to all the source's applicable Federal and State requirements, including those contained in the area's SIP. Therefore, for sources located in areas where the attainment or maintenance plan is based on a source's actual emissions, the generation baseline would be the lower of the source's expected actual or allowable emissions. In areas that have fully approved attainment or maintenance plans which are based on sources' allowable emissions, the State has the option to let sources use their allowable emissions as the generation baseline. For sources not subject to any applicable VOC or NO_x requirements, and located in areas that are not required to have attainment or maintenance plans, the baseline would also be based on the source's actual pre-generation strategy emissions.

In some cases, the sources "actual" baseline emissions could be measured directly, for example, as the pre-control device emissions. In other cases, the baseline could be determined by reference to emissions rates for the two years immediately prior to the generation period in question, unless some other time period was deemed to be more representative of the operation of the source. In such cases, the expected actual emissions would be the product of the historical baseline emissions rate per unit production and the actual production during the generation period. The expected allowable emissions would be the product of the allowable emissions rate per unit production and the actual production during the generation period.

Some comments have expressed concern about the establishment of the emissions baseline for sources generating DER's in areas which have failed on a prolonged basis to submit and gain EPA approval of: (a) Measures needed to meet rate of progress (ROP) requirements, (b) attainment demonstrations, or (c) maintenance plans. These commenters have argued that if a State has not yet adopted the additional emissions control measures that would be necessary to rectify such a SIP deficiency, DER generating sources would be operating from an inappropriately high baseline. The commenters have suggested that steps would need to be taken to address such situations, for example, (a) barring further DER accrual by generators until the ROP, attainment demonstration, or maintenance plan deficiency is remedied, or (b) discounting DER generation by an amount proportional to the area's overall reduction deficiency.

Other commenters have argued that while a DER generator's baseline would be inappropriately high in such cases, all sources' baselines would be inappropriately high, whether the sources are participating in the open market program or not. These commenters believe that including in the OMTR a requirement to address such SIP problems by selectively targeting DER generators and users is unwarranted, since all sources reap an economic benefit from not having a lower baseline and tighter control requirements. They also believe that singling out open market participants would act to discourage participation in the open market system by creating undue regulatory uncertainty about the ability to create and use DER's, thereby sacrificing the efficiency gains provided by this regulatory approach. They have argued that States should rectify such attainment problems without singling out open market participants.

The EPA believes that both arguments raise valid concerns, and requests comments on whether the OMTR should require action to address DER generation in cases where States have such attainment problems, and, if so, what those actions should be.

2. Start Date for DER Generation

DER's that may be used for compliance under this model rule must have been generated after the start of the 1995 ozone season (May 1, 1995 in most cases) and must meet all other requirements of the model rule. One of the objectives of this model rule development process has been to make trading possible during the 1995 ozone season. Earlier dates were considered but rejected because of the potential to overwhelm the market with pre-existing reductions that by definition were not motivated by the prospect of creating a tradable product of value. Another objective of the rule is to create an incentive for sources to make additional reductions beyond those they would otherwise have made. It would not be consistent with this objective to give retroactive credit for actions taken before this rule was developed and which were made for other reasons. The EPA is also concerned that crediting earlier reductions could lead to an imbalance in the first years after a State program is in place. Thus, if a large-scale use of pre-1995 reduction stockpiles occurred in that period, before large-scale generation of new DER's had developed, it could lead to elevated ozone levels during the use years, creating human health consequences and jeopardizing an area's compliance with underlying Act requirements.

The EPA acknowledges that some stationary sources in the Northeast have participated in the NESCAUM–MARAMA Demonstration Project, and have made discrete reductions before the 1995 ozone season which they intend to sell as DER's. While EPA has acknowledged and encouraged these potential trades, they cannot fall within this model rule. These facilities may need to proceed through source-specific SIP revisions. The EPA will continue to work with the NESCAUM–MARAMA participants to process revisions expeditiously.

3. Converting ERC Activity Into DER Activity

The EPA recognizes that there are beneficial emissions reductions that will occur in the future under the current ERC program. Emissions reduction activity intended for ERC use would be creditable as DER's, provided that the activity met all applicable requirements of the OMTR. However, the same emissions reduction activity may not be used in both programs; the source would have to choose one program to the exclusion of credit in the other. Reductions made before the 1995 ozone

season by an activity approved as an ERC could not, however, be used as DER's.

4. Prohibited Generation Activities

a. Shutdowns & Production Curtailments. Under the proposed model rule, DER's would be generated by actions that reduce the rate of emissions of a source per unit of production. Typically, these actions would consist of installing control equipment, making process changes, or changing fuels or other inputs so as to reduce emissions per unit of production. The proposed model rule would not allow shutdowns or production curtailments to generate DER's.

Many participants in stakeholder meetings have argued that shutdowns and curtailments would not be undertaken, or hastened, to generate DER's (i.e., they would have happened anyway). The EPA has no evidence at this time that shutdowns and curtailments would occur earlier on account of the economic benefit derived from generating DER's. Shutdowns and curtailments generally occur due to economic conditions, and they do not result in an improved efficiency of emissions per product. In addition, EPA is concerned that for major sources under emissions rate limits, economic-related curtailments could be used to generate DER's with no requirement to offset higher emissions through use of DER's during full production boom periods. Therefore, EPA believes that in general, allowing DER's to be generated from shutdowns and curtailments could lead to increased emissions from sources using DER's without real, additional reductions having been made by DER generators.

As noted previously, a major purpose of this proposed rule would be to promote innovative approaches to controlling and preventing air pollution, involving the full range of major, minor, area, and mobile source sectors. The EPA believes banking of DER's created from shutdowns could provide a massive supply of inexpensive DER's that would inhibit investment by others in measures that actually reduce emissions per unit of production from sources that continue in operation. The EPA believes this glut of DER's from actions that would have otherwise occurred and that produced no additional reductions could also lead to emissions spikes and therefore jeopardize compliance with underlying Act requirements for attainment of the ozone standard.

In addition to concerns about the effect of shutdowns on attainment, EPA is also concerned with load-shifting that could occur when sources shut down. If small sources (e.g. gas stations or print shops) reduce emissions by shutting down, their economic activity will likely be picked up by new or existing sources in the same areas. Since emissions created by increased operating rates by other existing sources are not limited, and since new small sources are not subject to an offset or cap requirement, the net effect of allowing shutdowns to generate DER's would be to increase overall emissions.

The EPA does recognize some situations in which DER's generated from activities that appear to be shutdowns and curtailments might be consistent with an open market system. For example, for mobile sources, reductions in use levels should be allowed to generate DER's if such reductions occur in the context of a formal plan to shorten or obviate trips and are generated with an appropriate emission quantification protocol. Such use level reductions would not be considered curtailments. An example of a program that could reduce motor vehicle use levels is an employee commute option that generates emissions reductions beyond what might be required for an area under section 182(d)(1)(B) of the Act.

Another example would be the early automobile retirement program known as scrappage. The EPA does not consider mobile source scrappage to be a shutdown, and scrappage programs would be allowed to generate DER's under the proposed rule. This would be acceptable because scrappage programs conforming to EPA guidance actually would achieve earlier retirement of old, high-emission vehicles than would otherwise occur.

In the process of developing this rule, a number of industry and State groups offered other examples where shutdowns and curtailments might be consistent with an open market system. One example is the concept of allowing DER's to be generated from shutdowns and curtailments when such reductions can be captured within a "closed loop" of existing and new sources. Facilities that replace small boilers with a central energy source and thus create fewer emissions might create a net environmental benefit through small boiler shutdowns. This differs from the more common shutdown case, where a facility closes and the production load could shift to another unrelated source. In general, establishing conditions by which closed loop or other potentially beneficial shutdowns could be considered in the open market program would add complexity to the proposed rule and still might be problematic with respect to the intent of the rule as outlined above. The EPA requests comments on language that would allow for acceptable, environmentally benign or beneficial exceptions to the common shutdown circumstances.

The EPA is also interested in public comment on whether a State that has an approved attainment demonstration or maintenance plan that does not rely on emission reductions from shutdowns and curtailments may permit such shutdowns and curtailments to generate DER's. In such cases, EPA believes that the use of DER's generated from shutdowns and curtailments would not jeopardize attainment, since the SIP would already contain enough emission reductions from other sources to satisfy the attainment demonstration requirement of the Act. Thus, it might be appropriate to allow States to credit emission reductions from shutdowns and curtailments.

On the other hand, except where shutdowns are used for new source offsets, air quality improves as sources shut down. Shutdowns are already available as offsets for new sources. In the major new source offset program, Congress decided that encouraging continued economic development in nonattainment areas by allowing emission reductions from shutdowns to offset new source emissions was worth the sacrifice of the natural improvement in air quality that results from sources that shut down. If existing sources are allowed to relax otherwise applicable emission limits by using DER's generated from shutdowns and curtailments, States would be giving up this built-in air quality improvement. The EPA believes that allowing DER's to be generated from shutdowns could be inconsistent with Congress' intent to encourage economic development, since the value of DER's generated from shutdowns would be expected, on the margin, to encourage sources to shutdown. The EPA is interested in comment from the public on this matter.

In the event that shutdowns and curtailments were allowed to generate DER's in areas with approved attainment demonstrations or maintenance plans that do not rely on such reductions, EPA requests comment on the period of time into the future that a shutdown source would be allowed to continue generating credit. The EPA also requests comment on the effect that allowing DER's to be generated from shutdowns and curtailments would have on incentives for owners and operators of existing, ongoing sources to invest in innovative pollution control or prevention measures. The EPA also

requests comment on how to treat discrete increases in emissions that result from full production boom periods if discrete decreases due to production curtailments are creditable.

While EPA is proposing that the use of credits from shutdowns be restricted under the proposed open market system, this does not imply that such reductions cannot be used in other programs. Emission reductions from shutdowns remain creditable in the offset program for major new sources discussed previously, and can be used in emissions budget systems. In emissions budget systems, the integrity of the agreed emissions budget cannot be violated by emissions credits from shutdowns and curtailments, since the closed system ensures that the stated emissions target will be attained and maintained.

The Department of Defense (DoD) was especially concerned about the impact of the rule on military base closures and the civilian redevelopment of closure properties, as well as the ability of DoD to use shutdown reductions to support other military installations of other federal activities. In particular, DoD highlighted the fact that most redevelopment of closed bases occurs over a long period of time in a phased process. Credits for shutdown reductions are not only needed at the time of the shutdown, but need to have an extended life to be available to support actions 5, 10, or 15 years in the future.

The EPA believes that its current new source review (NSR) rules and soon-to-be proposed changes to those rules will support base closure redevelopment needs. For areas with approved attainment demonstrations, current NSR regulations allow the use of emission reductions that are contained in the emissions inventory at time of use—including emissions from shutdowns and source curtailment—to be used to comply with the NSR offset requirement.

In areas without approved attainment demonstrations, current EPA regulations restrict the use of shutdown/source curtailments to be used as NSR offsets where the reductions occur prior to submittal of the permit application by the new source (with the exception of replacement facilities). However, EPA is already planning a regulatory change as part of the NSR update package that proposes to relax this restriction in the Federal NSR requirements. This package is scheduled to be proposed this fall. This would mean that under EPA's proposal, emission reductions from shutdowns held by DoD or the local redevelopment authority (LRA) would be available until needed for NSR offset purposes.

The DoD was also concerned about the availability of shutdown reductions to satisfy general conformity requirements. Since the preamble of the general conformity rule references the NSR rules to define offsets, any emission reductions that are consistent with EPA guidance regarding NSR offsets are also available for conformity offsets. This means that any mobile or stationary source emissions increase needing conformity offsets may obtain them from both mobile or stationary source reductions, including reductions resulting from shutdown or curtailments if such sources are contained in the emissions inventory at time of use. The EPA also confirms conformity offsets from shutdown (closure reductions) could be retained by DoD or the LRA indefinitely, freely transferred, and used for conformity purposes when needed. The EPA requests comments on these determinations.

b. Overcompliance With An Alternative Emission Limit. In many States, sources are given flexibility from RACT requirements when the State grants them an alternative emission limit (AEL) that is less stringent than the RACT standard. The OMTR would not allow sources to generate DER's by reducing emissions below levels required by an AEL but still above levels required by the otherwise applicable RACT standard. Sources subject to AEL's could, however, generate DER's by reducing emissions below the levels associated with the otherwise applicable RACT standard.

C. DER Use and Transfer. 1. Potential Uses. One key to a strong DER market and to minimizing compliance costs is enhancing the demand for DER's created by allowing as many and varied uses as possible. One use of DER's would be as a substitute for compliance with an applicable RACT standard. However, EPA expects that there would be many other uses as well. The philosophy of the model OMTR is that any use not prohibited in the rule is a valid use. The EPA encourages States that adopt this OMTR to adopt this approach.

a. Use by Regulated Sources. The EPA believes appropriate use of DER's by sources would include, but not be limited to:

(1) Use for delayed RACT compliance;

(2) Use as compliance insurance margins to cover uncertainties in the value of DER's or variations in process emissions or control device efficiency;

(3) Use as a substitute for reductions to be achieved through certain non-statutory mobile source requirements not otherwise prohibited in the rule;

(4) Use as offsets for new stationary sources used either by a new source or by States as an incentive for economic development;

(5) Use as part of a noncompliance settlement to compensate the environment for past violations.

b. Advantages to States. States could also benefit from the adoption of an open market program because the existence of DER's could give the State more flexibility in attainment planning. For instance, a State could eliminate the granting of alternative emission limits or variances, or regulate emissions from occasional small-scale research and development activities. Sources could comply with applicable requirements through the use of DER's. These measures could increase rule effectiveness.

2. Special New Source Review Requirements. Any proposed major stationary source or major modification applying for a permit to construct in an ozone nonattainment area may employ DER's to satisfy the requirements for offsets. Offsets are governed by EPA and State regulations for new source review (NSR).[3] Nothing in today's notice would alter EPA NSR requirements or exempts owners or operators from compliance with applicable preconstruction permit requirements under section 173 of the Act or regulations contained at 40 CFR 51.165(a).

Today's model rule establishes specific criteria which the State must ensure would be met if DER's were used for offsetting new source emissions. In general, emissions reductions used as offsets must be real, surplus, enforceable, permanent, and quantifiable. In addition, section 173 of the Act sets forth specific requirements for emissions offsets which must be satisfied by a proposed major stationary source or major modification.

Section 173 of the Act requires that the emissions reductions be Federally enforceable before the construction permit may be issued (section 173(a)(1)), and achieved by the time the source or modification commences operation (section 173(c)(1)). In using DER's for offsets, it would be necessary for the new major source or modified source to secure a series of DER's over the life of the source. The EPA believes that it is reasonable to require that sufficient DER's be obtained to offset the source's emissions on at least an annual basis. The first year's DER's should be

[3] 3 States have rules concerning the preconstruction review of major stationary sources and major modifications applying for permits to construct in nonattainment areas. These rules must be consistent with the minimum requirements set forth under Federal regulations at 40 CFR 51.165(a).

submitted to the permitting authority prior to the public notice announcing the proposed construction permit. The determination of the amount of offset needed must take into account the prescribed offset ratio for the nonattainment area of concern. The permit must contain an enforceable condition requiring the source, each year, to have demonstrated to the permitting authority that, at that time, it held sufficient DER's to meet offset needs for at least the next year of operation. Failure to obtain any required offsets in a timely manner would be a violation of the source's permit.

Section 173(c)(2) of the Act prohibits emissions reductions otherwise required by the Act from being used as offsets. For example, reductions required to meet RACT, MACT, acid rain reductions, and the phase-out of chlorofluorocarbons pursuant to statutory requirements are not creditable as emissions offsets.

3. Special DER Use Restrictions. The proposed model OMTR would limit the use of DER's with respect to certain generation and use characteristics of the DER. Relevant characteristics include pollutant type, the modeling domain or nonattainment status of the area where the DER was generated, and the time of generation. The proposed OMTR would provide for these limiting provisions, in part, to assure that in nearly all cases the uses would be helpful toward reducing peak ozone concentrations. That is, the connection between generation and use must be correct, considering the distance between the generator and user sources and the patterns of pollutant transport in the relevant area (direction). States would be encouraged to assess their own unique situations, and devise an OMTR that contains special DER use limitations that are consistent with relevant modeling analyses that are in the SIP.

a. Geographic Restrictions. Ozone smog formation is a difficult problem that has resulted in various approaches aimed at resolving it. Prior to the 1990 amendments to the Act, ozone attainment plans largely focused on emission reductions in nonattainment areas. More recently, attention has been focused on the issue of long-range transport and its contribution to ozone formation and to violation of the ozone standard. Ozone precursor pollutants mix and react together as they travel long distances over several days, thus creating a serious problem. For example, high ozone concentrations in the northeast occur on scales of over 1,000 km and can persist for many days. Our current understanding of ozone formation suggests that the relative importance of VOC and NOx control varies with the location and scale of the ozone problem. In general, VOC control is most likely to be effective in urbanized nonattainment areas, and less effective in the surrounding countryside where local natural VOC emissions can overwhelm those from human activities. On the other hand, NOx control tends to be most beneficial over larger distances. Therefore, the model OMTR would restrict VOC DER use to the same area in which the DER was generated, and would permit NOx DER trades to occur within the larger modeling domain.

While considering the general relationships among VOC, NOx and ozone formation, it is also important to consider unique local effects that might be characterized in a specific SIP modeling analysis. DER uses should be consistent with relevant modeling analyses that are in the SIP to preserve the integrity of the SIP. In these modeling analyses, distance and direction effects are considered by analysis of various episodes, meteorological regimes, and boundary conditions. SIP's may define locations where emission reductions are most helpful, marginal, or even counterproductive.

Some SIP's may have a regional NOx strategy component. A regional strategy means that emission reductions are planned to occur across a large area that may include sources located both within the local urban airshed modeling domain and outside the modeling domain. A modeling domain is the geographic area covered by an air quality model used to support an attainment or maintenance demonstration. The domain can be thought of as a rectangular box which is superimposed over the area being modeled. For the current (1994) revisions to State implementation plans (SIP's) for ozone, 23 modeling domains have been defined for different locations in the United States. Typical domain size ranges from 100 km x 100 km to 350 km x 350 km. Specifications for each of the 23 modeling domains are available through the U.S. EPA's Technology Transfer Network (TTN). In addition, maps should be available from the State agency having lead responsibility for the modeling analysis. Lead State agencies are also identified in the TTN.

In the regional strategy knowing the precise location of each emissions reduction is not as critical as understanding the general distances and directions emission reductions travel from the nonattainment area. In such cases, the modeling analysis shows ozone reductions in the nonattainment area through both local emission reductions within the modeling domain and by reduced regional, boundary concentrations coming in to the area due to emission reductions outside the modeling domain.

The above considerations are reflected in SIP attainment demonstration or other modeling analyses conducted in support of the SIP. Thus, in some cases a SIP's control strategy may simply call for local reductions in a nonattainment area and, in other cases, the SIP may be supported by modeling analyses which indicate that both local and regional emission reductions are needed.

In general, EPA would view NO_X DER's used within the same urban airshed modeling domain as they were generated as acceptable as long as they: (1) Are consistent with the regional concept in the SIP strategy, and (2) address distance and direction concerns. The EPA acknowledges that in special cases, NO_X trades within a modeling domain could result in higher NO_X emissions in an urbanized area, and may increase already high ozone levels in that area; in this case, the use of NO_X DER's in that area might not be consistent with attainment demonstration and in such cases should be disallowed.

In addition, EPA believes that DER uses would be generally beneficial where NO_X or VOC DER's generated inside a nonattainment or maintenance area were used by sources not located in a nonattainment area, maintenance area or modeling domain. Trades which crossed or were entirely outside of modeling domain boundaries could be ineffective where the distances are great or the direction of pollutant transport showed little benefit in reducing peak ozone concentrations from such a trade.

Because of the complexity that would be required of EPA to list in the model rule all possible combinations of distance and direction for NO_X and VOC trades in all areas wanting to adopt open market trading programs, the model rule proposes to allow NO_X DER use only if the NO_X DER was generated within the same modeling domain, and VOC DER use only if the VOC DER was generated in the same area. States would be encouraged to assess their own unique situations, and propose an OMTR that allowed NO^{T2X} trades from outside the modeling domain at an appropriate discount, or allowed VOC trades with adjacent nonattainment areas, after taking into account and justifying the distance and direction considerations.

In addition, States could choose to adopt rules which allowed NO_X trades

without discount where certain distance and direction criteria were met. For example, EPA would approve a State OMTR that allowed trades without discounting for distance and direction where the rule included the following criteria. Regarding distance, the generator and user sources should be within either 200 km or 2 days transport of each other. The transport criterion should be determined by examining the average wind speed which occurs on days with ozone exceedances near the user source. In all cases, the direction of the prevailing wind near the generator source and the user source should be within a ± 22.5 degree sector of a straight line between the two sources. Average wind speed and prevailing wind direction should be based on data from National Weather Service stations near both the generator and user sources. The prevailing direction and average speed should be calculated over the period 7 a.m. to 7 p.m. This period captures the time of day when emissions are typically highest, as well as to include the portion of the day when surface wind measurements are most representative of overall transport within the mixed layer. In calculating the prevailing wind direction, one could include those days with exceedances near the user source during the years used for classification of the nonattainment area. As an alternative, one could base the direction calculation upon all days in the "ozone season" for any year used for classification purposes in the area of the user source. For distances or directions which extended beyond these criteria, EPA believes that discounting may be necessary.

In general, EPA encourages States to propose their own geographic requirements based on the characteristics of their areas. The model OMTR would contain generic restrictions that States could modify to more appropriately meet their air quality objectives. The EPA is committed to working with States in creating the most beneficial geographic restrictions for their specific areas.

b. Interpollutant Trading. Interpollutant trades are defined as trades that occur between the two classes of ozone precursor pollutants, VOC and NO_X. The available scientific and modeling information suggests both positive aspects and risks with an interpollutant trading program. Certain trades have the potential to be complementary, leading to greater reductions in ozone than would otherwise occur (e.g., a facility sells NO_X DER's to a buyer who operates a VOC source in a rural area within the Northeast Ozone Transport Region). Others, however, may be counterproductive. For example, if a modeling analysis in the SIP identified a specific geographical area as an area where VOC reductions were needed and NO_X reductions were not helpful over a local or regional scale, then a reduction in NO_X emissions in that area should not be exchanged for required reductions in any other area. Since EPA cannot account for all possible site-specific cases where interpollutant trading is beneficial, the proposed model OMTR would not include interpollutant trading.

States are nevertheless encouraged to submit as variations on the model OMTR, rules of their own that would permit interpollutant trading if adequate prior analyses had been performed which indicated that the nature of trades meeting specific criteria was consistent with expected lower ozone concentrations. These prior analyses might be performed by the State(s) or by others in support of one or more SIP's. Although a user could perform modeling analyses to support each proposed use of specific DER's, this would not be required. In general, interpollutant trading rules should encourage excess VOC emission reductions in geographic locations where ozone is limited by available VOC or encourage excess NO_X emission reductions in locations where ozone is limited by available NO_X. In the event a user and generator were in different States, review responsibility should be consistent with the policy on interstate trades. Where such interpollutant trades were permitted by States, the applicable rule should address distance and direction considerations as they applied to allowable interpollutant trades. The EPA would expeditiously review any such variations.

c. Seasonal Restrictions. Whereas DER's generated in the ozone season might be traded to meet emissions requirements either during or outside the ozone season, DER's generated in the non-ozone season could be used only to meet non-ozone season emissions requirements. Using DER's during the ozone season that were generated outside the ozone season should not be allowed since such uses clearly would run counter to programs designed to attain or maintain the ozone standard and to meet ROP requirements. Ozone season reductions are the only ones effective in reducing peak ozone concentrations and are needed then. Thus, the rule would not allow DER's generated during a time outside of the ozone season to be used to comply with any air quality obligations during the ozone season.

The time of year in which areas experience ozone concentrations above the standard varies with location. In general, areas with greater intensity of sunlight will experience longer ozone seasons. Thus, southern areas tend to have longer ozone seasons than northern areas of the country. The EPA has defined the ozone season for each State at 40 CFR part 58, Appendix D. The purpose of this definition is to set the time of year during which States must monitor ozone concentrations. Ozone violations are not expected to occur outside the defined ozone season.

4. Prohibited DER Uses

The proposed model OMTR prohibits several uses of DER's for a variety of statutory and policy reasons. The following sections explain the rationale for each specific prohibition, and where appropriate, seek comment on specific issues relating to the prohibition. In general, EPA requests comment on any DER use that would be expressly prohibited by the proposed model OMTR. Comments that explain in detail how EPA could allow the prohibited uses given the language in the Act and the rationale for current EPA policies would be particularly helpful.

a. Compliance With Certain Mobile Source Requirements. The EPA believes that compliance with national mobile source programs (i.e., national exhaust and evaporative emission standards for cars, trucks, and nonroad equipment under sections 202 and 213 of the Act, plus any national fuel standards under section 211 of the Act) cannot be avoided through the use of DER's generated by other control measures. Some of these national mobile source control programs have internal averaging, banking and trading provisions, and EPA is currently examining whether more flexibility can be built into them. However, the statutory provisions by their terms appear to preclude compliance through DER's generated from other sources. In addition, using DER's generated outside of these programs (e.g., between different mobile source programs) would be inappropriate in instances where reductions associated with these programs occur nationally, and stationary and area source DER's generated in a specific region would be used to increase emissions nationally. The EPA is currently considering whether DER's generated regionally can be credited toward meeting same-source national requirements within a specific program (e.g., a scrapped outboard engine could create a DER in the national marine engine average standard structure).

The EPA also believes the Act would not allow the use of DER's generated from other programs to meet the requirements of certain regional or local mobile source control programs. Many local or regional mobile source control programs, such as vehicle inspection and maintenance under sections 182(b)(4) or (c)(3) of the Act, employer trip reduction programs under section 182(d)(2)(B) of the Act, or clean fuel fleet requirements under section 246 of the Act, have provisions that appear to preclude compliance through DER's generated from other sources. However, unless prohibited by other provisions of the Act, DER's could be used to meet any regional or local mobile source requirements that are in addition to those specifically mandated by the Act. The EPA requests comment on whether the Act would allow the use of DER's to meet Federal mobile source requirements and whether EPA should adopt such an approach.

The EPA believes that emission reductions generated in the context of an existing averaging, banking, and trading (ABT) program specific to a particular mobile source program should not be used to generate DER's. The same rule applies to fuel producers. The reason for this restriction would be to avoid double use of DER's, especially since the State may not be aware of the use of the ABT DER in the context of the relevant program.

The EPA is concerned about quantifying DER's generated for upstream and downstream emissions reductions strategies. An example of an upstream activity is fuel distribution emissions—providers of natural gas may seek to generate a DER to reflect reductions in gasoline distribution emissions that result from sales of natural gas for alternative fuel vehicles. In this case, the use of an additional clean fuel vehicle does not necessarily take a known quantity of gasoline out of the conventional fuel distribution system. However, these kinds of emission reductions may be allowed to generate DER's if an adequate quantification method can be devised and approved by EPA. The EPA solicits comments on whether and under what conditions these emission reduction strategies should be allowed to generate DER's.

b. Compliance With Certain Technology Standards. Today's proposal is consistent with the EIP rule (59 FR 16696 (1994)) in that DER's could not be used to meet Act sections 111 and 129, new source performance standards (NSPS), best available control technology (BACT) standards, or lowest achievable emissions reduction (LAER) standards.

The EPA believes it is important to begin investigating whether compliance flexibility and costs savings can be offered to new sources. In this regard, the Agency has proposed in the model rule that DER's be used for offsets that satisfy new source review requirements. However, EPA questions whether additional flexibility and cost savings can be achieved by allowing sources subject to NSPS, BACT or LAER to utilize the open market program to meet these control technology requirements. In certain cases, the compliance requirements for NSPS, BACT or LAER may inhibit new low-pollution facilities from replacing older, high-pollution facilities as quickly as would have occurred otherwise. If DER's were used to lower the economic hurdle in these cases, both the environment and the economy would be better off in the long run.

The EPA requests comment on how to allow the use of DER's under the open market program to meet NSPS, BACT and LAER requirements.

c. Compliance With Toxics Standards. Today's proposal would not relieve sources participating in the open market trading of the obligation to meet all requirements under section 112 of the Act. Standards promulgated under section 112 require sources to meet maximum achievable control technology (MACT) standards for air toxics. Often, section 112 standards apply to the same emissions point at a facility as RACT requirements. For example, a RACT requirement and a MACT requirement could both require control of an emissions point to a level achieved by a flare. In such a case, the source could not use a DER to meet the RACT control requirement because the MACT standard imposes an independent obligation to achieve the specified level of control. This ensures that trading would not result in higher levels of hazardous air pollutant emissions from a source than are permitted by Federal air toxics control requirements.

d. Avoiding New Source Review. While allowing the use of DER's to satisfy the requirement for offsets, EPA believes that it would be unlawful to allow DER's to be used to avoid new source review requirements altogether. Therefore, the model rule would specifically prohibit the use of DER's to "net out" of review.

In addition, sources that had previously agreed to operational limitations in order to avoid the new source review requirements, could not use DER's to subsequently increase their emissions to major source levels, and thus circumvent the provisions requiring retroactive review as a major source or major modification.

e. Use To Avoid Penalties. The proposed model OMTR would require sources to purchase DER's before using them. A user could not defer purchase until after failing to comply. The EPA believes allowing such a retroactive acquisition of DER's would encourage sources to avoid their compliance obligations until such time as they were determined to be out of compliance. However, as described elsewhere in today's preamble, EPA does not wish to preclude the purchase of DER's as part of a settlement agreement for a violation or as a potential component of EPA's penalty policy.

f. Use To Increase Over 1990 Emissions Levels. The EPA recognizes the possibility that a source may want to use DER's to allow that source to relax current costly compliance obligations. Such use of DER's may, in some cases, allow a facility to emit levels of pollution greater than levels accounted for in the 1990 emissions inventory. The EPA requests comment on whether in order to prevent excessive degradation of air quality near a particular source the OMTR should prohibit sources from using DER's to revert to pre-1990 levels. The EPA acknowledges that it may be difficult to effectively enforce such a provision since the State may not know with certainty the lower of actual or allowable emissions from a particular source prior to 1990.

5. Use for Conformity Offsets

The EPA's General Conformity rule allows the conformity requirements to be met by a Federal agency obtaining emissions offsets (40 CFR 51.858, 93.158). The rule requires the offsets to come from within the same nonattainment or maintenance area.

The definition of emissions offsets in the conformity rule is intended to assure that offsets within the air programs are calculated and credited consistently and that the term is used the same in the conformity rules as in the EPA NSR program. All offsets must therefore be quantifiable, consistent with the applicable SIP attainment and ROP demonstrations, surplus to reductions required by—and credited to—other applicable SIP provisions, enforceable at both the State and Federal levels, and permanent within the time-frame specified by the program. DER's used in accordance with the OMTR could meet these requirements. Thus, the current conformity rule allows DER's to be used as conformity offsets where they occur

in the same nonattainment or maintenance area.

Since the purpose of conformity is to assure that Federal actions are consistent with SIP's, SIP's which explicitly allow the use of DER's should logically allow the use of DER's as part of their conformity SIP. That is, DER's which meet the SIP requirements should also be considered to be DER's which conform to the SIP. Thus, if a State adopts an OMTR into their SIP, such DER's should be available for conformity offsets.

6. Use in Place of Variances

Many States currently provide for source-specific variances in the form of compliance extensions and alternative emissions limits for circumstances where it would be economically or technically infeasible to install controls. States are encouraged to consider discontinuing variances in areas where open market trading exists. Several States have already included such provisions in their proposed EIP's. Instead of granting variances, the State could achieve universal application of a RACT standard and allow sources that might otherwise be granted variances to comply through use of DER's. Discontinuing variances has the potential to improve "rule effectiveness" by allowing more timely rule compliance. This benefit could be reflected in attainment demonstrations or maintenance plans, if approved by EPA.

7. Holding DER's Before Use

The model OMTR would require that DER's intended to be used by sources for compliance purposes must be held before the intended use period. This means that a particular DER generation activity must be completed prior to the start of the use period. To meet this requirement, a stream of DER's generated from an ongoing generation activity could be broken and parcelled prior to the start of the use period. This approach ensures the benefits of retrospective quantification described elsewhere in today's preamble. Under the OMTR, near-simultaneous trades similar to ERC trades could occur. For example, two facilities could arrange beforehand a series of transactions where one facility made reductions that were creditable to another facility. The EPA believes this type of transaction could facilitate same-season trading.

However, this near-simultaneous transaction must comport with the 30-day advance Notice of Intent to Use requirement. One way to enable this transaction would be to prearrange such transactions 30 days in advance and maintain a 30 day lag-time between the continuous generation and use of the DER's. Another method might be to make an exception for this special transaction, such that steps are taken to assure the benefits of retrospective quantification while allowing near-simultaneous trading. The EPA requests comment on how near-simultaneous trading could occur or be improved in light of the 30-day advance notice requirement.

The EPA recognizes that the near-simultaneous use and generation might increase transactions costs since the Notice and Certification of Generation and the Notice of Intent to Use, as well as the underlying generation and use documentation, would have to accompany each transaction. While these notices could be made routine and could be kept in electronic form, EPA requests comment on procedures that could be used in the open market trading program without compromising the program's enforceability, that maintain the benefits of retrospective quantification, but result in reasonable transactions costs for the sources that wish to engage in near-simultaneous trading.

8. Contribution to the Environment

The final economic incentive program (EIP) rules (59 FR 16690 (1994)) and guidance establish as a goal for all EIP's that they be designed to benefit both the environment and the regulated entities. The rule and guidance requires States to design programs that would meaningfully meet this goal, while providing flexibility to the States in determining how best to accomplish such benefit-sharing in the context of each specific program. Requiring that at least ten percent of the DER's traded be retired would meet this benefit sharing goal.

The EPA believes this ten percent requirement is justified because the OMTR has the ability to greatly reduce costs to regulated industry and it is fair that some of those savings should be used to achieve further emissions reductions. Such a discount is clearly appropriate in the case where intertemporal trading is permitted. Intertemporal trades can increase the risk of emissions spiking, which in extreme circumstances could, in some years, negate the benefits of the early reductions provided by banking. The discount decreases the risk of spiking, and provides additional confidence that a retrospective approach to auditing the effects of the program will be sufficient.

Therefore, EPA would approve the component of a State OMTR that required a user to retire any specific percentage of at least ten percent of the DER's it purchases for compliance use.

9. Potential Market Participants

An active market with a large number of participants helps to promote economic efficiency in air pollution control. Subject to the limits specified by the rule, any source that emits NO_X or VOC in an area that adopts an OMTR could participate in the open market system as a DER generator, and any source subject to a VOC or NO_X emissions reduction requirement could participate as a DER user. The open market system would provide an incentive for VOC and NO_X sources that have traditionally not been regulated to make pollution reductions. Large sources, small sources, area sources, mobile sources and non-title V sources could all participate.

The EPA anticipates that DER's will be handled much like any other tradeable emissions reduction. They could be bought and sold by service-providing intermediaries, brokers, or even speculators. DER's could also be purchased and permanently or temporarily retired solely for environmental benefit by environmentally minded individuals or charitable organizations.

D. Characteristics of DER's

1. DER Life

The maximum length of time between DER generation and use is the DER life. The proposed OMTR places no limit on DER life. The EPA considered a variety of approaches to limiting DER life, and concluded that longer lives promote market stability and diminish the risk of emissions "spiking." Market confidence increases as the life increases, because DER holders are assured that barring unusual circumstances, their DER's will not "die" before they are needed for use. Spiking risks appear to diminish in proportion to longer DER lives because the timing of DER use presumably becomes more random and less tied with anticipated DER expiration. DER's with unlimited lives would also require less recordkeeping and tracking burdens.

In recognizing the value of long DER lives, EPA found no obvious basis for any particular number of years that DER's should last. Any limit to DER life—however long—might encourage DER's being stockpiled for future use, which creates the risk of spiking. Moreover, no procedural or environmental problems have been found to date with the unlimited lives granted for allowances in the acid rain trading program. The EPA is therefore

inclined to adopt the same convention for DER's in the open market program. The EPA requests comments on whether and for what reasons a long finite life might be more appropriate than an unlimited DER life.

2. Limited Authorization to Emit and DER Limitation or Termination

Just as under the Title IV SO2 emissions trading program, the OMTR would not confer property rights to the DER holder. Section 403(f) of the Act states:

> An allowance allocated * * * is a limited authorization to emit sulfur dioxide * * * Such allowance does not constitute a property right. Nothing in this subchapter or in any other provision of law shall be construed to limit the authority of the United States to terminate or limit such authorization. (42 U.S.C. 7651b)

Congress included this requirement to ensure that allowance holders understood that they were barred from claiming a governmental taking under the 5th Amendment of the U.S. Constitution. Like the acid rain SO2 allowances, DER's would not be property, but would be limited authorizations to emit the regulated pollutant. Property status is unnecessary to secure a stable commercial setting for DER trading and could produce undesired and perverse results, such as requiring a government agency to compensate the owner of a pollution source when its emissions are limited. A tradeable reduction derives its value wholly from the regulation under which it was created. DER holders could exercise a specific license to use DER's in the manner set out under the model OMTR.

Program audit and reconciliation provisions in the model rule would authorize the participating air pollution control agency to limit or terminate DER use in extreme circumstances. States should consider this an option only when other options have failed to provide for meeting the State's underlying Act obligations. Although EPA would not expect this to occur, and would expect that the program will achieve real and cost-effective emissions reductions without having to resort to DER limitation, this contingency measure must be available to provide confidence that States will make continued progress toward their air pollution control goals.

E. Notices, Reporting and Recordkeeping

As with all environmental compliance programs, appropriate reporting and recordkeeping would be necessary to allow for the proper enforcement of all applicable requirements and the tracking of the overall compliance program. In addition, there is a need for the public to obtain access to sufficient information to monitor the performance of industry and government in meeting their obligations. In an emissions trading program of this type, these reports are essential for ensuring the integrity of the system and the confidence of the public that air quality goals are being met.

Each record that must be kept, or report that must be filed, puts a resource burden on the entity required to produce it. Therefore, it is important to reduce the amount of recordkeeping and reporting to the minimum necessary to ensure a high-integrity market. Three notices would be considered necessary: (1) A notice of generation of DER's, (2) a notice of intent to use DER's for compliance purposes, and (3) a notice of use of DER's for compliance.

1. Notice and Certification of DER Generation

A DER generator would be required to file a Notice and Certification of DER Generation with the State containing information on the creation of DER's. This notice must be submitted within 90 days after a generation action is complete, or 1 year after commencement of the generation action, whichever is sooner. A responsible corporate officer must certify under penalty of law that the information in this notice is true, accurate and complete, based upon information and belief formed after reasonably inquiry.

This notice would provide potential buyers, the States (in their role as prospective compliance authorities), and the public the opportunity to review the records concerning the methods (protocols) used to generate reductions, the specific data (emissions rates, production volumes, etc.), and the relevant baseline (lower of actual or allowable) to verify that the DER's are real, surplus, and accurately quantified. Second, this notice, coupled with the user's responsibility to report a DER use, would serve as the necessary "tracking" record to assure that a specific DER was used only once, since the tracking system should uncover the case of multiple use of a ton with the same serial number. Third, the notice would provide pertinent information for audits of the overall emissions trading program by the State.

To provide systematic certainty and integrity to the program, the State would assign a unique serial number to each ton of reduction. This would allow a subsequent Notice and Certification of DER Use to be matched to the exact tons which were generated and ensure that such tons came from a relevant geographic location and were used only once. Each State could establish its own numbering system, or could collaborate with other States to design a regional or national system.

2. Notice of Intent to Use DER's

The Notice of Intent to Use DER's for compliance purposes would be required in order to alert the State and public that a source intended to use DER's. The State and the public would have the opportunity thereby to examine a DER compliance strategy prior to use and prior to the possibility of any environmental harm. The notice must be filed at least 30 days prior to the source's first use of DER's and renewed at least annually in cases of continued or repeated use. This notice would serve to ensure that a prospective user held sufficient DER's prior to use. It also would allow the State to consider the level of inspection oversight to employ with the user. This notice only signals intent to use DER's; a notifying source would not actually have to use them.

As part of their Notice of Intent to Use, States may want to require sources to submit the price paid for each DER. The EPA believes that knowledge of DER price could serve to assist States in determining which DER's were high quality and which were low quality. Therefore, price could serve as a signal to target a State's enforcement resources. For example, a generator would be likely to charge premium prices for DER's they created that were supported with high quality documentation, whereas a generator of a less supportable DER might tend to lower its DER price in order to compete. The lower-priced DER in this context would denote a lower quality, or higher risk product. Of course, in other instances low price may indicate no more than that the generator has found a low-cost control opportunity. Nonetheless, price might serve as a signal to a State to examine specific DER's more carefully during compliance reviews. The EPA requests comment as to whether price should be a required submission in the model rule.

3. Notice and Certification of DER Use

The Notice and Certification of DER Use would be required in order to provide the State with information on the actual amount of DER's used by a particular source for compliance purposes. It would include information on the methods by which both the amount generated and the amount needed for compliance purposes were calculated. A duly authorized corporate

officer must certify under penalty of law that the information in this notice was true, accurate and complete, based upon information and belief formed after reasonable inquiry. Based on receipt of this notice, the State could conduct compliance determinations and inspections to ensure that the source had met all of its obligations through the use of DER's. This notice is essential for the purposes of compliance assurance and enforcement.

No action would be required by the State when it received a notice, other than to make it publicly available as discussed below. The Notice and Certification of Generation and the Notice and Certification of Use, however, would be the State and Federal authorities' main compliance and enforcement tools for generators and users of DER's.

To lessen the paperwork burden on sources, the information in each of the proposed notices has been reduced to the minimum necessary. However, the source would be required to keep full records of all of the documentation associated with the generation and/or use of DER's at their facility.

4. Notice of Intent to Generate Rejected

The EPA has considered creating a Notice of Intent to Generate which would be filed before any generation activity, but prefers not to require it in the model OMTR. Proponents advocated the notice so as to provide the State with advance notice of the time period over which DER's would be generated and the method that would be used to generate them ("Emission Reduction Credit Demonstration Project," Phase II, Volume I; Final Report, April 1995). Proponents cited reasonable justifications for such a notice. The notice could provide some preemptive assurances against invalid DER generation, and hopefully could result in a higher level of scrutiny which would lead to a system with enhanced environmental integrity. However, EPA believes this benefit is outweighed by the resource burden required to be placed on each participating source and State, since the notification is, by definition, a non-binding assertion of intent that some facilities may and will ultimately decide not to follow. Although the model OMTR would not require a Notice of Intent to Generate, a State may decide that in its particular case that the benefits of the notice outweigh the burdens. Therefore, EPA would approve specific OMTR's that require this notice.

5. Public Availability of Information

Adopting the model rule into the SIP would replace the need for single-source SIP revisions. Such SIP revisions, however, serve the purpose of providing the public with notification of each proposed trade. Without some other vehicle for public notice, the public would not be aware of DER trades. The EPA believes public confidence is essential to the success of the open market program. Members of the public have a legally recognized role in compliance assurance and enforcement through the citizens suit provisions under section 304 of the Act. The public must have fair access to the information related to DER generation and use activity.

The proposed model rule would require the State to make all of the notices received available to the public. For sources with a title V permit, the information must be filed with or attached to the permit and made available where the permit is available. For non-title V sources, the State would make the notices available in a similar manner to the title V sources. Facility documentation that is not included in, but supports the information in, the notices must be made available through the State's "freedom of information" or other laws, if applicable, relating to the public's access to a source's compliance documentation.

The EPA is concerned that not all States will have laws that allow the documentation underlying the notices to be reasonably accessed by the public if it is not submitted to the State along with the required notices. The Agency considered a range of requirements that would facilitate the public availability of such documentation. At one end of the range, the Agency considered a rule requirement for sources to make the documentation available to the public upon request. At the other end of the range, the Agency considered a rule requirement that all source documentation be submitted to the State along with the required notices so that the State could make the information available. A middle ground option would require sources to submit the underlying documentation to the State, but waive the requirement if the source agreed to make the documentation available to the public upon request. The Agency requests comment on the appropriate way to ensure that the public has reasonable access to a source's compliance documentation without unreasonably burdening either the source or the State.

F. Federally Enforceable Operating Permits

The purpose of the title V program, codified in 40 CFR Part 70, is to ensure effective implementation of all applicable requirements of the Act for those sources subject to a Federally enforceable operating permit. The title V program rules impose various important administrative and procedural provisions (e.g., permit fees, opportunity for public participation). The title V program does impose a limited number of requirements relevant to source operation that supplement the applicable requirements of the Act in order to enhance their implementation. For example, a source's title V permit must specify methods for monitoring and certifying compliance, and must address these if the applicable requirement fails to otherwise provide them. The provisions of the Part 70 rule that provide for individual source emissions trading under permit-specific caps and for trading under a SIP are currently the subject of rulemaking.

If adopted into a State's SIP, the provisions of the OMTR become part of the underlying requirements reflected in a source's operating permit. Therefore, changes in a source's operating permit language are not necessary for the source to participate in the open market program. However, for the benefit of both the source and the public, language that specifically addresses the ability of the source to comply with applicable requirements through emissions trading could appear in the permit. The EPA intends to issue permit writing guidance that would include language on open market trading that could be incorporated into individual permits.

G. DER Registries

Open marketplace participants would require access to information that enabled them to make accurate and informed decisions about the supply, demand, quality and expense of DER's. This information could be efficiently transferred among participants through one or more registries that sent and received relevant DER information. Registries should provide convenient and inexpensive public access, should not interfere with the ability of "small" market players to participate, and should help assure that specific DER's are not used more than once.

Comprehensive, high-quality information should be readily available at reasonable cost to all participants and the public. Such information might include: DER source listings, generator source type, location, contact name of DER holder or holder's agent, DER

generation period, DER price, specific use restrictions if applicable, generator and user nonattainment area classification, and DER user's needs and requirements.

The EPA also believes that small market players, i.e., generator or user sources that generate or use relatively small market quantities, should not be disadvantaged by registry access requirements or the listing fee structure. The EPA does not wish in any way to discourage small sources from taking advantage of the benefits of open market trading.

The EPA has addressed the issue of double-counting of DER uses through the proposed rule's notice requirements. States must ensure that unique identification is assigned to each ton of DER's generated and reported in the Notice and Certification of Generation that each generator source would be required to submit. States could then check that a specific DER was used only once by cross-referencing DER use notices with the DER generation notice. This check would be more complicated in a case where use occurred in a State other than the generator source's State. Therefore, the proposed OMTR would require that States that allow such uses must have a memorandum of understanding (MOU) or similar agreement approved by the EPA, which facilitates checking for double-use of DER's.

While EPA recognizes that this function might best be performed through a national registry, a question remains as to whether EPA, State governments, or the private sector should provide these services. The EPA is inclined to encourage registry development in the private sector. For resource and efficiency reasons, EPA believes the private sector is a more appropriate choice than EPA. Thus EPA requests comment on (1) whether the private sector should provide such services; (2) whether registries should be subject to regulation to assure access and coverage of relevant information; (3) whether EPA or the State should operate registries; and (4) whether a national registry, as opposed to multiple regional or local registries, is necessary for the open market program to function properly.

H. Protocol Development and Approval

A key to integrity in the operation of the open market trading system is accurate quantification of the amount of surplus DER's created and of the amount needed to meet compliance obligations. Emissions quantification is generally divided into two conceptual components. First, emissions quantification protocols specify the type of data needed on emissions rates and operating rates (e.g., monitoring methods, emissions factors, production rate or other activity measures) and address other critical methodological issues (e.g., data quality and statistical considerations). Second, specific data must be developed pursuant to such protocols and used to calculate specific results. Quantification protocols can be defined to varying degrees of specificity in advance of particular emissions reduction actions. The actual data used in particular cases, naturally, can be developed and evaluated only case-by-case.

A number of cross-cutting factors must be considered regarding the development of emissions quantification protocols. On the one hand, both emission sources and compliance authorities have strong interests in certainty. Federal and State authorities want to be sure that methods are technically sound and that sources can be held to follow them. Sources want methods they can use with assurance of predictable outcomes at the time of compliance determinations. Based on these concerns, some State and industry stakeholders have urged that protocols be reviewed and approved by EPA before DER's are introduced into the market. This would give both sources and compliance authorities a common yardstick with which to gauge the validity of DER's and the greatest certainty of outcomes, without requiring redundant resource investment by multiple States.

On the other hand, a protocol pre-approval requirement would greatly strain governmental resources and significantly dampen development of the open market system. Given the variety of source types eligible to participate and the variety of emissions reduction strategies available to them, dozens (possibly hundreds) of specific quantification protocols would be needed. Resource constraints on EPA and States could severely limit the number of such protocols that could be developed and approved in the near future, even with the benefit of partnerships with industry and others. Many DER generation and use actions could be delayed or precluded by the unavailability of pre-approved protocols and the lack of a route for proceeding without such protocols.

In response to these cross-cutting considerations, EPA has tried to develop a middle ground that provides a sufficient measure of certainty and predictability with due regard for governmental resource constraints and the need for flexibility to adapt to new situations. The EPA intends to issue guidance containing criteria for acceptable emissions quantification protocols. The criteria would set forth meaningful standards for the kinds and quality of data required to support the calculation of amounts of emissions reduced by generators or needed by users. DER Generators and users would be able to employ these criteria to develop specific quantification protocols for their applications. Compliance and enforcement authorities would be able to use these criteria to determine whether submitted protocols, and associated data, are sufficient to establish compliance. The guidance would be issued with the final model OMTR and revised and expanded as necessary from time to time. Generators and users would be able to rely on, and would be held to, the guidance in effect at the time they generated DER's or at the time they determined their need for DER's to meet compliance obligations, respectively.

In addition, EPA intends to create a mechanism for working with States, industry, and the environmental community to develop and approve specific quantification protocols for priority types of generation and use activities. It is envisioned that some such protocols would be drafted by industries, and others by EPA or States. They would be reviewed by a multi-stakeholder process prior to an EPA approval decision. The EPA believes that in many cases emissions quantification protocol development may not be a large additional burden. This could be especially true for protocols that determine the amount of DER's needed to be in compliance, since user sources subject to emissions limits may be already familiar with the task of evaluating their emissions levels.

The EPA specifically requests comments on two variations on this basic approach. In both cases, sources would develop their own protocols subject to EPA's protocol guidance criteria where no pre-approved protocol existed. Where EPA-approved protocols existed, however, two options could be followed. In one case, a source would be required to use the pre-approved protocol unless it obtained EPA's approval of an alternative protocol. In the other case, a source would be allowed to use an alternative of its own design in lieu of the pre-approved protocol, so long as the alternative conformed to the criteria in EPA's protocol guidance.

The model rule would allow State OMTR's to incorporate EPA's protocol guidance and specific pre-approved protocols by reference. In this way, a

source which generated or used DER's would be on notice that it was legally bound by the protocol guidance or specific protocols (as applicable) that were in effect at the time of their generation or use action. Incorporation by reference would provide fair notice and binding effect while avoiding the need for continual SIP revisions as new specific protocols were adopted and as EPA's protocol guidance was revised. In the interest of assuring enforceability, EPA is also considering whether each EPA-approved protocol and/or the EPA protocol guidance should be incorporated directly into State SIP's and requests comment on the sufficiency of the incorporation by reference approach.

The EPA acknowledges, however, that there are risks for both sources and authorities associated with allowing operation under protocol guidance as proposed. Generators would be allowed to introduce DER's into the market based on specific protocols that they devised pursuant to the guidance, without advance approval. Compliance agencies would have to determine the protocol's consistency with the guidance at the time of the compliance determination, after sources had made use of the reductions. Despite the fact that the proposed rule assigns users the burden of proof of DER validity, it may be more difficult at this stage for compliance authorities to reject DER's based on unsound methodologies. Further, at least a portion of the resource burden associated with evaluating protocols in advance would be shifted to State and Federal compliance authorities later in the process. The EPA requests comment on these issues.

The EPA believes this combination of protocol guidance and specific protocols would give generators and users, as well as compliance authorities, a predictable "road map" for distinguishing DER's that have a high likelihood of being considered valid from ones that are doubtful or clearly inadequate. The EPA requests comment on all aspects of this approach.

I. Meeting Related Federal Requirements

The Act requires SIP's to include provisions to meet specific rate of progress (ROP) requirements applicable to certain ozone nonattainment areas under section 182. The Act also requires SIP's to provide for the attainment and maintenance of the NAAQS. SIP's must include specific emissions limits within a nonattainment area to meet ROP and, in moderate or above nonattainment areas, as well as certain marginal areas, the SIP must require RACT. SIP's may also include modeling analyses which result in emissions limits over an area larger than the nonattainment area—the modeling domain—as needed to attain the NAAQS. Emissions trades between sources far apart could cross multiple nonattainment areas and modeling domains and, thus, impact ROP, RACT and attainment requirements contained in more than one SIP.

As noted above, the proposed rule would limit certain DER uses with respect to pollutant, modeling domain, and nonattainment area. These provisions recognize the regional nature of the ozone nonattainment problem and the specific limitations are intended to help assure consistency with any attainment or maintenance plan and ROP requirements.

In addition, the model rule would require an audit of the trading program to evaluate, among other items, the effect of the program on the attainment demonstration and ROP requirements. The provisions would require a retrospective look at the effects of the trading program at least once every three years. Where an inconsistency with the attainment or maintenance plan or ROP is determined by the State, the State must institute measures to correct the problem.

1. Attainment and Maintenance Plans

The EPA recognizes that the intertemporal use of DER's may, under certain circumstances, place pressure on an area's attainment requirements. If numerous DER's generated prior to the attainment date were used near the attainment date, the additional emissions from sources that avoided otherwise required reductions could lead to violations of the NAAQS and delay attainment.

In addition, emissions trades between sources far apart could cross multiple nonattainment areas, States, and modeling domains and, thus, impact ROP and attainment or maintenance plan requirements contained in the SIP's.

The validity of attainment and maintenance plan modeling analyses could be eroded by trading if the location and amount of emissions significantly changed from the initial plan assumptions. Such shifts would add uncertainty to predictions of the ozone levels expected on peak ozone days. In a worst-case scenario, reductions created during non-episodic conditions could be used during episodic conditions, exacerbating peak ozone levels.

The EPA must evaluate these potential planning concerns in light of section 110(l) of the Act, which provides that EPA—

> shall not approve a revision of a plan if the revision would interfere with any applicable requirement concerning attainment and reasonable further progress * * * or any other applicable requirement of this Act.

Whether DER use would interfere with an attainment demonstration depends on numerous factors involving the amount, timing, and location of trades. Limitations in the model rule (e.g., spatial limitations) could reduce the risk of such interference. Based on available information, EPA does not have evidence at this time that would lead it to believe that an overly large number of DER's will be used during the year of an attainment deadline, or at any other time that could precipitate exceedances of the standard. Rather, it seems reasonable to assume that DER's will be generated fairly steadily as opportunities for better controls arise, in response to continuing demand by DER users. Moreover, certain sources may require use of DER's over a long period of time; under these circumstances, it is doubtful that the intertemporal or spatial aspects of the OMTR would interfere with attainment. The EPA acknowledges, however, that generation of DER's could be bunched at particular points in time, such as new control deadlines, by sources that are able to implement controls prior to the required date. Also, use of DER's could be bunched just after such deadlines. If this phenomenon occurs on a large enough scale and at a particular time, attainment could be jeopardized. On balance, EPA has concluded in this proposal that current information does not establish a sufficient risk of this scenario to constitute interference with attainment. Although the open market trading program adds an element of uncertainty to the attainment planning, attainment demonstrations have many other unavoidable uncertainties which may include growth projections, biogenic emissions, mobile source emissions, rule effectiveness, model boundary conditions, and model precision. The EPA invites comments on its analysis and conclusions on this point.

It is possible to imagine trades that could adversely affect a SIP's attainment or maintenance strategy by creating "spikes" over permissible aggregate emissions levels. The mere possibility of such events does not mean that the program would necessarily interfere with attainment planning. It does, however, offer support for the need of periodic trading program audits to monitor trading.

2. Rate of Progress (ROP) Requirements

ROP requirements must be met in nonattainment areas. Section 182(b)(1)(A) of the Act, applicable to ozone nonattainment areas classified as Moderate or higher, provides that the SIP—

> shall provide for such specific annual reductions in emissions of volatile organic compounds and oxides of nitrogen as necessary to attain the national primary ambient air quality standard for ozone by the attainment date applicable under this Act.

Section 171(l), applicable to all nonattainment areas, contains a similar requirement. Section 182(b)(1)(A) further requires a 15 percent reduction in VOC by the end of 1996. Section 182(c)(2)(B), applicable to areas classified Serious and higher, generally requires a 9 percent reduction in VOC or NO_X for each 3 year period thereafter, until attainment.

An area's success in meeting ROP requirements depends on many factors, including growth rate, rule adoption schedule, and control effectiveness. In many cases, trading would clearly not impact ROP: for example, in areas not covered by ROP programs; in areas trading NO_X emissions and affected by VOC-only ROP programs; for same pollutant trades within a single nonattainment area; and for trades involving emissions reduction from sources in one nonattainment area over one ozone season. In addition, where the SIP's nonattainment area reductions were greater than ROP requirements, VOC trading within that margin would not affect ROP and, thus, would be acceptable. In general, EPA believes that an audit program should be part of a State's ROP planning, because, like attainment planning, it may be affected by trades under an OMTR. The intertemporal aspect of trades, as well as trades across nonattainment areas, raise the possibility that under certain circumstances, trading could jeopardize ROP.

The EPA has made use of a computer model which allows a rough approximation of the impact of intertemporal trades on attainment and ROP plans, under various simplified assumptions about overall market activity and some alternative policy choices. As discussed above with respect to attainment planning, hypothetical circumstances may arise in which large quantities of DER's are generated in year 1 and used in year 2, or generated in one area and used in a neighboring area, to a degree that interferes with reduction targets in year 2 or in the neighboring area.

However, for much the same reasons discussed above with respect to attainment planning, EPA believes it reasonable to assume that intertemporal trading will not be of the magnitude necessary to interfere with the 1996 and subsequent ROP targets. For the same reasons, EPA believes it reasonable to assume that OMTR trading will not cause annual emissions spikes that may interfere with the section 182(b)(1)(A) requirement concerning annual reductions as necessary to attain. In any event, EPA believes that even if annual "spikes" were likely to occur as a result of an OMTR program, this requirement should be interpreted in light of the purpose of the OMTR, which is to encourage early reductions in exchange for an opportunity to trade the DER's so generated. If year 2 emissions are higher than in year 1 because DER generation causes emission reductions to occur a year early, EPA would not conclude that DER use interfered with the section 182(b)(1)(A) requirement. The EPA invites comment on its analysis and conclusions concerning ROP.

3. RACT

Act section 182(b)(2) requires a SIP revision implementing RACT for VOC sources for ozone nonattainment areas classified as "moderate" and higher. Section 182(f)(1) imposes the same requirement on NO_X sources. The Act does not define RACT; instead, EPA defines RACT as the lowest emissions limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility (44 FR 53762 (1979)). VOC RACT has traditionally been met on a 24-hour basis unless the State has shown that a longer averaging time is needed because of recordkeeping difficulties or control infeasibility. Many RACT rules adopted by States include emissions rate limits based on daily or 30 day averaging times.

For many years, EPA has interpreted RACT as a performance standard, which normally manifests itself as an emissions limitation based on a particular control technology, as opposed to a requirement for the technology itself. The EPA has applied RACT on an aggregate basis in the EIP rule, so that some sources may meet RACT limits through averaging (59 FR 16706 (1994)). However, under the model OMTR, DER's that were generated before a RACT compliance deadline could be used after the deadline. This raises the possibility that stationary sources subject to RACT requirements, in the aggregate, would not meet their otherwise applicable SIP RACT limits in the period after the RACT compliance deadline.

The EPA believes that it has the discretion to define "reasonable available control technology" to allow intertemporal averaging that may occur around a RACT compliance deadline under the OMTR. In the EIP rule, EPA considered air quality factors in determining whether stationary sources subject to RACT could emit at levels higher than levels otherwise deemed RACT if the excess emissions were more than offset by reductions among non-RACT sources. The EPA concluded that this system was consistent with the definition of RACT because the higher emissions levels of the RACT sources would be considered to be reasonable in light of the exceptional environmental benefits of the additional offsetting reductions.

A comparable analysis applies in the case of the OMTR. The OMTR would encourage early reductions by both RACT and non-RACT sources in year 1. In year 2, DER use might cause higher-than-current RACT levels of emissions. However, because DER generation would have provided early environmental benefits in year 1, and because 10 percent of the DER's used in year 2 would be retired for environmental benefit, EPA could conclude that the emissions levels in year 2 continue to reflect RACT.

J. Enforcement Issues

1. Calculation of Violations

The proposed rule provides for the calculation of violation days as consecutive days with a DER shortfall after first taking into account all valid DER's. This standard is applicable when emissions or emissions rates are measured on a daily basis. For example, if a source exceeds its emissions rate for 10 days and can demonstrate that it held sufficient DER's to cover its emissions overages for only the first 5 days, the source would be subject to penalties for the last 5 days. In circumstances when sources use a longer period of time for measuring emissions (e.g., a 30 day average period), violation days would be calculated based on the number of days of the measurement period for which there is any DER shortfall. For example, if a source measured emissions over a 30 day period and it was determined to have had a shortfall of DER's beginning any day during the measurement period, the enforcement action and penalty calculation would be for 30 days of violations. The EPA believes that this would encourage market participants to develop better, more accurate emissions measurement methods that will enable

sources to measure emissions on a daily basis.

2. State Compliance Determinations

Sources subject to the title I permit requirements would be required to submit compliance certifications annually. States monitor compliance of other stationary sources on a periodic basis. This rule would not impose a particular time period or frequency for States to review the validity of DER uses. However, it is EPA's expectation that States would develop inspection plans which address both generator and user sources in a manner consistent with EPA's Compliance Monitoring Strategy and other applicable guidance. In addition, because the integrity of the open market trading program relies so heavily on retrospective review, it is likely that EPA would identify the OMTR as a national priority in the early years of implementation. As a result, States would be expected to address a wide range of OMTR participants in their inspection planning. In this regard, DER use would be treated exactly the same as other air pollution control programs. The EPA solicits comment on whether a particular time limit within which to review particular DER uses should be imposed, in light of the fact that OMTR is a new program that carries risks concerning, for example, the quantification of DER's.

K. Program Audits and Reconciliation Measures

The OMTR would require States to conduct periodic audits of the open market trading program and implement reconciliation measures if appropriate. The State must evaluate and report on the following program elements:

(1) The amount and timing of emissions reductions (e.g. DER's used compared to DER's generated in a given year or ozone season);

(2) Compliance by generators and users;

(3) The effect of the program on temporal and spatial assumptions in the attainment demonstration and ROP plans;

(4) The effect of trading on emissions of hazardous air pollutants; and

(5) The effects of remedial measures, if applicable, implemented as a result of previous audit findings.

Unlike the EIP requirement (59 FR 16700 (1994)), under the OMTR program, reconciliation measures would not have to be automatically executing, and therefore, an appropriate "trigger" for the automatic execution of reconciliation measures would not be necessary. However, in the event the program audit revealed problems attributable to the trading program that were likely to persist, EPA encourages States to adopt remedial measures.

The following list of contingencies should be considered depending upon the nature of the problem that is uncovered by the audit:

(1) Restrict trading (limit trading so that the difference between DER generation and use is reconciled in a one-year period); increasing the environmental benefit component of DER's or limiting DER's or portions of DER's to compensate for the difference between the projected and actual emissions inventory;

(2) Enhanced monitoring (increase monitoring or quantification requirements for facilities in the OMTR program to better determine impacts on progress and attainment from the participating sources);

(3) Implement specific additional emissions reduction measures; and

(4) Increase enforcement and/or penalties (for use in the case where the discrepancy between actual and projected data is related to non-compliance with the OMTR program).

Audits must occur at least every 3 years, coinciding with a ROP milestone determination, or, if none applies, simply every three years after State adoption of the OMTR.

In conjunction with the triennial audits proposed above, EPA would work cooperatively with States that adopt open market programs to assess on a three-year basis the nationwide performance of open market trading programs. Using the results of State audits, an analysis would be prepared to assess the open market program's effectiveness. In the event that the triennial assessments showed that programs based on the OMTR jeopardized particular areas' ability to attain the NAAQS, to demonstrate required progress, or to meet other Act requirements, then EPA could issue specific SIP calls or, in the extreme case, adjust the OMTR program to compensate for such shortcomings.

The EPA solicits comment on all aspects of the audit requirements, in particular: (1) The frequency of the audits (more or less frequent than every three years); (2) the components of the audit program that should be required; (3) whether a mechanism for triggering reconciliation measures should be required; and (4) which, if any, reconciliation measures should be required.

L. Interstate Trading

The proposed OMTR limits interstate trades to areas which have Memoranda of Understanding (MOU's) to assure the success of the trading program in each State. This provision recognizes the regional and interstate nature of the ozone nonattainment problem and the specific limitation is intended to help assure consistent compliance programs and facilitate information exchange between the States.

After States adopt the model rule, sources might wish to effect trades across State lines. Such VOC trades could occur within interstate nonattainment areas; for NO_X, modeling domains are frequently interstate. A mechanism would be needed to assure that an emissions reduction in one State was recognized in another State and that trades were made consistent with the requirements of the respective State's rules. Further, a trading program needs enforcement provisions that assure proper monitoring and enforcement in all participating States. Therefore, EPA believes that States must sign a MOU or equivalent document. The MOU must include the following provisions:

(a) The State where the generator is located must agree to provide the State where the user is located in a timely manner with all relevant information it possesses concerning the DER's and the generator, including, but not limited to, information on the generator's SIP limits and permit, as well as a copy of the notice of generation proffered by the DER user;

(b) The user State must agree to provide the generator State in a timely manner with all relevant information, including the notice of intent to use and the notice of use;

(c) The State where the generator is located must agree to notify the State where the user is located as to whether the DER has been used previously;

(d) The State where the user is located must agree to enforce its individual State emissions requirements as modified by any valid trades.

The EPA solicits comment on all aspects of the interstate trading issue, including whether States should be permitted to include interstate trading only after EPA approval of its MOU's with other States.

M. Effect of VOC Trading on Emissions of Air Toxics

Many volatile organic compounds (VOC's) are listed as hazardous air pollutants (HAP's) under section 112 of the Act. Emissions of these toxic pollutants are often reduced incidentally by compliance with VOC limitation. Citizens groups have been concerned that by relaxing site-specific VOC limitations, VOC trading programs might lessen public health protection from air toxics at some facilities. The

EPA is considering whether open market trading programs should contain safeguards (beyond the continued requirement to meet section 112 standards) to reduce the chance that a facility using off-site DER's in lieu of meeting otherwise applicable VOC limits, would have higher HAP emissions than if it directly met the VOC limits with on-site controls.

Overall, EPA believes that open market trading programs would encourage quicker reductions of VOC emissions, including HAP's that are VOC's, by reducing the cost of Act control requirements and providing incentives for early reductions. This could reduce aggregate risks from toxic air emissions.

At the facility-specific level, however, results may not be geographically uniform. For example, if a facility emits VOC's that are toxic air pollutants, and buys DER's to satisfy a RACT requirement, the facility's emissions of air toxics would be higher than if the facility had installed controls. Conversely, if the facility chooses to make extra emissions reductions and sell them as DER's, toxic emissions from the facility should be lower than without trading.

The EPA has considered several options for dealing with potential changes in toxics emissions as a result of open market trading. The first option would require all sources participating in the open market system to disclose to the public when DER generation or use would cause HAP increases (or forgone decreases), and that States should retroactively study the effect of open market VOC trading on aggregate and facility-specific hazardous air pollutant emissions.

A second option would be for EPA to prohibit a source from using a DER for RACT compliance if the effect would be to increase hazardous air pollutant emissions.

A third option would require States to include in their programs some mechanism to prevent trades that could pose significant toxics concerns, with the mechanism to be determined by the State. Such mechanisms could include screening assessments to provide an indication of whether health or environmental risks from a facility might increase significantly, or a fuller risk assessment. As a variation of this option, a requirement for sources to notify the public of HAP increases due to trades could be among the options available to a State.

The fourth option would be for EPA to leave to State discretion the issue of whether State programs should include restrictions, disclosure, or other safeguards to ensure that toxic emissions changes are acceptable. The EPA could issue guidance on ways to determine whether a VOC trade should be considered unacceptable due to toxics impacts.

The EPA has decided to propose a disclosure requirement which might serve many purposes. Citizens who live near a facility could use the information to determine whether the trade posed a health concern. In many instances, this information may be reassuring, where perceived HAP emissions were larger than actual amounts. The State could also use disclosed information to help ascertain whether to use State regulatory authorities to curb any HAP increases (or to ensure attainment of expected decreases).

Many facilities already are subject to annual toxic release inventory reporting required by the Emergency Planning and Community Right-to-Know Act of 1986 and Pollution Prevention Act of 1990. These reports include estimates of annual emissions of all but eight of the 189 hazardous air pollutants listed under section 112 of the Act. Using the same methodologies it uses for toxic release inventory (TRI) reporting, the facility could estimate HAP emissions with and without DER generation or use. DER generators would include this information in their generation certification notices submitted to the State. DER users would include the information in their notice of intent to use DER's and in their post-use compliance certifications. As described in other sections of this preamble, the rule would require States to make these notices available to the public.

Some commentors have expressed concern that a toxic pollutant disclosure requirement would stigmatize the use of DER's with the detrimental effect of "chilling" the use of DER's and discourage market participation. These commentors have further argued that plant-specific fluctuations in HAP emissions resulting from the generation and use of DER's are not likely to be significant, and that they will in most cases be below the level of Federal and State regulatory concern. Toxic emissions that do not fall below this level are already (or will be soon) regulated under Section 112 of the Act. The EPA solicits comments as to whether it should balance this concern against the potential lack of knowledge about toxic pollutant emissions changes.

The EPA seeks comment on all aspects of this possible disclosure requirement. The Agency seeks comment on the suitability of TRI emissions estimation methodologies for the purposes of this rule. In addition, EPA seeks comment on alternative ways to estimate the difference in emissions of each HAP that would result from DER use or generation, especially for facilities not subject to TRI.

The EPA is also soliciting comments on the approach that States should take in studying the effects of open market VOC trading on the aggregate level of risk from air toxics, and on such risks from individual facilities. Depending on the results, the study could either allay concerns of significant increases in risk, or suggest a need for changes in open market trading or air toxics programs. One component of this study might be to evaluate the information that would be available as a result of the proposed disclosure requirement.

N. Impact of OMTR on Related Programs and Policies

1. Emission Trading Policy Statement

The final Emission Trading Policy Statement (ETPS), published in the **Federal Register** on December 4, 1986 provides a general framework for EPA-approvable emission trading. This policy requires that all reductions used in trades be enforceable, permanent, surplus and quantifiable. This policy provides guidance for States to develop model trading rules that would allow specific two-source trades without source-specific SIP revisions, as well as approval criteria for trades submitted as source-specific SIP revisions. The OMTR does not change the requirements of the ETPS, or the types of emissions trading that can occur under the ETPS.

2. Economic Incentive Program Rule and Guidance

The EPA's most recent policy on emissions trading is embodied in the Economic Incentive Program (EIP) rules that were promulgated on April 7, 1994. The 1990 Amendments of the Act required EPA to promulgate EIP rules for certain areas that must implement an EIP as part of their ozone and carbon monoxide attainment strategy. These rules also serve as guidance for all other areas that choose to develop and implement EIP's. The types of trading programs envisioned in the EIP are emissions limiting strategies (such as RECLAIM), market-response strategies, and directionally-sound strategies. The model rule proposed here would establish the ground rules for one type of market-response strategy, namely open market emissions trading of ozone precursor emissions. The model rule proposed today in no way limits the use of other strategies.

The open market program would differ from the requirements for EIP programs in many respects, including, among others:

(1) The intertemporal, spatial, and inter-pollutant trading requirements and restrictions;

(2) Requirements for trading between RACT and non-RACT sources;

(3) Notifications by generators and users;

(4) Lack of pre-approval for trades; and

(5) Requirements for program audits and reconciliation measures.

In light of these differences, EPA is considering amendments to the final EIP rules and guidance, so that the model OMTR would meet all the criteria for an EIP mandated under section 182(g). These amendments could affect the final EIP decisions in such areas as the definition of surplus, the averaging time for RACT, and the requirement that protocols be approved by EPA before they are used.

3. Memorandum to Region IX Regarding Surplus Determination

On August 26, 1994 EPA issued a guidance document on the use of pre-1990 ERC's and adjusting for RACT at time of use. In this memo EPA stated that for banked ERC's it was not sufficient to determine surplus at time of generation, but ERC's must be discounted at time of use to account for any new RACT requirements that may have occurred since the ERC was banked.

ERC's are reductions in the rate of emissions (e.g., pound per day or tons per year). When a source creates an ERC it takes an action which reduces the rate of emissions on a continuous basis. The ERC's are used to offset increases (or lack of decreases) in the rate of emissions on a contemporaneous basis. Thus the reduction created by the ERC must be surplus at the time of use. DER's, on the other hand, would be created and documented before they were used. Thus, barring any restrictions at the time of use, DER's would be surplus only at the time of creation.

The Memorandum also ties surplus to the 1990 and other subsequent emissions inventories as well as attainment demonstrations and ROP plans. The EPA believes that this policy is still valid for ERC programs but would only be partially applicable to DER programs. Several aspects of the proposed open market program illustrate this point. First, one purpose of the proposed open market rule would be to encourage early reductions, and this incentive would be reduced or lost if there were not a reasonable expectation that the reductions could be used at a later date because they were no longer surplus. Second, the proposed rule would not allow pre-1995 reductions to qualify for credit, which would reduce the likelihood that a large amount of banked reductions could be used in the future. Finally, the proposed rule would retain the link to emissions inventories, attainment demonstrations and ROP plans for determining surplus at the time of generation, but would rely on retrospective program audits to ensure that DER use would not chronically interfere with progress toward attainment or attainment.

4. Emissions Budget Programs

Since the 1990 amendments to the Act there has been considerable activity in developing emissions budget programs for attaining the ozone standard. These programs determine the quantity of emissions an area can emit and still demonstrate attainment. This emissions budget is then allocated among the sources in the nonattainment area in the form of emissions allowances. Sources are then allowed to trade their allowances. The EPA has proposed conditional approval of the NO_X/SO_X Regional Clean Air Incentives Market (RECLAIM) program in the Los Angeles area, which is the most fully developed ozone program of this kind. Various cap and trade programs are also being developed in Illinois for VOC, and in the Ozone Transport Region for NO_X. The model rule would not inhibit the development and implementation of these programs. The EPA continues to strongly encourage States to develop cap and trade programs as part of their attainment strategies.

The EPA envisions that open market trading programs could be complementary to emissions budget programs. It is typically difficult to include all of an area's VOC and NO_X sources in an emissions budget due to administrative costs or difficulty in quantifying the sources' emissions. For these reasons, smaller stationary sources and mobile sources are omitted. An open market program could offer sources not covered by the emissions budget a cost-reducing compliance option, as well as provide a continuous incentive to those sources to quantify their surplus emissions reductions.

IV. Administrative Requirements

A. Public Hearing

A public hearing will be held to discuss the proposed standards in accordance with Section 307(d)(5) of the Act. Persons wishing to make an oral presentation on the proposed model OMTR should contact the Agency in accordance with the instructions given in the **DATES** Public Hearing section of this preamble. Oral presentations will be limited to 15 minutes each. Any member of the public may file a written statement before, during, or within 30 days after the hearing. Written statements should be addressed to the Air Docket section address given in the **ADDRESSES** section of this preamble, and should refer to Docket No. A–95–21.

B. Docket

The docket is an organized and complete file of all the information submitted to or otherwise considered by the Agency in the development of this proposed rulemaking. The principal purposes of the docket are: (1) To allow interested parties to readily identify and locate documents so that they can intelligently and effectively participate in the rulemaking process; and (2) to serve as the record in case of judicial review (except for interagency review materials) (Section 307(d)(7)(A) of the Act).

C. Executive Order 12866

Under Executive Order 12866 (58 FR 51735 (1993)), the Agency must determine whether a regulatory action is "significant" and therefore subject to OMB review and other requirements of the Executive Order. The Order defines a "significant regulatory action" as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create serious inconsistency or otherwise interfere with an action taken or planned by another Agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order."

It has been determined that today's proposed model rule is a significant action because it raises novel policy issues arising out of the President's priorities. This action was submitted to OMB for review in accordance with the Executive Order, and changes made in response to OMB suggestions or recommendations will be documented in the public record.

D. Unfunded Mandates Act

Section 202 of the Unfunded Mandates Reform Act of 1995 ("Unfunded Mandates Act") requires that the Agency prapare a budgetary impact statement before promulgating a rule that includes a Federal mandate that may result in expenditure by State, local, and tribal governments, in aggregate, or by the private sector, of $100 million or more in any one year. A "Federal intergovernmental mandate" excludes "a duty arising from participation in a voluntary Federal program," unless the regulation "relates to a then-existing Federal program under which $500,000,000 or more is provided annually to State, local, and tribal governments under entitlement authority," if the provision would "increase the stringency of conditions of assistance" or "place caps upon, or otherwise decrease the Federal Governement's responsibility to provide funding. A "Federal private sector mandate" includes a regulation that "would impose an enforceable duty upon the private sector, except (i) a condition of Federal assistance; or (ii) a duty arising from participation in a voluntary Federal program."

The proposed model OMTR would be a volutary program that State and local governments could adopt. If adopted, the rule would govern the voluntary participation of private sector entities in an emissions trading program. Because the program would be voluntary for State and local governments and private entities, the Agency has not prepared a budgetary impact statement.

E. Paperwork Reduction Act

Today's proposal contains voluntary information collection requirements that are subject to review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501, *et seq.*

This collection of information has an estimated reporting burden averaging of 73.5 hours per trade and an estimated annual recordkeeping burden averaging 60 hours per respondent. These estimates include time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden to Director, Regulatory Information Division, EPA, 401 M St., SW (Mail Code 2138), Washington, DC 20460, and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

F. Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 and applicable EPA guidelines revised in 1992 require Federal agencies to identify potentially adverse impacts of Federal rules upon small entities. Small entities include small businesses, organizations, and governmental jurisdictions. In instances where significant impacts are possible on a substantial number of these entities, agencies are required to perform a Regulatory Flexibility Analysis.

Today's proposal does not of itself impose an requirements on small entities, nor require or exclude small entities participation in open market trading in the future. As a result, the EPA has determined that the proposed rule will not have a significant impact on a substantial number of small entities.

Therefore, as required under section 605 of the Regulatory Flexibility Act, 5 U.S.C. *601 et seq.*, I certify that this rule does not have a significant impact on a substantial number of small entities.

G. Clean Air Act Section 117

In accordance with section 117 of the Act, publication of this proposal was preceded by consultation with appropriate advisory committees, independent experts, and Federal departments and agencies. The Administrator welcomes comment on all aspects of the proposed model rule, including health, economic, technological, and other aspects.

Dated: July 26, 1995.

Carol M. Browner,

Administrator.

[FR Doc. 95–18869 Filed 8–2–95; 8:45 am]

BILLING CODE 6560–50–P

FEDERAL EMERGENCY MANAGEMENT AGENCY

44 CFR Part 10

RIN 3067–AC41

Environmental Considerations/ Categorical Exclusions

AGENCY: Federal Emergency Management Agency (FEMA).

ACTION: Proposed rule.

SUMMARY: This rule proposes to revise the categories of actions or categorical exclusions that normally would not require an environmental impact statement or environmental assessment. These proposed changes are intended to reduce the administrative processes and decrease the time required for project funding and implementation, while still ensuring that FEMA satisfies environmental concerns and issues. The proposed changes are consistent with Federal directives, regulations and statutes.

DATES: We invite comments on the proposed rule, which must be received on or before September 18, 1995.

ADDRESSES: Please submit written comments to the Rules Docket Clerk, Office of the General Counsel, Federal Emergency Management Agency, 500 C Street SW., room 840, Washington, DC 20472, (fax) (202) 646–4536.

FOR FURTHER INFORMATION CONTACT: Rick Shivar, Office of Policy and Assessment, Federal Emergency Management Agency, 500 C Street SW., Washington, DC 20472, or phone (202) 646–3610.

SUPPLEMENTARY INFORMATION: The proposed changes respond to numerous suggestions for additional exclusion categories and for modifications to existing exclusion categories. They reflect several years' experience on the types of actions that generally receive a finding of no significant impact after FEMA makes an environmental assessment. The proposed changes are intended to speed the approval of those projects with no potential for significant environmental effects and to allow attention to be focused on those projects with potential environmental concerns.

In order to produce a complete and effective update of exclusion categories, we conducted a review of the environmental assessments (EA) and the findings of no significant impact (FONSI) that FEMA has issued. In the last few years we have completed over 340 EAs, but there is only one case where an environmental impact statement (EIS) was written. While many EAs identified impacts that were able to be mitigated below the level of significance, we found that the clear majority of actions have no significant impact. Reviewing this last group revealed specific types of projects that historically did not produce significant environmental effects. In conjunction with the review of FEMA's EAs, we conducted a literature review of other Federal documents containing similar types of exclusions to ensure consistency of FEMA's exclusions with other Federal agencies' regulations. The results of these two reviews are the basis for the proposed change to FEMA's list of exclusion categories.

These proposed changes are also in keeping with the Council on Environmental Quality's guidance to

NBER WORKING PAPER SERIES

THE LIMITED FINANCING OF CATASTROPHE RISK: AN OVERVIEW

Kenneth A. Froot

Working Paper 6025

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
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May 1997

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The Limited Financing of Catastrophe Risk:
An Overview
Kenneth A. Froot
NBER Working Paper No. 6025
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Asset Pricing and Corporate Finance

ABSTRACT

This paper argues that the financial exposure of households and firms to natural catastrophe disasters is borne primarily by insurance companies. Surprisingly, insurers use reinsurance to cover only a small fraction of these exposures, yet many insurers do not have enough capital and surplus to survive medium or large disasters. In a well-functioning financial system, these risks would be more widely shared. This paper articulates eight different explanations that may lie behind the limited risk sharing, relating them both to recent industry developments and financial theory. I then examine how financial innovation can help change the equilibrium toward a more efficient outcome.

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The Limited Financing of Catastrophe Risk: Diagnosis and Solutions

Introduction

In recent years, the magnitude of catastrophic property/casualty disasters risks has become a major topic of discussion. The insurance industry now regularly discusses potential U.S. earthquake or hurricane losses of $50 to $100 billion, a magnitude of loss that was unthinkable 10 years ago. The disasters of Hurricane Andrew and the Northridge Earthquake alone totaled over $45 billion in 1997 dollars, with the insured component running to almost $30 billion. This compares with cumulative insured losses from natural catastrophes in the decade prior to those events of only about $25 billion.[3]

These enormous increases in potential losses are likely to be, at least in part, permanent. During the 1970-1990 period, the population of the southeast Atlantic coastal counties increased by nearly 75 percent, almost 4 times the increase for the nation as a whole. Annual growth rates in population per square mile in California and Florida have been 2 or 3 times the national average for the last three decades.[4] Indeed, analysis by Guy Carpenter & Co. suggests that, because of growth in hazard-prone areas, dollar damages of a given size natural event have grown at an average annual rate of 5 percent *in excess of* CPI inflation since 1950.

With prospective event-losses that can easily exceed $50 billion, the capitalization of the insurance and reinsurance industry is at issue. Estimates of total capital and surplus of US insurers runs to about $239 billion.[5] While a large natural disaster would not bankrupt the entire industry, this capital and surplus applies to *all* risks (property/casualty, liability, workers comp., etc.), not just catastrophes. A large event could therefore place firms' capital under severe stress, potentially jeopardizing the rewards of both policy holders and investors.

Traditionally, the insurance industry has avoided these financial stresses by pooling its exposures for large events. This occurs through reinsurance treaties with separately capitalized reinsurers to pass along the risks of low-probability / high-cost events. The pass through is, however, only partial. Very little of the reinsurance in place provides protection against industry-wide losses for catastrophic events greater than $5 billion. That is, for a $50 billion cat event, the overwhelming majority of the last $45 billion of losses are not covered by reinsurance. This is not surprising, in view of the fact that the capital and surplus of the reinsurance industry is relatively small (only $26.7

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[3] Data from Property Claims Services.
[4] From Christopher Lewis and Kevin Murdoch, "Alternative means of redistributing catastrophic risk in a national risk management system," NBER conference on The Financing of Property/Casualty Risks.
[5] As of September 30, 1996, from A.M. Best Co.

billion for US reinsurers, $6.5 billion for Bermudan reinsurers, $7.0 billion for German reinsurers, and $16.8 billion for others).[6] Thus, at present levels of capital, the worldwide reinsurance industry is not capable of funding large-event risks in the US alone, not to mention the rest of the world.

The paucity of reinsurance protection at high layers of exposure can be observed directly from reinsurance buying patterns. Using data from property/casualty contracts from Guy Carpenter & Co. which cover a large fraction of US nationwide reinsurance purchases, it is possible to gain a sense for the paucity of coverage at high levels of losses. Figure 1 shows the relationship in these data between the fraction of insurer exposure covered by reinsurance and the size of an industry event in each year since 1970.[7]

There are two important points to be made from the graph. First, reinsurance coverage as a fraction of exposure declines markedly with the size of the event, falling to a level of less than 20% for events of about $5 billion or greater. Reinsurance coverage is clearly only a small part of exposures for large events. And this is particularly noteworthy, given that the data are drawn only from those firms that actually purchase reinsurance. Thus, overall industry coverage is almost certainly lower than depicted in Figure 1. A second point to note from Figure 1 is that, for a given loss level, the fraction of reinsured exposure tends to fall after major cat events, such as Hurricane Andrew in 1992.

The fact that relatively little reinsurance is in place for large event losses is striking, as it is large events whose risks need most to be shared. By definition, event losses are paid *ex post* by some combination of insurers and reinsurers (and their investors), insureds, state and federal agencies and taxpayers, with only some of these payments being explicitly arranged *ex ante*. This introduces considerable uncertainty about burden sharing into the system, with no particular presumption that the outcome will be fair or exogenously determined. The result is incentives for players to shift burdens toward others, from the homeowner who builds on exposed coastline, to insurers who write risks that appear highly profitable in the absence of a large event. Some of these burdens will also be shifted to unrelated conduits, such as the U.S. personal income tax. But most importantly, bad or inefficient risk sharing raises the costs of capital for companies and required returns for households, reducing the amount of profitable investment and the rate of growth of the economy. While the link between lower capital costs and higher growth rates is difficult to measure, it is worth noting that the gains from higher growth are huge: each basis point of additional growth in the $7 trillion US economy is worth $700 million per year.

[6] Standard and Poor's, 1996, Global Reinsurance Highlights.

[7] Event losses are in 1994 dollars, and are adjusted for changes in demographics and GNP. The procedure for attaching individual reinsurance contract layers to industry losses is described in Kenneth Froot and Paul O'Connell, "The pricing of US catastrophe reinsurance," NBER conference on The Financing of Property/Casualty Risks.

The discussion below and the papers in this volume take as given what we have seen above – that the system of redistributed large catastrophe risks has not spread risks beyond insurer balance sheets and out evenly across investors. The discussion also takes as given that there are large costs associated with an equilibrium in which risk sharing is inefficient. We then go on to ask whether the current means of managing cat risk is functioning as well as is possible. What barriers (if any) prevent higher layer risks from being spread and/or mitigated? Are the capital markets likely to solve the problem? In what follows, I enumerate eight different explanations for barriers that have been proposed. Most of these explanations appear explicitly or implicitly in specific papers in this volume. Some perspective is provided on each. Naturally, one's view of the solution to the problem of inadequate catastrophic risk sharing depends upon the assumed cause. The discussion then turns to solutions that have been suggested, with a focus on the role of the capital markets and alternative means of distributing cat risk.

Explanations for the paucity of catastrophe risk sharing

Explanation 1: Prices of catastrophe reinsurance are "high" because of insufficient reinsurance capital

This explanation relies on the premise that prices are "high." Thus, before evaluating the sufficiency of reinsurance capital, we must first examine whether reinsurance prices are high. As an indicator, it would be useful to compare actual prices with a benchmark that somehow represents "fair" prices. For the sake of argument, I shall assume that fair prices are those which would prevail if the system for redistributing cat risk was perfect and frictionless. In such a system, catastrophe risk prices would be determined by investors. This makes sense because it is investors in one form or another who must ultimately provide catastrophic risk-bearing capacity.

As is generally argued by both practitioners and financial economists, investors require relatively low average returns for bearing risk exposures that provide large diversification benefits. Take, for example, investments which are a small part of total wealth and which are uncorrelated with the returns on other forms of wealth (such as stocks and bonds). Such investments improve the reward-to-risk ratio of investor wealth as long as their average returns exceed the return on riskfree investments like US Treasury bills. This suggests that the (relatively low) short-term US treasury rate is the threshold required return for a small, uncorrelated investment.

Historical data suggests that catastrophe risk is one such investment, since returns from bearing cat risk through reinsurance contracts are uncorrelated with all other major investor asset classes.[8] If this is true, then with wide risk distribution, the "fair"

[8] See Froot, Murphy, Stern, and Usher, Guy Carpenter and Co., "The Emerging Asset Class: Insurance Risk," July 1995 White Paper, which presents data showing that recent returns from bearing catastrophe

catastrophe premium on a reinsurance contract is just the actuarial contract loss. In other words, the contract premium should equal actuarial insurer losses covered by the reinsurance contract. Of course, actuarial losses are not known with certainty. One can only estimate actuarial losses. Nevertheless, as long as the estimate of expected loss is unbiased and the uncertainty in actuarial losses is itself uncorrelated with investor wealth, then premium should on average equal estimated actuarial losses.

To those in the industry, it comes as no surprise that reinsurance premiums are today considerably greater than estimates of actuarially expected losses covered by reinsurance. A good and very visible example is the recent purchase of reinsurance by the California Earthquake Authority (CEA) from National Indemnity, a subsidiary of Berkshire Hathaway. Under the structure of that contract, NI receives an annual premium which exceeds actuarially expected losses by 530%. To see this, note that the average annual premium for the 4 year aggregate cover is 10.75% of the annual limit, whereas the likelihood that the reinsurance is triggered is 1.7%, according to EQE International, a catastrophe risk modeling firm ((10.75 / 1.7) -1 = 530%). In other words, Berkshire Hathaway has a 1.7% chance per year of losing the $1.05 billion it has put up; in return it receives $113 million per year in premium. Indeed, under the contract specifications, Berkshire Hathaway receives four years worth of premiums in the first two years. Since the $1.05 billion cover aggregates over the 4 year period, Berkshire Hathaway is effectively putting up about $600 million in net exposure for a 93.4% chance to make about $400 million in premium.[9]

The pricing of this contract is, in today's market, not unusual. Historically, reinsurance contract premiums have exceeded actuarial contract losses by large amounts. Figure 2 shows a computation of the percentage excess of premiums over expected losses. While a multiple of five appears relatively high by the standards of the early 1980s, prices on average are nearly that high since Hurricane Andrew. In many instances, the prices are greater than shown in Figure 2, which averages across both high and low reinsurance layers. In general, the multiples on low-probability, higher layers (such as the CEA tranche) have been particularly high (see Figure 2a), the more so since Hurricane Andrew.

Once reaction to the Berkshire Hathaway example and the numbers shown in Figure 2 is healthy skepticism. The computations require one to measure actuarial value, which is not really possible. The actuarial values behind the Figure are derived from the historical distribution of catastrophe losses.[10] And this historical distribution is likely to

risk are uncorrelated with other major financial asset classes, such as US and foreign stocks and bonds, as well as currencies.

[9] Based on a probability of 1.7% per year, the chance of no event over the four years is $(98.3\%)^4 = 93.4\%$. Data in this paragraph from *IBNR Insurance Weekly* (Volume III, #46), Dowling & Partners Securities, LLC, and from remarks by Richard Sandor, NBER conference on The Financing of Property/Casualty Risks.

[10] For a description of how these numbers are calculated, see Kenneth Froot and Paul O'Connell, "The pricing of US catastrophe reinsurance," NBER conference on The Financing of Property/Casualty Risks.

differ from what market participants considered to be relevant at various times. Indeed, a portion of what appears to be a secular increase in prices in Figure 2 may actually be attributable to increasingly large losses expected by the market.

However, none of this skepticism changes the fact that, while the numbers in the Figure seem high by actuarial standards, they are not high by the standards of current market prices for catastrophe risk, at least as shown by the National Indemnity / CEA reinsurance layer. Indeed, Berkshire Hathaway shareholders appear to have rejoiced at having written the reinsurance: on the day of the contract announcement, Berkshire's stock market valuation rose by over $400 million, or 1%, in excess of the broad stock market change.[11] This suggests that shareholders saw the reinsurance contract (and those that might follow) as providing large net present value.

With these arguments about catastrophe reinsurance prices in mind, it is worth exploring the reasons *why* prices might indeed be "too high." (Below, we also consider explanations which assume that current prices are "fair.") The specific explanation considered in this section is that prices are high because catastrophic risk-taking capital is somehow limited. Such capital shortages, even if relatively temporary, might exist for a number of structural reasons: it may be costly for existing reinsurers to raise additional funds in the capital markets; it may be hard to find investors and names who expect adequate rewards for bearing catastrophic risks; it may also be that it is costly for reinsurers to accumulate large amounts of collateral on their balance sheets.

Shortages of capital are an important rationale for Berkshire Hathaway's strategy in reinsurance. In his 1996 letter to shareholders Warren Buffett observes, "Our ... competitive advantage [in writing "supercat" risks] is that we can provide dollar coverages of a size neither matched nor approached elsewhere in the industry. Insurers looking for huge covers know that a single call to Berkshire will produce a firm and immediate offering." Given that easy access by new and existing reinsurers to additional capital would remove this competitive advantage, it seems clear that Buffet believes in – and profits from -- capital shortages.

Indeed, there is a perception that the shortage may become even worse once reinsurer capital is depleted by a large event. Again from Berkshire Hathaway's 1996 annual report, Buffett writes:

> "After a mega-catastrophe, insurers might well find it difficult to obtain reinsurance even though their need for coverage would then be particularly great. At such a time ... it will naturally be [Berkshire's] long-standing clients that have first call on it. That business reality has made major insurers and reinsurers throughout the world realize the desirability of doing business with us. Indeed, we are currently getting sizable "stand-by" fees from reinsurers that are simply nailing down their ability to get coverage from us should the market tighten."

[11] Remarks by Richard Sandor, NBER conference on The Financing of Property/Casualty Risks.

Buffett's entire discussion of "supercat" risks emphasizes the value to Berkshire's shareholders of Berkshire's substantial financial capacity. In a world of no capital shortages, large capital capacity is nothing to write home about.

Are there more concrete facts to suggest that capital shortages are behind high prices? There are some. A second important feature of Figure 2 above is that prices appear to rise in the aftermath of major catastrophic events and then to fall afterward. This can be seen most clearly in the period around Hurricane Andrew (1992). Prices rise substantially in 1993 and have consistently fallen since. While the figure does not include 1995 and 1996 price data, preliminary estimates suggest that prices have fallen by approximately 27% during that time.[12]

Now it is perhaps not surprising that the price of reinsurance increases in the aftermath of an event, since event losses are likely to raise the demand for insurance and reinsurance. Of course, one reason for an increase in demand is that capital and surplus are in depleted and in short supply at the insurer level.[13] In a world of perfect markets, this depletion would, by itself, have no effect on reinsurance demand. Insurance companies would simply enter the capital markets, raising equity and even debt as needed, in order to put their capital back to original levels. Indeed, given the increase in consumer demand for insurance in the aftermath of a catastrophe, one might expect insurance companies to raise considerable amounts of capital. Thus one might argue that the increase in reinsurance prices is *prima facia* evidence that there are capital shortages somewhere in the system.

However, the behavior of prices alone cannot be decisive for whether the supply of reinsurance capital is relatively restricted after events. The combination of prices and quantities, on the other hand, are more decisive. Indeed, the cyclical price patterns turn out to be mirrored by synchronized declines in the "quantity" of reinsurance purchased.

Table 1 provides a kind of event study to demonstrate this. The table shows both price and quantity responses in reinsurance purchased during the year following hurricane Andrew. (Prices and quantity are measured using the same actuarially expected annual reinsurance benefits that lie behind Figures 1 and 2 above.) It is evident that in aftermath of large events like Hurricane Andrew, reinsurance purchases fall. (In practice this occurs primarily through an increase in insurer retentions.) Indeed, the table shows that the quantity purchased fell by more -- and prices rose by more -- for those insurers which had greater exposure to the Southeastern US and to hurricanes wherever they occur.[14]

The combination of a post-event increase in price and decrease in quantity cannot be explained by an increase in demand. High demand would be associated with high

[12] Paragon produces a catastrophe price index shows the following prices since peaking in late 1994 at 2.47 (and beginning in 1/184 at 1.00): 1/1/95, 2.32; 7/1/95, 2.16; 1/1/96, 2.14; 7/1/96, 2.06.

[13] For a study of demand and supply issues in pricing, see Anne Gron, "The demand for reinsurance," NBER conference on The Financing of Property/Casualty Risks.

[14] The table is borrowed from Froot and O'Connell, op cit.

prices *and* high quantities sold, much as if one were to observe transaction prices and quantities of electric generators sold during a blackout. What is going on in the reinsurance market is different: in the aftermath of events there is *less* provision of reinsurance capacity, even though prices are higher. This can only be explained by a temporary, shift backwards in the supply of capital.

In some sense, it should also not be surprising that the supply of cat risk bearing capital is restricted immediately following an event: after all, large events losses deplete reinsurers capital and surplus going forward. For at least a time, however, the high prices and low quantities are consistent with a view that additional capital has trouble flowing into the reinsurance sector.[15]

The final point in this section is that there is a kind of irony in capital market shortages and paucity of reinsurance: much primitive cat risk could be reduced through investments in mitigation, investments which are inexpensive in an actuarial sense. However, many of these investments are not made because they require individuals and corporations, who have scarce capital themselves, to raise (or deplete internal) capital. Thus, capital market shortages are in part responsible for the large and growing risk pool needing insurance and reinsurance. Without capital shortages, reinsurance capacity would be greater, but there would also be fewer risks to reinsure in the first place.[16]

Explanation 2: Prices of catastrophe reinsurance are "high" because reinsurers have market power

A number of observers have suggested that the evidence on prices and quantities above might be explained by market power rather than by a capital shortage per se. Under this explanation, prices rise and quantities decline not because reinsurance capital is impossible or costly to obtain, but because reinsurers have no incentive to increase their capital. By putting less money at risk, reinsurers keep prices high. James M. Stone of Plymouth Rock Company has argued that market power among reinsurers may be one reason that, for catastrophe exposures, reinsurance is a much more attractive business than insurance.

It is, of course, very hard to provide evidence that market power among reinsurers has increased secularly over time or cyclically in the aftermath of events. There is a general view that the reinsurance industry has been consolidating over time. There has been a distinct drop, for example, in the number of Lloyd's syndicates since the 1960s

[15] It is common in the industry for reinsurers to require "paybacks" for event losses and to do so through higher premiums and retentions. Note that there is nothing in this practice, to the extent it explains the data, to contradict explanation #1. However, an important question remains as to why this kind of contracting prevails and what it tells us about reinsurance markets. See explanation #5 below for one potential answer.

[16] See Howard Kunreuther and Paul Kleindorfer, "Challenges facing the insurance industry in managing catastrophe risks," NBER conference on The Financing of Property/Casualty Risks.

and 1970s. There has also been an increase over time in the capital and market share of large reinsurers. But neither of these facts are necessarily associated with increased market power in setting prices or restricting supply. For example, even when there were many more Lloyd's syndicates, catastrophic risk pricing was not typically determined by individual syndicates.

Furthermore, even if consolidation has occurred in the industry, it need not be associated with greater market power. Consolidation may be a natural result of economies of scale in the reinsurance business. Information-intensity is one possible source of scale economies. For example, there may be high fixed costs of developing analytic capabilities and systems.[17] Once these systems are in place, optimal reinsurer size grows as the required investment in fixed-cost systems increases. Consolidation may also be an efficient industry response to the costs of obtaining reinsurer capital from outside markets. (Size may help here as well.) If, in the extreme case, outside capital was effectively unavailable, then consolidation would follow from reinsurers' desire to diversify exposures and reduce the probably of ruin.

There may also be a kind of interplay between explanations 1 and 2 -- the insufficient capital and market power stories. Figure 2 suggests that prices have both increased secularly and undergone cyclical fluctuations associated with cat events. One would be hard pressed to explain the secular price increase with the insufficient capital story. For example, entry of capital into the Bermudan reinsurers, beginning in 1993 with Mid-Ocean, Ltd., suggests that the barriers to capital entry are not overwhelming, at least not over time periods of more than a few years. The insufficient capital story by itself is therefore likely to be better at explaining cyclical fluctuations in prices. However, to the extent that insufficient capital also drives consolidation, it may contribute to market power, thereby indirectly driving prices up on a secular basis.

Explanation 3: Prices of catastrophe reinsurance are "high" because the corporate form for reinsurance is inefficient

Under this explanation, the corporate organizational form of reinsurers is costly. Observers of corporate governance often point out that there are costs associated with discretion given to managers to run a business. In principal, managers could act in ways not in shareholder interest. It may be difficult for shareholders both to identify this behavior and to discipline it. Even if most managers are benevolent, the prospect that a bad manager might use his agency relationship against shareholders reduces stock prices and drives up the cost of capital.

This generic corporate finance argument of "agency costs" has application in a number of arenas. First, it clearly can be applied to insurers and reinsurers. Many of the

[17]Comments by Stewart Myers, NBER conference on The Financing of Property/Casualty Risks, panel on "Barriers to and opportunities for low-cost trading of catastrophic risk."

details of the reinsurance business and the specific contracts are not transparent to arms-length capital providers. And, given the occasional-big-loss nature of reinsurance, it takes many years to evaluate management efficacy and business profitability. In the reinsurance business, bad managers may have an unusually large incentive to effectively "take the money and run."

How costly is it to delegate discretion to managers? In the case of some businesses it is possible get a partial answer. Closed-end funds are one such business. Closed-end funds invest in publicly traded securities and then sell stakes in their portfolio to shareholders, much like mutual funds do. The difference is that mutual funds are "open-ended," so that shareholders can sell their shares back to the fund at a price dictated by the net asset value of the portfolio. Closed-end funds do not automatically buy and sell their shares; a shareholder wishing to sell must find another investor. And the price of the closed-end-fund shares, like the price of most traded stocks, must find its own value in the marketplace in accord with supply and demand.

Now there is a puzzle associated with closed-end fund shares: their prices are, on average, considerably below their net asset values. This cannot happen with open-ended fund shares. Closed-end share discounts average about 10%-20%, and are pervasive across funds. And it is often argued that agency costs account for these discounts. The story is that closed-end funds must pay an average return in excess of what would be required for holding the underlying net assets. The reason is that shareholders can't observe managers, nor can they easily discipline managers should they turn out to misbehave. The lack of transparency and control means higher capital costs for running a fund, even for ostensibly "good" managers.

This agency cost of capital may explain why the costs of reinsurance capital, and by inference reinsurance prices, are high. This agency argument is buttressed by two regularities. The first is that managers of reinsurers regard their capital costs as "equity-like" -- i.e., as requiring a return considerably above US Treasury rates. Writing reinsurance at anywhere near actuarially fair premiums is viewed as being against shareholder interest. Yet, given that catastrophe risks are uncorrelated with those of other financial assets, shareholders' required returns on cat risk should, as argued above, be low. Agency costs may be one factor forcing up required returns. The agency cost explanation may therefore help understand the view in the industry that, for many risks, there is "too much" capital and that prices are "too low." Indeed, some public reinsurers (such as Renaissance Re) are, as of this writing, in the process of repurchasing stock.

There is a second regularity behind the view that the corporate form is inefficient for the provision of reinsurance. This is that, even without agency costs, there is evidence that shareholders expect reinsurer equity returns to be well above US Treasury rates. Evidence for this comes from the behavior of stock prices of public Bermudian reinsurers, such as Mid-Ocean Ltd., Renaissance Re, and Partner Re. These firms hold large property/catastrophe liabilities, and generally hold assets in the form of short term notes and bills. Neither their assets nor liabilities are correlated with the stock market,

yet their share prices comove strongly with the stock market. Specifically, a 10% increase in the level of the S&P 500 is associated with an increase in the average value of these firms of about 6.5%.[18] All I know about the source of this comovement suggests that it does not emanate from the companies themselves.

If the source of the comovement lies outside the companies, there is an inefficiency. Investors who see a stock with higher systematic risk of moving with the market, they expect the stock to deliver a higher, more "equity-like" return. As a result, benevolent managers of reinsurers may be maximizing shareholder value by requiring high hurdle rates for writing reinsurance. This suggests that equity-financed reinsurance may be inefficient even if agency costs are completely unimportant. If equity capital requires an equity-like return and reinsurer assets and liabilities contain no broad equity market risks, then equity is an expensive form of capital, pure and simple. And if reinsurance is financed in an expensive manner, then reinsurance prices will be high.

Offsetting these arguments are several facts. Roberto Mendoza of J.P. Morgan has argued that Bermudian reinsurers, in particular, have a number of advantages which reduce their costs of equity capital. First, Bermuda's low corporate income tax rate means that reinsurers do not suffer by using equity finance versus debt, since there are no interest tax deductions available in the first place. Second, Bermudan reinsurer balance sheets provide an opportunity to achieve tax-free compounding on invested assets.[19] Both of these features tend to lower the cost of equity relative to what it would otherwise be.

Third, rather than an agency "cost," reinsurer managerial discretion may provide an agency "benefit." Smart managers may be able to cherry pick the better risk-writing opportunities, thereby raising share prices.[20] This set of features may imply that the typical corporate form of reinsurers, particularly those in Bermuda, is not so inefficient after all. Indeed, Mendoza argues compellingly that these advantages make the Bermudan corporate form the most efficient reinsurance delivery mechanism.

Explanation 4: Prices of catastrophe reinsurance are "high" because frictional costs of reinsurance are high

This explanation says that prices are high because, as financial instruments, reinsurance contracts are illiquid, have high transactions costs, brokerage, etc. These sources of friction imply that there are important costs in getting capital and reinsurance contracts together in a repository called a reinsurer.

[18] Data on unadjusted stock betas from Bloomberg.

[19] Comments by Roberto Mendoza, NBER conference on The Financing of Property/Casualty Risks, panel on "Similarities and differences between catastrophic risk and other markets."

[20] Of course, the same argument is often made in defense of closed-end fund managers.

There is abundant evidence that illiquid assets trade at significant discounts. Letter stock, as one example, typically trades at discounts of 25% versus publicly-traded stock; on-the-run bonds trade at significant premiums versus less liquid off-the-run bonds; and so on.

However, illiquidity of reinsurance contracts is not enough to drive up prices. In order to raise the cost of capital for reinsurers, reinsurers would themselves need to be financed through illiquid placements. This may arguably have been the case for Lloyd's commitments from names; it is unlikely to be true for publicly traded reinsurers in Europe, the US, and Bermuda.

Other frictions such as brokerage costs and servicing expenses can legitimately raise the cost of procuring reinsurance. However, these costs are not out of line with other financing charges. For example, in the National Indemnity transaction described above, annual brokerage fees were less than 1% of premium, and 0.1% of limit. If the reinsurance had been issued as a capital market instrument, as had been anticipated by some, these costs would have amounted to about 5% of annual premium. Brokerage / underwriting costs, for both traditional and new capital markets instruments can be expected over time to be competitive with those on other instruments.

Another kind of frictional inefficiency is the means by which reinsurer portfolios are managed. Oftentimes today, and in many more cases in the past, reinsurers manage their portfolios by aggregate limits, rather than exposures. For example, a reinsurer might decide it will risk up to $100 million on Florida, but without specifying the *probability* of Florida losses on contracts written, or the covariance of Florida losses with potential losses on North Carolina contracts. Removing such portfolio inefficiencies could have a substantial impact on the cost of risk transfer.

However, the main point here is that the high level of prices seems well above anything that can be explained by brokerage and underwriting costs. Even if brokerage and underwriting expenses had come to a high of 10% of premium in the National Indemnity deal, complete elimination of these expenses would have driven down the multiple of premium relative to actuarially expected losses by about 0.6 from 5.3 to 4.7. Brokerage and underwriting expenses cannot explain observed price levels.

Finally, it is hard to argue that inefficient reinsurance portfolio practices keep prices high. The financial technology to improve efficiency exists and can be transferred fairly cheaply. Indeed, the fact that these inefficiencies prevail today seems evidence for the lack-of-competition view (explanation #2).

Explanation 5: Prices of catastrophe reinsurance are "high" because of moral hazard and adverse selection at the insurer level

There is often agreement, implicit or explicit, that reinsurers will charge more in the aftermath of a catastrophe loss. In this sense, property / catastrophe reinsurance is much like "finite" reinsurance. Finite reinsurance does not so much transfer risk from the cedent, as it smoothes the risk over time. The insurer uses the reinsurance as a financing vehicle more than an instrument of risk transfer. During an event, the reinsurer makes funds available, expecting to be paid back later. In its purist form, the arrangement is just event-contingent borrowing.[21] Thus, to the extent catastrophe reinsurance resembles finite reinsurance, it may be transferring even less risk than might appear on a year-by-year basis. Indeed a prevalent view in the industry is that it is appropriate to have a "payback" to reinsurers after an event loss, and that this drives retention levels up.

While this theme is frequently echoed among practitioners, it further begs the question of why there is so little risk transfer in the first place. Two mechanisms that would explain both the use of finite-risk type contracts as well as high prices and low quantities would be moral hazard and adverse selection.

Moral hazard says that an insurer's behavior might change if it were too easily allowed to transfer risk to reinsurers. Once the risks are transferred, insurers have much less stake in prudent underwriting in the first place. Thus, it may be that the most efficient form of reinsurance is to allow very little risk transfer at all: it is only by forcing cat risk back upon insurers (or by charging a very high price to assume risk) that reinsurers get insurers to expend the resources to monitor and mitigate exposures. A reinsurance intermediary who came along willing to charge a low price and take a substantial quantity of risk from an insurer might find that the insurer misbehaves.

Adverse selection is a related problem. It says that insurers know more about their exposures and underwriting than do reinsurers. Those that are most eager to reinsure at any given price probably have private information that says their exposures are worse than average. Similarly, those that are least eager to reinsure have private information that their exposures are better than average. The result is that, at any given price, reinsurers will do business with an adversely selected group of (the worst) insurer risks. Clearly, in the presence of adverse selection, the reinsurer needs to charge more to make up for the degree of adverse selection.[22]

This explanation has some interesting implications (see the discussion below). Unlike explanation 4, it does have the ability to explain high levels of prices. However, it is not clear how it fits all of the facts. For example, it is hard to see how the cyclical pattern of prices and quantities would emerge. Why, for example, are reinsurers worried that insurers have a greater motive to forego monitoring after cat events? Why might the information-gap between insurers and reinsurers be greater in the aftermath of an event?

[21] The contingent credit arranged for the Nationwide by JP Morgan has many of these features.

[22] In some circumstances, higher prices may actually exacerbate the problem, making it impossible for the market to function. For a discussion of the implications of adverse selection on reinsurance contracts, see David Cutler and Richard Zeckhauser, "Reinsurance for catastrophes and cataclysms," NBER conference on The Financing of Property/Casualty Risks.

Is there a pattern whereby insurers who transfer more risk are less profitable? Much needed is further evidence along these lines that moral hazard and adverse selection are operative in the behavior of prices and quantities. Personally, I am skeptical that these explanations can explain prices and quantities, particularly at higher layers. These layers should be relatively immune to moral hazard and adverse selection considerations because the retentions (deductible amounts) are so high.[23]

Explanation 6: Regulation prevents primary insurers from pricing cat properly

This explanation observes that a number of major high-catastrophic-risk states use regulatory barriers to keep insurance prices down. In some states, lines of business, and specific geographic areas, insurers must underwrite risk at prices well below those that are actuarially and financially profitable. This is perhaps not a surprising state of affairs when the insurance commissioners are publicly elected officials in 12 states, including California and Florida.

Clearly this explanation cannot lead to a high level of prices in the reinsurance market. However, it can explain why there is so little reinsurance purchased, even if prices are actuarially fair. The basic reasoning is that if insurers are unable to earn a profitable return by underwriting risk, they need to cut costs. One way of cutting costs is to avoid purchasing reinsurance.

The mechanism here is analogous to that of rent control. Rent control is intended to make housing more affordable. It does so by reducing the return owners receive from making improvements in the housing stock. Owners therefore make fewer improvements, and the quality of the housing stock falls. This goes on until equilibrium is reached: eventually, the low rents are matched by a similarly low level of housing quality. The equilibrium rental rate – high or low -- is none other than a fair one. The old saw, "you get what you pay for," holds even in regulated markets.

In response to price controls, insurers likewise have an incentive to provide a product which is lower quality, and therefore cheaper to produce. They have less incentive to purchase reinsurance, even at fair prices, since much of the benefit of that reinsurance accrues to others (policyholders, state guarantee funds, other insurers, taxpayers, etc.). The result is that state guarantee funds must bear considerably greater risks that a large catastrophe will become their responsibility or the responsibility of policyholders and taxpayers. In short, everyone suffers if regulation makes it unprofitable for insurers to provide high quality insurance contracts.

This explanation also fits the cyclical behavior of quantities. After a big event, insurers may feel that their underwriting prices are particularly low. Thus, even with

[23] See also the discussion below for how capital market innovations might help solve these problems to the extent that they exist.

reinsurance offered at a fair price, they will cut back more on reinsurance purchases. The major weakness of this explanation is that it cannot explain high prices. However, it does explain why insurers may perceive reinsurance prices as high, i.e., as being in excess of what they can profitably afford to pay.

Much like with rent control, there is a social policy issue here that won't be dispensed so easily. What if, for example, the risk of earthquake along an old fault line in a local working class town suddenly surges? Charging the actuarially justified rate on homeowners insurance would result in reduced insurance purchases. Housing values would be hit with high homeowners rates in addition to the hit from the initial earthquake risk. And what of the uninsured? What is the appropriate policy? Should the state or federal government transfer taxpayer funds to subsidize insurance purchases? Should insurers be forced to bear the cost, and spread the burden across all their policyholders by either raising general homeowners rates or lowering the quality of their product? And whatever the answer, how does it change if the affected area is not a single town, but all of California?

Explanation 7: The presence of ex-post third-party financing

Ex-post financing of catastrophes occurs when other parties step in to prevent losses from being financed by policyholders. Chief among these entities is, of course, the US government. As is well known, the government has a major role in funding disasters at both state and federal levels, through a number of agencies, and through both the executive and legislative branches. During the 1977-93 period, the average Federal expenditure for disaster assistance was $7.04 billion (in 1993 dollars).[24] This is far greater than the average annual loss borne by reinsurers on US catastrophe coverage. In some forms of disasters, notably floods, the federal government has effectively eliminated the incentive for the creation of private market insurance contracts. Indeed, before the Federal government stepped in to provide disaster relief, private insurers *did* offer flood insurance.[25]

The federal government is not the only entity involved in ex-post financing of catastrophes. State guarantee funds and other insurers are often the next line of defense if an insurer is unable to meet is customer obligations. And if the fund is exhausted, then solvent insurance companies in many cases are to make good on claims against insolvent companies. This creates two types of bad incentives. First, companies have an incentive to shift the burden onto the fund or other insurers before the fund is exhausted. Second, companies who do not act to shift high layer losses onto the pool are themselves likely to have to pay for others. Well behaved insurers will wish to avoid doing business in states

[24] See David Moss, "Courting disaster? The transformation of federal disaster policy since 1803," NBER conference on The Financing of Property/Casualty Risks.
[25] See David Moss, "Government, markets, and uncertainty: An historical approach to public risk management in the United States," working paper, Harvard Business School, 1996.

with guarantees funds and pools. This is another way in which adverse selection can increase the cost of insurance. Overall, the outcome is an incentive for insurers to enter a race to the bottom in customer credit quality.[26] This strengthens the need for regulation and can create a kind of vicious cycle in market vs. regulatory incentives.

From an economist's perspective, such ex-post financing should be viewed as a form of market failure. The federal government cannot credibly commit *not* to fund disasters after the fact: even if it says it will not provide disaster relief *ex ante*, the political incentives to do so *ex post* are overwhelming . Given that this is the case, no one would have the incentive to buy a private insurance contract at an actuarially fair price or greater, since the government effectively subsidizes losses through these programs. Of course, by some means taxpayers will pay for subsidized losses. The government is unlikely to administer a disaster program and monitor disaster payments as well as a dedicated insurer, so the size of the loss (net of processing costs) paid by taxpayers is likely to be that much greater. Also, there is no mechanism to discipline risk-taking incentives: population growth in high flood-risk zones is not moderated by charging risk-takers for the expected losses that they impose on the system.

How does ex-post financing affect the price and quantity of reinsurance? Clearly, insurers have less incentive to provide insurance in the presence of ex-post financing. One way of doing this is not underwriting risk in the first place. A second way is to shift the actuarial costs of the risks onto others. Since insurers must pay for reinsurance, but may obtain ex-post financing at lower (even zero) costs, they have an incentive to substitute away from reinsurance.

As with explanation 6, ex-post financing cannot explain why prices might be high. It can, however, explain why insurers perceive reinsurance prices are high. It can also explain low quantities of high-layer reinsurance, and the cyclical downturns in quantities after major events.

Explanation 8: Behavioral factors

A commonly cited reason for the low quantity of high-layer reinsurance is that the *perceived* likelihood that reinsurance will pay is too low to matter. This issue about perception is ubiquitous in insurance markets.

For economists who use a utility-based approach to understand behavior, insurance against severe, but low-probability events is very valuable to consumers. Utility type approaches argue that outcomes which lose twice as much are perceived by people as more than twice as bad. Yet, in contrast, people often don't insure against low-probability, severe outcome events. They often under purchase insurance. They often do

[26] See Brian J. Hall, "The moral hazard of insuring the insurers," NBER conference on The Financing of Property/Casualty Risks.

not take mitigation seriously, and when they do, they require too high a return on mitigation expenditures.[27]

There are many potential reasons for this behavior. One is that people discount too heavily events they cannot readily perceive. Famous studies from the 1970s show that the rate of smoking is higher among the general populace than among general practitioners, higher among general practitioners than among internists, and higher among internists than among specialists who work directly with lung cancer patients. Even when the consequences and probabilities of bad outcomes are well-known, repeated hammering home of the bad outcomes affects behavior.[28]

A second behavioral effect is that individuals often seem "ambiguity" averse. A lack of clarity about the risks and events being insured may lead insurers and reinsurers to set premiums high.[29] Behaviorally, people distinguish between risk and uncertainty. With risk the probabilities of different outcomes are knowable. Examples would be from lotteries or card games. With uncertainty, however, the probabilities are unknowable. What is the likelihood of an earthquake in Boston? How frequently is a well-build house on the Florida coast destroyed by wind? Uncertainty is inherently more ambiguous, and surveys suggest that individuals charge more to bear it.

A related behavioral argument is that big events don't generate enough "job risk" for people in charge of buying insurance and reinsurance. Studies of corporate insurance purchases, for example, tend to show that mid-layer risks are often insured more frequently than high-layer risks. The argument is that managers are off the hook if the event is large enough, since many others will be in the same boat. For smaller events, insurance is easily available and purchased by others, which reinforces the desire for a manager to purchase (re)insurance. It is worth noting that this argument is another form of agency cost – "job risk" would not be an issue if people were buying insurance on their own behalf.

As under explanations 6 and 7, pricing may be fair, but the quantity of risk transfer is nevertheless low under the behavioral hypothesis.

Moving ahead: changing the distribution of risk through capital markets, deregulation, and alternative risk transfer

Many observers, practitioners, and academics have argued that bringing cat exposures directly to the capital market can help reduce reinsurance prices and increase

[27] See Howard Kunreuther and Paul Kleindorfer, "Challenges facing the insurance industry in managing catastrophe risks," NBER conference on The Financing of Property/Casualty Risks.
[28] Comments prepared by Peter Diamond, NBER conference on The Financing of Property/Casualty Risks.
[29] See Howard Kunreuther, Robin Hogarth, and Jacqueline Meszaros, "Insurer ambiguity and market failure," *Journal of Risk and Uncertainty*, 7:71-87 (1993).

risk transfer. Mechanisms include cat-linked bonds, swaps, exchange traded options and futures, cat-linked issues of equity, etc.[30]

Clearly, the degree of success that the capital markets can hope to bring depends upon one's assessment of the explanations above. If the problem is that catastrophe-risk taking capital is insufficient (explanation 1), then the capital markets clearly represent a potential solution. Indeed, the $50-100 billion dollar events discussed earlier are equal in size to a normal day's fluctuation in the value of US equities. With US financial assets totaling over $12 trillion, a large catastrophic event represents only about 50 basis points of wealth.

Similarly, if the problem is that the corporate form of today's reinsurers is inefficient (explanation 3), capital market devices would seem to help. Cat bonds specifically collateralized in a special-purpose trust to fund an insurers' higher-layer cat risks would not be subject to the kinds of agency costs experienced by firms. Moreover, if the equity of these firms is costly because of its tendency to move up and down with the market then these costs could also be eliminated by embedding the risk in a cat bond, which would be treated more as debt.

Certainly at first, these investments would need to provide an average return in excess of US Treasury bills. Indeed, cat bonds were originally envisioned for the CEA reinsurance layer written by Berkshire Hathaway, and were to be offered on terms not so different from the reinsurance. If these prices are to decline, it is clear that considerable infrastructure must first be laid. Investor education about cat risks, for example, is an important externality and will take time to build.

Another important piece of infrastructure is a means for standardizing risk. Simple securitization of existing reinsurance contracts is unlikely to lower costs or increase capacity. Reinsurance contracts have tailor-made features and cover company-specific exposures; they are therefore informationally intensive as investments. It makes little sense for each individual investor, or their institutional investment agents, to analyze these instruments. Existing reinsurance conserves on analysis by concentrating the exposures in a few places. Clearly, if it is to be economical to spread cat risk more widely, more standardization will be required.

Catastrophe indexes are one way to accomplish this. Indexes help avoid the redundant analysis of distinct risks. They also help promote liquidity, which further lowers the cost of risk transfer. Furthermore, to the extent moral hazard and adverse selection (explanation 5) are sources of high prices and low quantities, indexes can help. If insurers transfer risks that are linked to industry-wide losses, they can reduce problems of moral hazard and adverse selection faced by investors. Individual insurers may have

[30] See, for example, J. David Cummins, Christopher Lewis, Richard D. Phillips, "Pricing excess-of-loss reinsurance contracts against catastrophic loss," NBER conference on The Financing of Property/Casualty Risks.

control over their own losses and know more about those losses than reinsurers. However, they do not have control over, nor do they know more about, index outcomes. Thus indexes can make risk transfer more efficient, regardless of whether it occurs through capital market devices or traditional reinsurers. Indeed, index-linked cat reinsurance is already gaining popularity as a way of reducing reinsurer capital costs.

Of course, the standardization of an index is, all else equal, a disadvantage from the perspective of the (re)insurance buyer. An insurer would like to protect itself against *its* losses, not insurance industry losses. Thus, a critical issue in index design is that the index be flexible enough to keep down the "basis" between insurer-specific and index risk. An effective index must provide good hedging tools for cat-risk cedents.

Indeed, my own view is that existing indexes have not caught because they are poorly correlated with individual insurer losses, given a large event. Existing indexes aggregate industry losses at a state-wide level. Unfortunately, however, insurer exposure as a percentage of total industry exposure varies considerably across a state. The right hedge ratio therefore varies considerably across the state. To see this, suppose a company hedges on the basis of its 5% state-wide market share, and that a storm destroys a small portion of the state where the insurers market share happens to be 10% of the market. Only half of the insurer's losses will be covered by the index. In short, state-wide blocks are too large to yield low basis risk. To serve as good insurer hedges, indexes will need to report industry-wide losses for smaller geographic blocks (i.e., zip codes).[31]

Much of this will be soon be tested, as a new catastrophe exchange located in Bermuda, has, as of this writing, recently been announced. The Bermuda Commodities Exchange (BCE), owned by AIG, Guy Carpenter, and Chase Manhattan, and involving the Chicago Board of Trade, will trade contracts based on a US homeowners catastrophe index developed by Guy Carpenter. The index aggregates losses at the zip-code level, and therefore can match the exposure of certain insurer portfolios more precisely than state-wide indexes.

Clearly though, capital markets devices will not help solve all of the above explanations for the paucity of risk transfer. For example, if the problem is purely reinsurer market power, then innovations in financing will lower prices and increase quantities only if new entrants come along and make the market more competitive. On the other hand, to the extent that market power is created by high reinsurer costs of capital, capital-markets solutions could help reduce the adverse effects of market power.

Lowering the costs of risk transfer may provide savings, but it cannot directly solve the problems which result from state regulation and insurance pricing (explanations 6 and 7). However, transparent pricing of catastrophe risks in the reinsurance market

[31] For an analysis of how hedge performance is affected by geographic aggregation, see John Major, "Index hedge performance: insurer market penetration and basis risk," NBER conference on The Financing of Property/Casualty Risks.

may have important benefits for the efficiency of regulation. The market pricing of electricity is forcing the rationalization of utilities across the US. This process will result not only in more efficient plant and equipment, but also in more rational pricing by utilities and their public commissions. Customers will benefit by having a transparent and observable market energy price to which to tie rate-payer contracts and service. By analogy, reinsurer and insurer financing costs can be useful benchmarks for regulatory review of underwriting prices. However, pricing is only one of many regulatory hurdles which may prevent efficient distribution of catastrophe risk.[32]

Clearly, government regulation can facilitate or impede risk transfer outside of traditional reinsurance channels. Regulation can also mandate reporting of loss and exposure information to authorities, thereby permitting easy aggregation. Much as with Fannie Mae, the government can pursue "market-enhancing" policies designed to jump start broader market exchange of these risks.

Going forward, it is most likely that traditional reinsurance contracts will continue as the preferred risk transfer vehicle, even if capital market and other alternative-risk-transfer solutions take off. Insurers that are small, and/or have less well diversified exposures are likely to continue placing their risks with reinsurers. Indeed, it may well be that reinsurers, not insurers, will be the direct beneficiaries of capital-market products. These products will simply allow reinsurers to place their risks with investors in many forms other than those of standard equity. The almost inevitable result is that reinsurer cost of capital will decline, and specialized capacity will increase. As a result, more insured assets will be insurable than ever before. This will make risk sharing in society better, with better risk sharing being the fundamental goal of an insurance system.

[32] Another example of costly regulation is that financial instruments linked to catastrophe losses can in some cases be considered insurance contracts by state insurance commissioners. Because only licensed insurers are allowed to write such contracts, financial instruments which transfer premiums to investors in return for catastrophic risk bearing must seek exemptions and approval from commissioners.

Figure 1

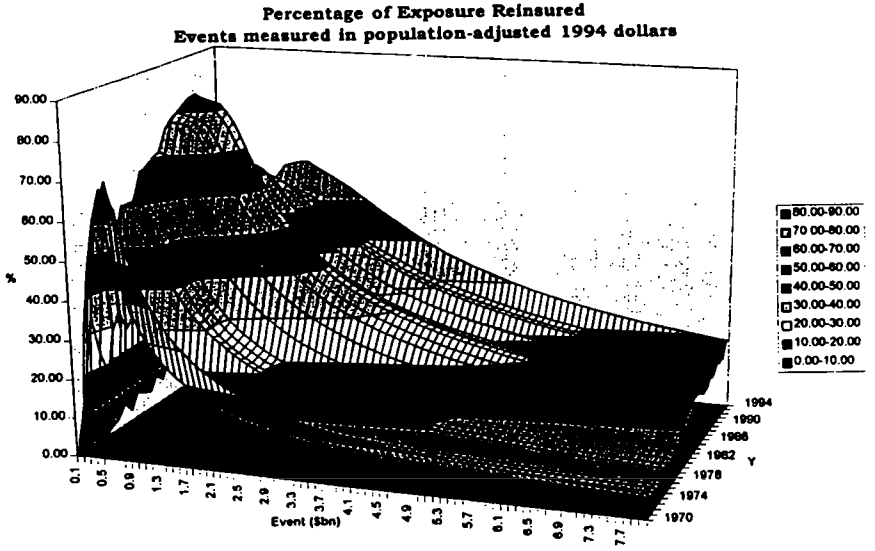


Figure 2:

Industry price per unit of ceded exposure

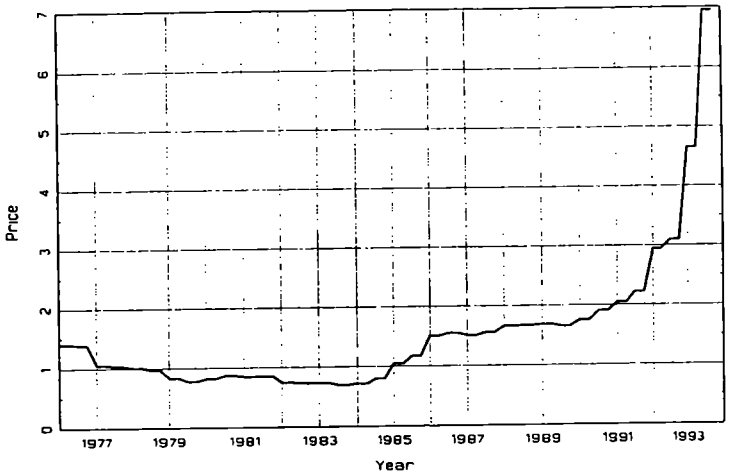


Figure 2a
Relation of price to attachment probability, by year, 1970-1994

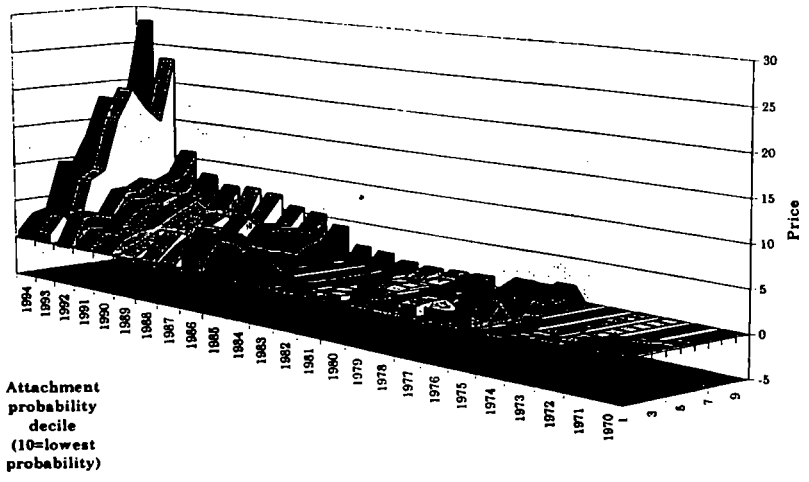


Table 1
Event study of hurricane Andrew

	(a) Southeast exposure			(b) Hurricane exposure		
	Mean exposure	Mean $\Delta\ln(p_{j,t})$	Mean $\Delta\ln(q_{j,t})$	Mean exposure	Mean $\Delta\ln(p_{j,t})$	Mean $\Delta\ln(q_{j,t})$
5 most-exposed insurers	0.707	0.415	-0.021	0.918	0.583	-0.082
5 least-exposed insurers	0.000	0.335	-0.013	0.561	0.336	-0.047

Comparison of price responses in the year after hurricane Andrew (8/20/92–8/19/93) for different insurers. Panel (a) contrasts insurers which have high and low exposure to the Southeast (as measured by market share). Panel (b) contrasts insurers which have high and low exposure to hurricanes. The table shows the mean exposure and the mean price change of the 5 most extreme contracts in each case. The mean price change for the insurers with lesser exposure to the Southeast is calculated using all 14 of the insurers that have zero market share in that region.

CEA

FEATURE

CATASTROPHE

AND THE CAPITAL MARKETS

Insurers Faced with Crippling Losses from a Major Hurricane or Earthquake Are Taking a Closer Look at "the Most Innovative Idea in Insurance in the Last 200 Years"

The scenarios are not pleasant: An earthquake that swallows up Los Angeles or a hurricane that destroys Miami and the southern half of Florida.

The image is enough to send tremors through the U.S. insurance industry — with good reason. In the past few years, catastrophic events have occurred with more frequency and severity — and at greater cost to insurers — than ever before: Hurricane Andrew in Florida in 1992 (insurance claims, $15.5 billion); the Northridge, Calif., earthquake in 1994 (insurance claims, $12.5 billion); and the Kobe earthquake in Japan in 1995 (insurance claims, $1 billion but costs of uninsured repairs estimated at $100 billion). In the aftermath of Hurricane Andrew alone, nine U.S. insurance companies filed for bankruptcy.

Up until now, property and casualty insurers have protected themselves by buying policies from reinsurance companies designed specifically to cover losses from a catastrophic disaster. But these kinds of disasters have traditionally been defined as anything involving claims up to $1 billion. The magnitude of events since 1992 clearly exceeds that figure.

"Insurance companies got a big shock with Hurricane Andrew," says Neil Doherty, Ronald A. Rosenfeld Professor of Insurance and Risk Management. "They realized that a

single catastrophic event could lead to phenomenal bankruptcies."

Just look at the numbers. America's insurance industry holds approximately $250 billion in equity. Yet given substantial increases in populations and property values in hazard-prone areas, "it's not unrealistic to expect that one major catastrophe could result in $70 billion or even $100 billion of claims," says Howard Kunreuther, Cecelia Yen Koo Professor of Decision Sciences and Public Policy and Management, and co-director of Wharton's Risk Management and Decision Processes Center.

Other experts estimate that a repeat of the earthquake that destroyed Tokyo in 1923 could result today in damages of between $900 billion and $1.4 trillion.

"When the question is raised as to whether the insurance industry can pay for 'the big one,'" says Peter Burns, project director of Wharton's Catastrophic Risk Management program (see box), "the answer is clearly no."

According to a growing number of experts, relief for the insurance industry lies in securitizing catastrophic risk — i.e. packaging it in the form of securities which are sold to private investors ranging from pension funds to hedge funds to sophisticated individuals.

The more popular offerings include catastrophe ("cat") bonds (also known as Act of God bonds), cat options and catEPuts (catastrophe equity puts), but there are other approaches as well, such as reverse convertible debt and a catastrophe insurance risk exchange. Taken together, these various instruments — all of which offer different combinations of risk and reward to investors, depending on how they are structured and priced — are seen as potentially revolutionizing the insurance industry's approach to catastrophic loss.

The idea is to shift the risks, and costs, of a major catastrophe from the backs of insurers/reinsurers to the heftier shoulders of the capital markets.

Once again, the numbers tell the story. "Say a major hurricane strikes Charleston, S.C., and causes $80 billion in damages," says Doherty. "That would obviously have a very adverse effect on the industry's $250 billion equity pool. The capital markets, however, represent a $19 trillion investment pool. What would be devastating for the insurance industry would be a drop in the bucket for the markets. So why not invent capital market instruments that would be a better way of spreading the losses incurred by that hurricane?"

The point has not been lost on many of the parties involved, including insurers, reinsurers, investment banks, commercial banks and brokers. Swiss Re, Goldman Sachs, Lehman Brothers and Merrill Lynch have all worked on cat bond issues; Goldman Sachs and Lehman Brothe recently opened insurance arms; and large internation reinsurers are establishing their own capital marke divisions.

"The financial services market is undergoing a conv gence that will involve commercial and investment ban getting into insurance, and insurers getting into the ban ing and investment business," says Norman L. Rosenth W'73, WG'76, PhD'78, a Philadelphia-based consultar and chairman of a capital markets advisory board . insurance broker Aon. "These are trends that will lead the more efficient use of capital and new ways to bett manage risk."

"The traditional view of insurers is that they underwri people," says J. David Cummins, Harry J. Loman Profess of Insurance and Risk Management. "They look at your ris characteristics and they either want to insure you or no for a set premium. But what we are talking about here ar totally anonymous financial contracts. It makes no diffe ence who the buyers and sellers are as long as they mee the solvency criteria of the exchange. It's what makes th capital markets approach the most innovative idea in th insurance industry in the last 200 years."

Faced with the grim prospect of severe loss of sur plus or even insolvency, the insurance industry ha been transforming the way in which it absorb risk. Among its strategies: new catastrophe reinsurers i Bermuda that are better equipped to handle cat losse increased consolidation among reinsurers; new state insur ance programs in Florida (the Florida Catastrophe Fund California (the California Earthquake Authority) an Hawaii; an insurance swap market (CATEX) to allow for bet ter geographic diversification of disaster risk, and variou excess-of-loss reinsurance programs around the world t better diversify claims.

Within the context of these various loss containmen strategies, capital market instruments play an interestin role. On the one hand, some experts see them as foreve changing the industry's approach to risk management. O the other hand, they are also considered a complement to rather than a substitute for, more traditional defenses.

The reinsurance industry, notes Anthony M. Santomero Richard King Mellon Professor of Finance and director o the Financial Institutions Center, "is defined by long entrenched customer relationships. Most capital marke instruments like cat bonds are just the opposite. They ar simple, specific, single-period assets ... It's clear that rein surers see cat bonds both as competitors but also a complements — i.e. a potential way for them to expan their own capacity to take on risk."

If reinsurers knew, for example, that they were covered for a huge catastrophe — either because they can lay off some of the risk they have assumed or can arrange for their customers to be able to access the capital markets directly — "they would be freed up to write more conventional reinsurance," Santomero says.

In any case, most experts agree, it's too soon to say exactly how these financial instruments will evolve. It was only five years ago that the Chicago Board of Trade (CBOT) first introduced catastrophe (cat) options as a way to tap into the capacity of the capital markets. Investors "trade on an industry-compiled index of cat losses that is based on events such as hurricanes, earthquakes, windstorms, ice storms, anything that could cause major losses," says Cummins. "If no disaster occurs, the investor makes money. But if the index goes above a certain level agreed on in the contract, it triggers the option."

The market for this instrument, however, has tended to grow slowly, for several reasons. "The liabilities on the options could be high if a huge hurricane occurred," notes Doherty. "Also, investors are used to looking at such criteria as a company's balance sheet or anticipated changes in interest rates. They are not experts on storm occurrences." Finally, insurance companies themselves haven't always seen cat options as a good bet. "After all, it's not the insurance company's own loss that determines whether it gets paid, it's the whole industry's losses," says Doherty. "If one particular company got hit harder than others, the payback might not be sufficient to cover its claims."

SIX CAT BOND ISSUES WORTH A TOTAL OF $1.1 BILLION HAVE BEEN ISSUED SINCE 1994. THE BIGGEST WAS A $477 MILLION ISSUE FROM USAA IN JUNE 1997

The next major innovation — and one that seems to be enjoying a recent surge in popularity — was cat bonds. Six issues worth a total of $1.1 billion have been offered since 1994. The latest was a $100 million bond issue in November from Tokio Marine & Fire, the biggest a $477 million issue from USAA in June 1997.

The idea is that investors buy bonds from an insurance company (or more accurately, from a reinsurance company set up offshore specifically for this transaction). If no major catastrophe occurs during an agreed-upon time period, investors get their money back with interest high enough to reflect the riskiness of the investment. If a catastrophe of a certain size does occur, the insurance company can use the investors' money to pay out claims. In that situation, and depending on how the issue is structured, investors lose all or part of their principle and/or interest.

"We expect a substantial growth in the next couple of years in the cat bond area," says Robert H. Litzenberger, Ph.D., managing director, Goldman Sachs, and co-leader along with Merrill Lynch and Lehman Brothers on the $477 million USAA bond issued in June 1997, "mainly because there is very limited capacity for supercat events in the reinsurance industry.

"USAA's exposure to hurricanes is generally on the East coast, particularly in southeast Florida," says Litzenberger. "The company views the cat bond issue as a way of purchasing more reinsurance protection than it normally would. It is a complement to their insurance package, not an alternative."

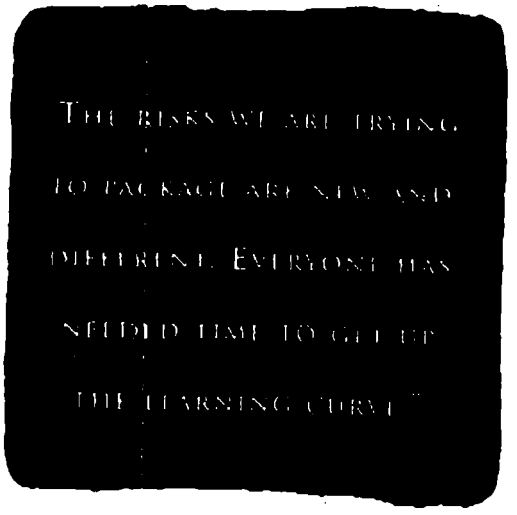
The one-year $477 million USAA bond issue has two layers of debt, a principle protected part and an unprotected part. If a certain category of hurricane hits the East Coast and causes at least $1 billion of damages (the figure can vary depending on how the bond is structured), the protected class is guaranteed its principle back but loses its interest for up to 10 years. The unprotected class starts to lose principle at a $1 billion loss to USAA and loses its entire principle for losses in excess of $1.5 billion.

The USAA bond, which ran out in June during a year of no major hurricanes, paid a return of about 11 percent to its investors.

The issue was "several times oversubscribed," says Litzenberger. "The original intent was to have a $100 million issue. Based on initial investor response, USAA increased the amount of risk coverage to $400 million and demand for it was about $1 billion ... Relative to high yield debt issues that have similar levels of principle risk, such as BB rated debt, it had a high coupon." (The $477 million issue included $400 million of risk protection; the remainder was principle protected).

"There is an interesting story connected with the issue," notes Litzenberger. "The reason there are more intense

hurricanes in southern Florida than in New England is because the water temperature is higher. This was an El Nino year, which produced higher ocean temperatures, but El Nino also tends to produce shearing winds that break up tropical waves before they can form into hurricanes. This had happened during the previous El Nino in 1982. Some investors knew that, increased their holdings and decided to bid up the price of these bonds because they figured the hurricane risk would be less than usual. Also, after the hurricane season ended last fall, many people sold out and took their profits."



Goldman was co-leader with Swiss Re on the smaller, $100 million Tokio Marine & Fire issue, also oversubscribed. This bond was not indexed to the actual losses from a catastrophic event, as the USAA bond was, but to the location and intensity of an earthquake in a precisely defined area around Tokyo.

Peter Bouyoucos, WG'85, head of Morgan Stanley's insurance capital markets group, is another proponent of cat bonds. His group's overall focus has been to develop broad-based capital market risk transfer alternatives to the reinsurance of property, life and credit exposures.

Two years ago, Morgan Stanley was senior underwriter for what would have been a path-breaking $1.5 billion cat bond issue — larger than all the other issues combined — for the California Earthqua Authority. Investor Warren B fet's National Indemnity C showed up at the last minu and insured the risk instead.

Since then, Bouyoucos ar his group have made progre on a number of other deals take advantage of what he pr dicts will be an upturn in t market. "The pipeline of pr jects we have, and I am sure o competitors have, is signi cantly greater than the numb of deals you have seen," Bou oucos says, noting the time h has spent with ratings agenci and risk modeling firms, an the visits he has made to hundreds of investors in the U.S Europe and Asia. "The risks we are trying to package a new and different. It means that everyone has neede time to get up the learning curve ...

"The difficult part about these deals is getting across th finish line," Bouyoucos adds, "because at the moment the isn't an absolutely compelling need for insurance comp nies to issue bonds given the affordability of mor traditional means of reinsurance.

"Three years ago, in the aftermath of Hurricane Andre and the Northridge earthquake, the availability of reinsu ance was tight and prices were high. But since then, ther have been very few catastrophes of any real magnitud Consequently prices have come down about 15 percent pe year over the last three years. As the prices come down, th

In January 1997, the Wharton Financial Institutions Center and the Risk Management and Decision Processes Center initiated a multi-year research project on "Managing Catastrophic Risks."

Their timing couldn't have been better. "Up until now, people have looked only at bits and pieces of this whole issue," says Peter Burns. "Our program is unique in that it takes a holistic view of the subject. We use models to help measure risk, look at the impact of public policy on mitigation and insurance regulations, study the role of reinsurance and analyze how you create and finance capital market instruments, which comes back full circle to the use of models to structure and price investment vehicles."

The success of the cross-disciplinary program, which includes faculty from Wharton's finance department, insurance and risk management department and operations and information management department as well as doctoral students, draws upon critical input from the government and industry.

The "Managing Catastrophic Risks" project has eight financial sponsors: American Reinsurance Co., CIGNA Property and Casualty, E.W. Blanche Co. Reinsurance Intermediaries, General Reinsurance, Morgan Stanley & Co., Sedgewick RE Reinsurance, State Farm Fire and Casualty Co., and USAA Property and Casualty.

Research Associates include Applied Insurance Research, Inc., Ernst & Young, LLP, EQECAT, Inc., Institute for Business and Home Safety, Insurance Service Office, Inc., Reinsurance Association of America and Risk Management Solutions, Inc.

Last December, the program was featured as part of a Public Private Partnership Forum (PPP2000) on natural hazard management held in Washington and sponsored by 19 federal agencies and a variety of private organizations.

amount of available capacity has increased. So from a competitive perspective, trying to develop a new marketplace has been a little more difficult...

"For now at least, reinsurers and the capital markets can reasonably coexist," Bouyoucos adds. "The ability of reinsurers to provide protection for their longstanding relationships with insurers can be increased through capital market instruments as needed. In fact, reinsurers, through their ability to aggregate and transform risk, may be the ultimate source of capital market securitizations.

"At the end of the day I expect that companies who want to optimize their risk management program will be looking at all different types of alternatives. The right answer will be a combination of the capital markets, traditional reinsurance and risk financing."

If cat bonds are considered high-risk, why are investors so interested? "Because it's what financial people call zero beta asset," says Cummins. "The bond is uncorrelated with the market, so it is a great instrument for diversification. Taken in a small enough proportion it actually improves your risk return profile."

Yet cat bonds, as innovative as they seem, aren't for everyone, including some insurers. First, because cat bonds are so new, there are no standards or ratings for evaluating the quality of a particular instrument. "Once these bonds are rated as other financial instruments are, they are likely to be more popular with investors," notes Kunreuther.

Second, "some insurers say they value their relationships with their reinsurers, and they are reluctant to give them up," says Cummins. "That may be true, but in addition to the fact that there isn't enough capital to cover catastrophes, the reinsurance market is cyclical. It goes through periods of high prices; high prices are most likely to occur after a Hurricane Andrew type of event, which is when an insurer needs lower prices the most."

Then there is always the chance that a particular investor or class of investors might buy in shortly before a huge earthquake hits San Francisco. It's one reason these bonds are billed as only appropriate for sophisticated investors. "Anybody would be foolish to put half their wealth in a single cat bond," notes Litzenberger. "But when you talk about two to three percent of your portfolio, that's a relatively small and controlled exposure."

In a recent study of catastrophe hedging instruments, Doherty looks at the more familiar reinsurance strategies as well as some of the newer instruments like cat options, cat bonds and CatEPuts.

Each of these approaches, Doherty says, offers a different combination of credit risk, basis risk (the potential mismatch between the payout on the contract and the hedging insurer's actual losses) and moral hazard (the natural incentive of the insurer to exercise less control over underwriting and loss settlement because of reinsurance protection).

"It is incumbent on the primary insurers to determine exactly what tradeoffs they want to accept," Doherty says.

While Doherty himself believes that no particular instrument will dominate the market, the choices at the very least "offer insurers a richer portfolio of risk management strategies ... Just like with derivatives, the evolution of the market will bring a broader, not narrower, array of instruments to bear."

Meanwhile, some observers are also predicting an eventual "unbundling of insurance products, with insurers

Wharton faculty involved in the project include Howard Kunreuther, Celia Yen Koo Professor of Decision Sciences and Public Policy and Management; and Paul Kleindorfer, Universal Professor of Decision Sciences, Economics, and Public Policy and Management. Both men are co-directors of the Risk Management and Decision Processes Center.

Other faculty include J. David Cummins, Harry J. Loman Professor of Insurance and Risk Management, and executive director of the S.S. Huebner Foundation; Neil A. Doherty, Ronald Rosenfeld Professor of Insurance and Risk Management, and Anthony Santomero, Richard King Mellon Professor of Finance and director of the Financial Institutions Center.

Their research agenda focuses on five areas:

- Measuring catastrophe risk and using computer simulation models to enhance understanding of a company's or individual's exposure to natural disaster risk
- Identifying the best ways to encourage pre-disaster mitigation as a way of reducing risk and losses
- Studying how federal and state governments can improve society's ability to reduce and finance disaster losses
- Estimating the capacity of the insurance and reinsurance industry to sustain cat losses and the degree of default resulting from a natural disaster
- Analyzing how capital markets can assist in financing disaster risk; designing and pricing new catastrophic risk securities.

Much of the work with computer modeling is being done by Kunreuther and Kleindorfer. With the help of three natural hazard modeling firms — Applied Insurance Research, EQECAT and Risk Management Solutions — the two professors are examining the impact that mitigation measures would have on three cities — Oakland and Long Beach, Ca., both earthquake

retaining marketing, underwriting and settlement services, while risk-bearing bypasses the reinsurance industry and is being provided more directly from the capital markets," Doherty notes. "I have some mixed feelings about this. It makes sense in some cases and not others. Once you start separating out parts of the contract, for example, you start changing incentives, which can be disastrous. It's an area to look at with caution."

Up until recently, insurers, reinsurers, financial institutions, government agencies and disaster-prone communities had to rely on historical data to estimate the likelihood of an earthquake or hurricane and also the level of damages.

That is no longer the case. Today, a number of firms offer sophisticated catastrophe models that, when measured against actual events, have proven to be remarkably accurate.

A catastrophe model uses data bases and computer programs to analyze the impact of different scenarios on hazard-prone areas. The information can be presented in the form of expected annual losses based on simulations over a long period of time or in the form of damages caused by a specific event (a worst-case disaster scenario.)

The impact of modeling on capital market instruments is already evident. For example, prices for cat bonds are now based in part on very detailed simulations of the effects of hurricanes and earthquakes in catastrophe-prone states such as Florida and California. "Using historical data, engineering studies, and so forth, these companies can simulate tens of thousands of events to eventually come up with mates-of how much damage would be done and wh would cost," says Cummins, who along with Doher using simulations created by Boston-based Applied I ance Research, Inc. for a study of basis risk.

"Until recently, insurers and reinsurers had a comp tive advantage in information on catastrophic ever Doherty adds. "But now a number of modeling firms l developed models that combine seismic and meteorol cal information with data on the construction, siting value of individual buildings.

"More importantly, these models are now availabl other companies and investors, which means the com ative information advantage of insurers and reinsure being eroded and the door is being opened to new playe Adds Cummins, "we feel that the more information there about the effectiveness of derivatives, the better everyone."

A key component of the research agenda is work be done by Kunreuther and colleague Paul Kleindorfer, U versal Professor of Decision Sciences, Economics, and Pu Policy and Management, on risk mitigation measu (RMMs) — actions that reduce or eliminate the losse individuals and their property from natural hazards. T can include everything from installing hurricane shut and roof bracing to strapping down a water heater and b ing a structure's side walls to the foundation.

Mitigation, Kunreuther notes, affects both the rein ance market and capital market instruments. For exam insurers who successfully encourage homeowners to ad mitigation measures should benefit from lower rein ance costs because of the anticipated reduction in lo

Continued on page

prone, and Miami/Dade County, hurricane prone.

The main question being asked is, 'What effect would adoption of mitigation measures by property owners have on their own welfare as well as the solvency of insurers?'

"We constructed a series of residential homes in three model cities and then set up small, medium and large insurance companies," says Kunreuther, noting that commercial and other structures may soon be modeled along with the residential ones. The researchers asked what would happen to an insurer's business — and its target level of insolvency — if it turns out that a certain percentage of the homes adopted a variety of cost-effective mitigation measures, e.g. bolting house foundations in an earthquake area or reinforcing roofs in a hurricane area.

Once those mitigation measures are modeled in, "we take a look and see how this changes the insurer's business. For example, the insurer may now be able to write more policies for that insolvency level, which in turn would affect the company's profitability. We ask a variety of questions related to the insurer's portfolio."

These models are "tools to help indicate how well mitigation is likely to work," says Kunreuther. "We have shown that when mitigation is widely adopted, it will substantially reduce losses, increase insurers' ability to write c erage, lower the premiums charged reduce the chances that insurers become insolvent from a catastrop disaster. We are also looking at impact that state insurance regulat of prices will have on the availability coverage in hazard prone areas ...

"Broadly speaking, we are analyz the role of public-private partnership dealing more effectively with low pr ability-high consequence events than have in the past," Kunreuther adds. are asking questions such as: What can the private market play? Wher there a need for public sector invol ment? Our hope is that this research provide us with insights and answers."

LEVOVSKY *Continued from page 18*

interviews and audio and visual clips, and is working on the launch of a home video line of original programming for the channel.

For Levovsky, the job is a labor of love. She spent a year at New York's School of Visual Arts taking filmmaking courses, and recently completed her first screenplay called *Crossing the Line*. "It's about a nice Jewish girl who gets mixed up with the Jewish Mafia," says Levovsky. "Producers and other screenwriters have told me they think it's a very commercially viable property. I'm trying to decide if I should sell it off as a screenplay or actually try and produce it myself."

MCLAUCHLAN *Continued from page 21*

Corporation, and a member of Bankers Trust's management committee and chair of the client committee. He is responsible for the firm's public relations and advertising, marketing service and risk management advisory functions. He joined the bank's Latin America group after graduating from Wharton in 1978.

McLauchlan's favorite overseas assignments have been London and Tokyo, his toughest was London. "When I went there in 1989 the economy was clearly turning downwards and then the Gulf War followed shortly after. Europe was in a recession and market conditions were very tough."

His current assignment in Asia is also difficult, but McLauchlan is upbeat about Asia's future. "Given the magnitude of the crisis, I don't see a quick resolution. But overall we are optimistic about the region," he says. "There are lessons to be learned and tremendous opportunities going forward."

ESCARRER *Continued from page 22*

before coming to Wharton, did an internship at Coca-Cola and worked at IBM, First Boston and Hyatt International. "I believe our success has been due to my father's vision, experience and energy together with ideas I learned at Wharton in such classes as finance, marketing and multinational strategic management."

For example, shortly after taking over as CEO in 1994, Escarrer separated the real estate holdings of the company from the management operations, streamlined management controls and set up distinct geographic divisions. Recently he appointed classmate Monique Skruzny, WG'93, as CFO of MIA.

Escarrer does not rule out the possibility of a future alliance with an American hotel chain, although at the moment Sol Melia, which now totals 24,000 employees, is focusing on Europe and Latin America.

The hardest part about competing with U.S. ch Escarrer adds, "is that they have acquired such a high of professionalism from having had to compete in the w — meaning the most competitive — markets. They are fast learners. Also, American chains are based in one o four great markets — the U.S., England, Germany and Ja — which means they have high levels of brand awarer already in place."

Internally, his biggest challenge is "to create an org zation that is totally focused on client needs. That me creating benefits for our four main client groups: the c sumer, our employees, the shareholders and, of course, owners of the hotels we manage."

CATASTROPHE *Continued from page 12*

from catastrophic events.

As for capital market instruments, "as you reduce losses through mitigation, two things happen," Kunreu says. "One, the need for these cat bonds is some circumscribed because you have reduced the pote for catastrophic losses. Second, mitigation lessens uncertainty surrounding these losses because of a b understanding of what may happen after a disaster. should not only be easier to price cat bonds, but the co insurers and reinsurers will also be lower because the c ages and uncertainty have both been reduced."

Cat issues, while they cover a very small part o worldwide catastrophic risk market, are most li here to stay, and to grow.

"Obviously a big catalyst to this market would be an er major storm," notes Frank S. Wilkinson, WG executive vice-president of insurance broker E. W. Bla Co., which has a unit dedicated to capital market prodi "With the contraction of the traditional market, that w be a time for the capital markets to come in."

In the meantime, adds Cummins, "some insurers rer a little resistant to the concept, and I would agree that a tain amount of caution is warranted. But my view is this new market, if not revolutionizing the industry r will do so in 10 years. Somewhere along the way, insu will come aboard.

"One of the things that convinces me of the mark viability is that almost all of the major reinsurance c panies are now gearing up for cat bond issues.

"It would be a mistake to say that financial instrum will replace reinsurance, but I can see them absorbing ger and bigger proportions of the traditional reinsura market." *R.W.S.*

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9 Welfare Aspects of Government Issue of Indexed Bonds

Stanley Fischer

Economists' discussions of the welfare aspects of government issue of indexed bonds are of less practical than intellectual interest. Governments in inflationary difficulties issue indexed bonds, and those that can avoid it, do not. It is nonetheless worth discussing whether economic analysis provides any rationale for government issue of either indexed or nominal bonds, or in general for government financial intermediation.[1]

Recent analyses of government financial intermediation suggest government issue of indexed bonds is at best irrelevant (Levhari and Liviatan 1976, Wallace, 1981) and may well be harmful (Peled, 1978). In this chapter I make two main arguments. First, there is a role for government financial intermediation to provide intergenerational risk sharing that private markets cannot—but this does not directly suggest government issue of price-level indexed bonds. Second, the question of why governments do not issue indexed debt is the wrong one to ask: the more appropriate question is why governments issue nominal debt. In this context, I argue that the presumption of stability of the price level, combined with frictions that are associated with indexed debt, led to nominal debt as the standard form of government liability. As the presumption of price-level stability disappears, indexed debt is more likely to be and should be issued.

Because the chapter is directed toward government issue of indexed bonds, I do not discuss private nonissue of such bonds. That question was taken up in an earlier paper (Fischer, 1977). It would be a mistake to build too convincing a theory explaining private nonissue of indexed bonds since price-level indexed mortgages have now been introduced in the United States.[2]

9.1 Review

It is well known that many of the most distinguished of past economists, including Jevons (1875), Marshall (1925), Keynes (1927), and Fisher (1934) advocated government issue of index bonds. Jevons, Marshall, and Fisher spent more time discussing the virtues of creation of a reliable price index than those of issue of index bonds; they seem to have taken it for granted that once a reliable index was available, it would be used in both private and government transactions—unless the price level was stabilized through appropriate monetary policy.[3]

Subsequently other economists have argued for government issue of indexed bonds; few economists have shared the opposition of practical men and central bankers, though skepticism has recently become more common.

The arguments in favor are

1. Indexed bonds would provide the economy with a safe real asset it otherwise does not have, and which is needed for optimal risk sharing.

2. Monetary policy could operate more accurately if indexed bonds were introduced (Tobin 1971). Indexed bonds are seen as a closer substitute for physical capital than are other government liabilities. Monetary policy should aim to control q, the market price of installed capital; such control is more accurately achieved through changes in the quantity of indexed rather than nominal bonds.

3. Government issue of an indexed bond would (a) encourage saving and reduce inflationary pressure, and (b) encourage portfolio holders to shift away from money toward bonds, implying that deficits can be financed at a lower real rate than is possible when nominal bonds are issued (Bach and Musgrave 1941, in the context of wartime financing).

4. "... by imposing upon the government a contingent liability dependent on its failure to check inflation, the flotation of stable purchasing power bonds would exert a wholesome pressure upon Congress to adopt aggressive anti-inflationary policies" (Bach and Musgrave 1941).

5. By creating inflation, the government has systematically cheated purchasers of nominal bonds, particularly small savers. This is not desirable and would not happen if indexed bonds were made available to the public (Friedman 1974, Tobin 1971).

In this chapter I concentrate on arguments (1), (4) and (5), briefly commenting on the remaining points.

The recent skepticism about government issue of an indexed bond is based largely on a number of neutrality theorems for government finance and financial intermediation:

*N*1 (Barro 1974). Debt financing of deficits has no different effects than tax financing.

*N*2 (Levhari-Liviatan 1976). Government intermediation in indexed bonds has no real effects.

*N*3 (Wallace 1981). Open market operations between money and bonds have no real effects.

*N*4 (Peled 1978). Any efficient equilibrium attainable with indexed bonds can also be attained without them; if indexed bonds make a difference, they make things worse.

An associated meta-theorem is

*N*5. If indexed bonds were a good idea, the private sector would already have invented them.

Theorems *N*1 and *N*2 turn on the internalization of the government's budget constraint by the private sector. Thus, for instance, when the government issues index bonds in exchange for nominal bonds, it is merely changing the pattern of its contingent liabilities. These future liabilities will one way or another be paid off by the private sector, which therefore is not fundamentally in any different position than it was before. This argument assumes both types of debt were in existence before the government undertook its intermediating activities.

Theorems *N*3 and *N*4 depend on the interpretation of money as purely a store of value, the role it typically plays in overlapping generations models. When money acts only as store of value, there is little or nothing that bonds can do that money cannot, particularly when the stock of money can be adjusted to affect its real rate of return.

Assumptions other than those underlying *N*1 through *N*4 have been pursued. In particular, Helpman and Sadka (1979) derive rules for the optimal financing of the government's budget, where the choices are among taxes, bonds, and money. The choice between taxes and bonds is meaningful because it is assumed individuals maximize over a finite horizon and no lump-sum taxes are available. The choice between bonds and money is determinate because money is viewed as providing productive services that bonds do not. This notion is represented by putting money in the utility function. The Helpman-Sadka framework produces results that differ from *N*1, *N*3, and *N*4, though they do not explicitly discuss *N*3 and *N*4. Because their framework is one of certainty, they do not consider government financial intermediation.

In this chapter I first examine the question of the government's potential role as financial intermediary (argument 1) and show that the govern-

ment can indeed make a positive difference by issuing securities and using its taxing power to produce appropriate patterns of returns. The difference arises from the government's ability to use taxes to enforce intergenerational risk sharing.

I then briefly discuss using an optimal tax framework, like that of Helpman-Sadka, to analyze optimal forms of government debt issue when there is uncertainty. It is in this context that the Modigliani-Miller type neutrality theorems are relevant: the framework suggests that the government will optimally run deficits or surpluses on occasion, but it does not provide any guidance to the type of debt that should be issued or bought.

To understand government issue of nominal versus indexed bonds, it is necessary to move to arguments like point (4). This chapter therefore discusses government issue of nominal and indexed debt in a context where dynamic inconsistency of government policy is possible. I conclude with a brief discussion of the remaining arguments reviewed above for government issue of indexed bonds.

9.2 Government Financial Intermediation for Intergenerational Risk Sharing

In this section I outline a simple model in which government financial intermediation makes intergenerational risk sharing possible.[4] The assumptions are those of the Samuelson (1958) overlapping generations model. To begin with, assume there is only one type of person N born each period. Each person lives two periods and has a utility function defined over consumption in the two periods. Random nonstorable endowments are received in each period.

The consumer maximizes expected utility,

$$E[U(C_1^t, C_2^{t+1})|I_t], \tag{9.1}$$

and receives endowments,

$$W_1(t) \geq 0, \quad W_2(t+1) \geq 0,$$

in the two periods of life. The distributions of the endowments are identical over time and not serially correlated, with

$$W_1(t) + W_2(t) \equiv W. \tag{9.2}$$

C_1^t is the first-period consumption of an individual born in period t; C_2^{t+1} is second-period consumption of that individual. I_t is information available in period t.

In the simplest environment all individuals within each generation are identical in tastes and endowment. There is no reason for trade among members of any one generation and nothing to trade with members of other generations. Each generation therefore consumes its endowments. For convenience, assume the utility function is separable and logarithmic, in which case

$$E[U(\quad)] = \ln W_1^t + \beta E \ln W_2^{t+1} \tag{9.3}$$

is the utility of the representative individual.

Assume further that

$$\bar{W}_1 = E(W_1(t)) > \frac{W}{1+\beta}, \quad \bar{W}_2 = E(W_2(t)) < \frac{\beta W}{1+\beta}$$

but that with finite probability $W_1(t)$ takes on values

$$W_1(t) < \frac{W}{1+\beta}.$$

Intragenerational Trade

Trade within a generation can take place if there are differences in tastes or endowments. For instance, if endowments are identical and the function $U(\quad)$ in (1) is the same for all individuals, but rates of time preference differ, the more patient will lend to the less patient. Markets in all second period contingent commodities may exist, and each individual can be thought of as maximizing subject to a wealth constraint given by the market value of the endowment. If tastes are homothetic, and given the same $U(\quad)$ functions and distributions of endowments, a single second-period composite asset can be created. But in general that will not be possible.

If the utility functions differ in risk aversion, the less risk averse will be willing at a price to destabilize their consumptions relative to the pattern of endowments in the second period, enabling the more risk averse to have a more stable pattern of consumption.

Will this intragenerational trading produce a safe real asset? A complete market equilibrium will call for a full menu of contingent commodi-

ties, with agents either buying or selling the contingent commodities in different proportions, depending on their tastes and endowments. If there is a full set of contingent commodities, then a safe real asset can be created, which will pay off one unit of consumption in each second-period state of nature.

Whether such an asset will actually be created when there is a full set of markets depends on costs of transactions. Any type of model in which there is some type of fixed cost for dealing in an asset will lead to repackaging of contingent commodities in forms that fit the excess demand patterns of consumers for second-period contingent commodities. For instance, a safe real asset is most likely to be produced if there is some notion of essential consumption, represented for example by the Stone-Geary utility function $U(C - \bar{C})$, $\bar{C} > 0$, where $U'(0)$ is infinite, and if many people have no second-period endowment at all.

If there is not a full set of contingent commodities, then invention of a safe bond changes the consumption possibilities of economic agents. Assuming that transaction costs are ultimately the reason for nonexistence of particular markets, invention of a safe real asset would again be more likely under the circumstances outlined at the end of the previous paragraph.

The role of government in a model of this type is limited, perhaps to ensuring that contracts are carried out. There might be some difficulties in this regard if, for instance, the second-period endowments are wages, and if human capital is not tradable. In that event the government ideally would want to intervene to reproduce the private sector equilibrium.[5]

Given the constraint of no intergenerational trade, the equilibrium attained in models of this type with a full set of contingent markets can be described as constrained Pareto efficient. But there may be possibilities for intergenerational trade, along grounds made familiar by Samuelson (1958).

Optimal Intergenerational Allocations

The possibilities for intergenerational trade depend on the pattern of endowments. For instance, if the desired pattern of trade always involves transfers from young to old, the introduction of money or government bonds will bring about a better equilibrium than is possible with purely intergenerational trade. The allocation is better in that every generation is made better off, so long as it is assumed that the horizon is infinite.

The assumed pattern of endowments here highlights the possibilities for intergenerational risk smoothing. Specifically, the assumption in (9.2) is that the total endowment each period is nonrandom and constant. It is only the division of the endowment between the generations that is uncertain.

Clearly, allocations are possible in which every generation has a nonrandom pattern of consumption over its lifetime. But direct intergenerational trade is not possible. The introduction of money will not itself solve the problem since sometimes the optimal arrangements will call for transfers from old to young, which cannot be achieved with money held by the old.

Return now to the case where tastes of all agents are identical. An optimal allocation in some sense is one where consumption in each period for each individual is certain and the allocation between young and old reflects time preference. For instance, if the utility functions are logarithmic as in (9.3), consider the solution to the following problem:

$$\max_{\{y\}} V(W, y) = \ln(W - y) + \beta \ln y, \tag{9.5}$$

which implies

$$y = \frac{\beta W}{1 + \beta} = C_2^t,$$

$$W - y = \frac{W}{1 + \beta} = C_1^t. \tag{9.6}$$

This allocation is optimal in the following sense: suppose individuals are told before knowing their first-period endowments what the probability distribution of the endowments is, and what the technical possibilities for trade are. Then they will choose this allocation.[6] This optimality criterion may be objected to on the grounds that it seems to imply prior (to their existence) agreement by economic agents on the rules of resource allocation.

The issues here are deep and not simply resolved. But the criterion is appealing because it is clear that some criterion of this type is in practice used in establishing property rights, in the sense that it is assumed the rights will be binding on agents as yet unborn and that notions of fairness are used in discussing the establishment of the rules.[7] There is certainly no presumption in most societies that anyone is free to opt out of paying

taxes if benefits fall short of contributions, except in the limited sense that emigration is typically permitted.

There is need for some criterion of optimality since the allocation implied by (9.6) is not ex post a Pareto improvement for all generations. Some generation might have been lucky and had high drawings in both periods of their lives. They would lose under the allocation (9.6).

Institutional Arrangements: Can the Private Sector Do It?

How is this allocation to be achieved? There are several possibilities, all involving the use of taxes.

1. The simplest in the present model is for the government to take command of all resources and allocate them between the generations as implied by (9.6).

2. The endowments of the old could be confiscated in each period and given to the young. At the same time the first old generation could be given fiat money, as in the original consumption loans model. The old sell money to the young in exchange for goods; the allocation is the same as (9.6).

3. The government could act as a financial intermediary, each period buying the rights to the second-period endowment of the currently young and paying out to the currently old the amount that generates the resource allocation (9.6). It may also be necessary to use taxes and transfers to effect the appropriate allocation.

The first two institutional arrangements require direct government intervention. The question pursued now is whether the third set of arrangements requires any government action, or whether alternatively a private financial intermediary could produce the allocation (9.6), without a government role. The question is whether use of taxation is necessary to achieve (9.6) when financial intermediation is available. If not, a private financial intermediary could be set up that would generate zero cash flow each period, balancing its payments with its receipts. If taxes and transfers are needed, government action is necessary.

To study the operation of the financial intermediary, it is convenient to assume there is a discrete number of states of nature, indexed by j, $j = 1, \ldots, J$. Let $p_{2j}(t)$ be the price in terms of period t goods for delivery of one unit of the consumption good in state of nature j in period $(t+1)$. The probability of state j occurring is q_j, and q_j is constant over time. Taxes in amount $T_j(t)$ are levied on the old in state of nature j in period t, and transferred to the young. The taxes may be negative.

The currently young maximize

$$E[U(\ \ )] = \ln C_{1i}(t) + \beta \sum_{j=1}^{J} q_j \ln C_{2j}(t+1)$$

subject to

$$C_{1i}(t) + \sum_{j=1}^{J} p_{2j}(t) C_{2j}(t+1) = W_{1i}(t) + \sum_{j=1}^{J} p_{2j}(t)(W_{2j}(t+1) - T_j(t+1)) + T_i(t) \equiv Y(t).$$

In the new notation, $C_{2j}(t+1)$ is consumption by the old in state of nature j in period $(t+1)$; $W_{2j}(t+1)$ is the endowment received by the old in state of nature j in period $(t+1)$; $W_{1i}(t)$ is the endowment of the young in state of nature i in period t. It is known that state of nature i has occurred.

The optimization results in

$$C_{1i}(t) = \frac{1}{1+\beta} Y(t) \tag{9.8}$$

$$C_{2j}(t+1) = \frac{\beta}{1+\beta} \frac{q_j}{p_{2j}(t)} Y(t), \quad j = 1, \ldots, J. \tag{9.9}$$

To attain the optimal allocation (9.6), it is necessary that

$$C_{1i}(t) = \frac{W}{1+\beta} \tag{9.10}$$

$$C_{2j}(t-1) \equiv \frac{\beta}{1+\beta} W, \quad j = 1, \ldots, J. \tag{9.11}$$

From (9.8) and (9.10),

$$Y(t) = W. \tag{9.12}$$

From (9.12), (9.9), and (9.11),

$$p_{2j}(t) = q_j. \tag{9.13}$$

Table 9.1
Resource flows to the financial intermediary

Inflows		Outflows	
Endowments of the old	$W_2(t)$	$\bar{W}_2$	Purchase of endowment of current young
Purchases of index bonds by current young	$B(t)$	$B(t-1)$	Payments to holders of index bonds (currently old)
		$T(t)$	Net transfers to the young

Thus actuarially fair prices should be charged for contingent commodities.

Using (9.13), we return to (9.12) to obtain

$$T_i(t) + W_{1i}(\quad) + \sum_{j=1}^{J} q_j(W_{2j}(t+1) - T_j(t+1)) = \bar{W},$$

or

$$T_i(t) + W_{1i}(t) = \bar{W}_1 + \sum_{j=1}^{J} q_j T_j(t+1). \tag{9.14}$$

On the right-hand side of (9.14), we have a term which is the expected value of second-period taxation of the old. Assuming taxes are only state and not time dependent,

$$T_i + W_{1i} = W_1 + \bar{T} \tag{9.14$'$}$$

where $\bar{T}$ is the expected value of second-period taxation.

From (9.14)$'$ it is clear that the optimal allocation can be achieved for more than one value of $\bar{T}$. It is natural to set $\bar{T}$ to zero, in which case

$$T_i = \bar{W}_1 - W_{1i}, \quad i = 1, \ldots, J. \tag{9.14$''$}$$

Thus the financial intermediation scheme cannot operate without use of taxes and transfers, though it can operate with expected taxes equal to zero.

Given the result that contingent commodity prices are, in the optimal allocation, actuarially fair, we can describe the operations of the financial intermediary quite simply. Its resource flows are shown in table 9.1. Each period it buys the second-period endowments of the current young at their expected value, as prescribed by (9.13). It also pays out claims owned by the current old. These can be thought of as indexed bonds, paying the same amount in each state of nature. Resource inflows come from the endowments of the current old, which were purchased last period, and from sales of index bonds to the current young. Any excess of inflow over outflow is handled by making a distribution to the young; alternatively, any excess outflow is paid for by taxing the young.

It is worth noting that the financial intermediation solves two allocational difficulties. First, the intermediation makes intergenerational risk-sharing possible. Second, the government makes it possible for each generation to choose the optimal time profile of consumption. The first function can be performed without the second being satisfied. For instance, suppose that both generations alive at the same time can contract before their endowments are revealed. They will in general want to trade in contingent commodities. But such trading will still leave further gains from intergenerational trade, in that, given the pattern of endowments described by (9.4), each generation would likely want the opportunity of saving in the first period.

Dynamics of the Financial Intermediary

The financial intermediation scheme can be instituted in a period when the division of resources between the generations is about average, and in this case will make the first period old better off and raise the ex ante expected utility of all subsequent generations. For example, again using the logarithmic utility function (9.3), consider the introduction of the scheme in period t, with purchase by the government of the rights to $W_2(t+1)$, for which it pays $\bar{W}_2$. It sells to the young an amount of bonds $B(t)$ implied by

$$\max_{\{B(t)\}} \ln(W_1(t) + \bar{W}_2 - B(t)) + \beta \ln B(t), \tag{9.15}$$

or

$$B(t) = \frac{\beta}{1+\beta}(W_1(t) + \bar{W}_2). \tag{9.16}$$

The goverment's net resource flow in period t is

$$B(t) - \bar{W}_2 = \frac{1}{1+\beta}[\beta W_1(t) - \bar{W}_2]. \tag{9.17}$$

If $W_1(t)$ is equal to $\bar{W}_1$ or close to that level [see assumption (9.4) that $\bar{W}_1 > \frac{\beta}{1+\beta} W$], the scheme generates a first-period surplus that can be given to the old.

The dynamics of first-period consumption are given by

$$C_1^{t+j} = \frac{W}{1+\beta} + \frac{(-\beta)^j}{1+\beta}(W_1(t) - \bar{W}_1). \tag{9.18}$$

This converges to (9.6). Provided $W_1(t)$ is close to $\bar{W}_1$, the scheme increases the ex ante expected utility of all generations. However, if the scheme were started when the first generation had very high $W_1(t)$, there would be a large demand for bonds. The next generation would accordingly have low first-period consumption and could therefore be made worse off, in an expected utility sense, by the introduction of the scheme.

Choosing among the Schemes

At the present level of abstraction there is nothing to choose between these schemes. Additional elements would have to be included in the model to make the choice determinate. If there are differences in tastes, and if the government cannot discriminate between economic agents, then the direct allocation method (1) is less likely to be optimal. The difficulty is that the total amount allocated to the young generation may be wrong. There will subsequently be trading within that generation, but there is no mechanism for them to trade with other generations. Neither of mechanisms (2) nor (3) suffers from this particular difficulty.

Choice between (2) and (3) requires more explicit modeling of the effects of taxation of second-period endowments (in 2) as compared with purchase of the endowment (as in 3). If the endowments are lump sum, as so far assumed, there is again no basis for choice. However, we might assume that the endowments represent, for example, labor income and that labor supply responds to wages. In that case the imposition of taxes under scheme (2) in general distorts the labor supply decision. But there is similarly a severe moral hazard problem under scheme (3) where individuals have sold their labor income forward. In principle a contract could be drawn up that would specify the amounts to be worked in each state of nature; with such an agreement the optimal allocation could be attained. But if the government cannot discriminate between workers, it is difficult to see how such optimal agreements could ever be negotiated.

This is to say that it is very unlikely that there is a way of attaining the optimal allocations. There is no way the government can bring about that allocation without either buying claims on future endowments (presumably human capital) or taxing. If it is not possible for the government in effect to deal in human capital, it will have to use taxation along with security issues to improve the allocation of resources. It will in general be able to improve the allocation of resources by engaging in intergenerational transactions, but because it does not have lump-sum taxes, it cannot achieve a first best allocation.[8] And because it cannot achieve the first best solution, it will not generally be optimal to eliminate uncertainty entirely.

Aggregate Uncertainty

To this point it has been assumed that the aggregate endowment is certain, although its distribution between the generations is not. Suppose now that $W(t)$, the aggregate endowment, is uncertain. It will still be true, unless the endowments are perfectly positively correlated, that there will be risk-sharing grounds for government financial intermediation.

There are again J states of nature, $j = 1, \ldots, J$. The optimality criterion for the logarithmic utility function now becomes

$$\max_{\{C_{1i}(t),\, C_{2k}(t+1)\}} \sum_{i=1}^{J} q_i \ln C_{1i}(t) + \beta \sum_{k=1}^{J} q_k \ln C_{2k}(t+1), \tag{9.19}$$

subject to $C_{1i}(t) + C_{2i}(t) = W_i(t)$, $i = 1, \ldots, J$, for all t. The optimal allocation specifies the consumption levels for both generations in each state of nature. It is

$$C_{1i}(t) = C_{1i} = \frac{W_i}{1+\beta}, \tag{9.20}$$

$$C_{2i}(t) = C_{2i} = \frac{\beta W_i}{1+\beta}.$$

Here W_i is the aggregate endowment in state of nature i.

This allocation can once again be brought about through the three schemes, including government financial intermediation in scheme (3). Prices and transfers are chosen to replicate the allocation (9.20). These prices are no longer equal to the probabilities of the states of nature but in addition reflect aggregate endowment in the state of nature. The financial intermediary will no longer buy second-period endowments for

an amount equal to their expected value. Nor is it natural any longer to think of the financial intermediary dealing in indexed bonds, since the amount consumed in each second-period state of nature will depend on the state and no longer be state independent.

Of course, if the intermediary chooses to provide a full menu of contingent commodities, it is possible to buy an indexed bond in the sense of a financial asset that provides a payoff that is constant. But with the postulated patterns of endowments and utility functions, there is no one who will want to consume identical amounts in each state of nature.

If the financial intermediary wants to reduce the number of assets in which it deals, the natural index to use is the aggregate amount of goods available in each state, since consumption for each individual will be proportional to the aggregate endowment in each state. This is a result of the assumption of identical homothetic tastes.

9.3 Government Financial Intermediation and Indexed Bonds

The preceding analysis establishes that there may be a role for government financial intermediation that private markets cannot provide. It demonstrates that meta-theorem *N*5 does not establish the optimality of the status quo in all situations.

But the role of government as financial intermediary has to be related to the source of the private sector's inability to provide the appropriate bundle of assets. If the government's advantage derives from its claims on future labor income, then it is likely optimal for the government to sell claims on labor income in different states. Claims on the income of capital are already tradable. The institution of social security does provide some, though nontradable, claims on future labor income.

The improvement that can be expected from financial intermediation of the type described in the previous section depends on the correlation of returns on human capital with returns on other assets. Those returns are in fact highly correlated. Further the wages earned by different generations of labor alive at the same time are also strongly correlated. No great reduction of risk for the individual should therefore be expected from optimal risk-sharing arrangements provided by the government based on its ability to tax future labor income.

The case for government financial intermediation outlined here implicitly uses, as its definition of an indexed bond, a bond that pays off the same amount of goods in each state of nature. But since there is no money and no price level, the bonds are not indexed in the conventional sense that the amount of money paid out to bondholders is related to the behavior of the price level. To discuss the issue of indexed bonds in this sense, the model has to include money and prices. I now discuss a framework that seems ideal for analyzing government financial policy in such a context.

9.4 Optimal Government Financing and Index Bonds

Consider a model in which individuals maximize over two-period lifetimes, supplying labor services, using money, and able also to save by the accumulation of capital. The government has only distorting taxes at its disposal. Potentially, any asset could serve as medium of exchange. But it is technically difficult to pay interest on securities that change hands in the day-to-day process of exchange, and for that reason there is a separate noninterest-bearing asset, money, that serves as medium of exchange. Technical innovations in the process of exchange occur randomly. This last assumption is an important one, for it means that there are specific risks associated with the return to money and that money therefore will not necessarily serve in such a model to produce exactly the same pattern of returns as real assets.

Consumers maximize an expected utility function of the form:

$$E\left\{V\left[C_1^t, C_2^{t+1}, L^t, f\left(\frac{M_{t+1}}{P_{t+1}}\varepsilon_t\right)\right]\right\}, \tag{9.21}$$

where $f(\ )$ represents the services provided by the holding of money. L is the amount of labor supplied. Random variable ε_t is a technological factor representing the ability of money to perform its utility or labor-saving services; uncertainty about future values of ε generates uncertainty about future price levels as of any given values of the remaining variables in the economy. Inclusion of real balances in the utility function is a method of ensuring a demand for money even if interest is earned on other assets.

First, return to the optimal intergenerational risk sharing with aggregate certainty model of section 9.2, omitting government and labor supply from (9.21). Suppose there is a given constant money stock. The constant money stock does not in this context generate efficient intergenerational

risk sharing, since uncertainty about the rate of return on money does not provide the certain one-for-one intertemporal trade-off that society faces between consumption of the generations.

This price level uncertainty provdes a role for government in the model of section 9.2, either as issuer of an indexed bond or to conduct monetary policy. Monetary policy will consist of transfers to the old that produce price-level certainty. With money as a safe asset, there is no need for indexed bonds, provided appropriate resource transfers are made between the generations. If monetary policy cannot operate rapidly enough to stabilize the price level, money will be an unsafe asset, and there will be room for indexed bonds. Indeed the government might want to lend in nominal terms to the private sector, enabling it to hedge the risks of price-level changes. At the same time the government would continue to issue the safe or indexed bond.

Analysis of optimal government policy in such a model requires full specification of the optimal tax problem. A model of this type under certainty has already been analyzed by Helpman and Sadka (1979) who show, under the assumption of no lump-sum taxation, that the government optimally will sometimes want to use deficit financing. When uncertainty is introduced, we should think of the model in terms of contingent commodities. The optimal state-contingent taxing scheme for given patterns of government spending will involve purchases or sales of contingent commodities.

Borrowing implies merely that the government collects resources today that will be paid for by delivery of commodities in future contingencies—which commodities will be provided through taxation, money issue, or future borrowing. The positions that the government takes in various markets for contingent commodities can be viewed as determining the optimal financing of the debt. In this sense, the type of debt issued by the government matters: if it takes another position, the real equilibrium is changed.

Neutrality of Government Financial Operations

Once government positions in each market for contingent commodities have been optimally determined, the government can engage in financial intermediation by taking, at the equilibrium prices of contingent commodities, positions of zero net worth across contingent markets. For instance, it can buy contracts for future delivery of wheat and sell contracts for future delivery of corn. If the profits or losses are merely to be handed back to the private sector in a neutral way, then these further financial transactions have no real effects. For the government to return the proceeds in a neutral way, it holds constant optimally determined planned spending, taxes, and transfers within each state of nature, aside from those arising from its financial intermediation activities. Thus it disposes of its wheat by selling the wheat to the market and distributing the profits of losses—it is doing nothing except churning the market. Such financial intermediation cannot in a complete contingent market setup do any good.

What is the relationship between the public finance framework of optimal debt determination outlined above and the five neutrality theorems, $N1$ through $N5$? $N1$ does not apply because individuals maximize over only two periods and therefore cannot engage in intergenerational risk sharing. To the extent that the horizon is lengthened or effectively made infinite, more intergenerational risk sharing should be expected from within the private sector. The case for government issue of special types of debt would then depend on the absence of markets for human capital and the inability of individuals from different families to arrange smoothing that is possible through pooling of the risks of within-generation wage incomes.

There is a sense in which neutrality theorem $N2$ holds. Namely, there is under reasonable assumptions a determinate optimal pattern of government spending, taxation, and money issue in each state of nature. This optimal pattern implies net supplies of contingent commodities. It is possible to superimpose on this pattern a variety of government financial operations that have no real effects, provided the underlying real activities of the government are unaltered. But it is precisely that underlying pattern of real activities that implies the optimal pattern of government financing.

Neutrality theorem $N3$ does not hold when it is optimal to pay interest on debt and when it is technically impossible to do so on money, as shown by Helpman and Sadka. Theorem $N4$ depends on the availability of lump-sum taxes. $N5$ was discussed extensively in section 9.2.

Government Issue of Indexed Debt

In the foregoing framework optimal government policy implies a particular pattern of net supplies and demands of contingent commodities by the government. The type of securities—that is, packages of contingent

commodities—issued by the government will depend, as in section 9.2, on the advantages the government has over the private sector in issuing valued securities and on the small frictions associated with the packaging of assets. For instance, if many investors have very high risk aversion and no future endowments, they would essentially want to buy only indexed bonds. Rather than require them to mix their own indexed bonds, or leaving the job for private financial institutions, it could be cheaper for the government to do so.

The framework is not, however, totally compelling, except as a way of organizing thought, for its fails to explain why governments have traditionally been assumed to have an obligation to issue safe debt. Nor does it handle the question of which markets in contingent commodities are in fact available at any time. Without knowing why markets are missing—and many are missing—we cannot in some ultimate sense pronounce on the desirability of alternative forms of government deficit finance.

9.5 Government Debt Issue: An Alternative Approach

The general presumption that government deficits should be financed by the issue of safe debt probably arises from the fear that the government is big enough to manipulate the returns on any other type of debt in a way that will be disadvantageous to the lenders. In more modern terms the issue is one of the dynamic inconsistency of policy (Kydland and Prescott 1977, Fischer 1980). Given this view, indexed debt would be the standard form of government liability, particularly since the government is exceptionally well placed to affect the inflation rate.

From this perspective the right question to ask about government debt is not why it is not indexed, but how it ever came to be nominal. One argument that may have some appeal is that the government by promising to pay off in dollars (or the currency of the country) is making the only promise it can with certainty keep, since it prints the dollars. However, nominal debt predates fiat currencies, so this cannot be the explanation.[9]

The predominance of nominal government debt in countries with relatively stable inflation histories derives from frictions associated with indexed debt. The first friction is the delay in the collection and publication of price date, which means that indexed debt is not conveniently used in short-term transactions. Second, as often pointed out, variations in relative prices imply that different price indexes are appropriate for different people and purposes: when inflation rates are reasonably predictable, there is no assurance that the appropriate real value of indexed debt is more predictable than the value of nominal debt.[10]

Once the economy has accustomed itself to using nominal debt and institutions, and given the frictions associated with indexed debt, there are costs to innovating by introducing an indexed bond, and no assurance that the social surplus from doing so is appropriable by the innovator. There is no presumption, even if there were no government advantage in the issue of indexed debt, that indexed debt would be introduced by the private sector at precisely the right time. Indeed, given a nominal tax system, there is a presumption that some government action is needed to get the process under way.

Government innovation comes when the pressures to move away from nominal contracting become strong enough: these pressures arise in part from the exhaustion of devices for enforcing cheap nominal financing of deficits. They arise also from the dissatisfaction of existing lenders to the government who have suffered from the effects of unanticipated inflation on the real value of their assets.

The notion that indexed debt is an incentive for more consistent behavior by government, point 4, as argued by Bach and Musgrave (1941), is appealing, particularly given that governments typically do not appear to behave in the ways that economists' models of optimizing governments suggest they should. However, it is interesting briefly to explore the question of whether governments should always honor past commitments. The existence of a nominal debt makes it possible for the government very cheaply to impose a capital levy (by inflating). The best of all possible worlds, if governments acted optimally, might be one in which governments had the option of imposing a capital levy in this way in emergencies, like wars. Provided there is a political cost to violating past obligations, it may be optimal to set up arrangements in which they can easily be violated.[11]

Taking this logic a step further, we note the argument by Levhari-Liviatan (1976) that the direction of the effect of past commitments on current actions is ambiguous. If, in an emergency, inflation is the first line of increased government revenue, then the existence of indexed debt may make the government response to difficulties more rather than less inflationary.

Lest these speculations obscure the main message, I repeat the argument

of this section. Given the ability of the government to affect the payoffs that it makes on debt whose return is uncertain, the general presumption would be that governments should finance themselves with indexed debt, as a means of encouraging consistent behavior. The predominance of nominal debt results from frictions associated with the use of indexed debt and relies heavily on the presumption that price-level behavior is reasonably predictable. Once that presumption is lost, governments will likely have to issue indexed debt in order to finance themselves.[12]

9.6 Concluding Comments

Finally I turn to arguments (2), (3) and (5) for government issue of indexed bonds. Argument (2), that monetary policy could more accurately affect q if there were indexed bonds, assumes that real bonds are a closer substitute for capital than are nominal bonds. Empirically this turns out not to be the case. It would nonetheless be useful to know what a market real rate of interest is and how it varies through time, and for that reason issue of an indexed bond would be of assistance to monetary and fiscal policy makers.[13]

Argument (3), that issue of indexed bonds would reduce the interest cost borne by the Treasury for financing the debt, and also promote saving, has been extensively investigated. If government debt issue is neutral, in the sense of *N*2, then government issue of indexed bonds would have no real effect. If the government issue of indexed debt changes its patterns of taxation and money issue, then the effects on interest rates and saving depend on how taxes and inflation rates are changed by the introduction of the indexed debt. An individual with given wealth, and given future tax payments, will be willing to hold indexed debt at a lower real return than nominal debt if the remaining assets available are on balance not hedges against inflation. Certainly, given the adverse effects of inflation on equity returns, the presumption is that individuals would be willing to hold indexed bonds at lower real rates than nominal bonds holding constant future tax payments. The effects of the issue of indexed bonds on saving depend on the responses of saving and labor supply to changes in the real interest rate, topics on which there is little empirical knowledge.[14]

Finally, consider argument (5), that government issue of indexed bonds is desirable on distributional grounds. In the United States the adverse distributional consequences have been associated particularly with the U.S. savings bonds program. The ability of the government to continue obtaining financing through these instruments indicates a lack of access, for whatever reason, to higher yielding dominating assets, and strongly suggests that a part of the market would be made better off by government issue of indexed bonds, or alternatively as now proposed, floating rate notes.[15]

At the theoretical level this chapter should be viewed as an exploratory attempt to analyze the question of optimal government financial policy. Previous analyses have tended to take the types of assets to be issued by the government as given. There is as yet no satisfactory theory of what types of assets governments should issue, and such a theory may require further analysis of reasons for the absence of particular markets.

Because the anslysis is exploratory, it cannot reach any firm conclusions on the desirability or otherwise of government issue of indexed bonds. There is no strong welfare argument for government issue of an indexed bond, at the abstract level of this chapter. But nor is there a strong argument against such an issue. And the analysis certainly provides little explanation or justification for the issue of nominal bonds.

Notes

Department of Economics, MIT, and National Bureau of Economic Research. At the time this chapter was written, I was a Visiting Scholar at the Hoover Institution. This is a revised version of a paper prepared for the Conference on Indexation and Economic Stability, Funacao Getulio Vargas, Rio de Janeiro, December 16–17, 1981. I am grateful to my discussants Eduardo Modiano and Stephen Ross and to participants in seminars at MIT, Stanford, and Berkeley for comments and suggestions, to Jeffrey Miron for research assistance, and to the National Science Foundation and Hoover Institution for financial support.

1. For earlier examination of the issues, see Fischer (1975), Levhari and Liviatan (1976), and Peled (1978), as well as references cited at the end of this chapter.

2. See the *Deseret News*, September 10, 1981. I am indebted to J. Huston McCulloch for this information.

3. Eagly (1967) suggests that Jevons and Marshall advocated use of a price index in private rather than government transactions. However, reading of Jevons (1884) and Marshall (1925) supports the view outlined here. Collier (1969) and Fisher (1934) both survey the literature.

4. In chapter 8 of this volume Stiglitz independently makes very similar arguments.

5. For analysis of social security and taxation as methods of overcoming the absence of human capital markets, see the excellent paper by Merton (1981). Merton also discusses the case where the government has only distorting taxes at its disposal and cannot produce the first best allocation of resources.

6. Atkinson and Stiglitz (1980), p. 340, provide references and discussion. See also Peled (1978), who discusses the criterion under the heading Equal Treatment Pareto Optimality, referring to discussion by Muench (1977). Peled is wary of the criterion, arguing that it is not compatible with a requirement that individuals have the right to refuse to participate in a cooperative procedure if that is costly. He conjectures that whenever the optimality criterion used by economists is stronger than that used by individual agents, private equilibria are likely to be nonoptimal.

7. Robert Barro, in his summary discussion at the conference, argued that use of this criterion was incompatible with the notion that individual utility is not affected by the utility of subsequent generations. However, the criterion can be thought of as follows. Suppose an intergenerational arrangement can be introduced that will make existing generations better off. How likely are future generations to repudiate the arrangement? Future repudiation is more likely if subsequent generations see that, at the time it was introduced, the scheme was known to benefit one generation at the expense of specific future generations. But if it was reasonable to think at the time of introduction of a new set of arrangements that future generations would be benefited, the future generations are more likely to uphold the scheme. It will be seen later in this chapter that introduction of government financial intermediation between generations can satisfy this criterion, benefiting the current generation and increasing the utility expected for all future generations.

8. Bhattacharya (1981) examines a related case.

9. Nor can it seriously be believed that government debt of any type is totally safe, in light of possible revolutions, debt repudiation, and so forth.

10. Michael (1979) examines variations in consumption bundles and associated price indexes in a cross-section study.

11. Keynes, *Essays in Persuasion* (Harcourt Brace, 1932), is worth quoting: "... the benefits of a depreciating currency are not restricted to the government.... Those secular changes ... which in the past have depreciated money, assisted the new men and emancipated them from the dead hand; they benefited new wealth at the expense of old, and armed enterprise against accumulation." (p. 87) Of course he was only half serious: he concluded that it would be better to handle redistributive and inheritance problems directly rather than through (unanticipated) inflation (p. 92).

12. It is difficult to see why the Treasury should not undertake an experimental issue of indexed bonds, sold at auction. These could be discount bonds, promising payment of a given real sum on a specific future date. Tax treatment of the returns would have to be specified. The simplest arrangement would be to make the returns nontaxable. Such a bond could quite easily yield a negative real return in equilibrium.

13. This assumes reasonably that either monetary or fiscal policy decisions might optimally react to changes in the real interest rate.

14. Bhattacharya (1979) examines the theoretical arguments.

15. This argument takes the existence of the U.S. savings bonds program as given. Ronald McKinnon suggested that the program would lose its rationale if interest rate controls on financial intermediaries were lifted. In the last few years the outstanding volume of savings bonds has been falling. At the end of 1981 it was $68 billion, only about 6 percent of the value of total time and savings deposits at financial intermediaries.

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10 On the Nonexistence of Privately Issued Index Bonds in the U.S. Capital Market

Stanley Fischer

10.1 Introduction

"Why, if both borrower and lender benefit from them, [does] an index loan market . . . not develop spontaneously and without any government initiative?" This question, asked by Professor Arvidsson at the IEA conference on inflation in 1962, provides the major theme for the present chapter which pursues in some detail possible reasons for the nonexistence of privately issued index bonds in the United States.[1]

In an earlier paper, I used portfolio theory and the capital asset pricing model to study the demand for index bonds and some properties of equilibrium in a capital market with equity assets as well as indexed and nominal bonds [7], and in which individuals may also own (but not sell) human capital. The major conclusions of that paper are that the equilibrium relationship between the real yields on indexed and nominal bonds depends on the extent to which equity and human capital are hedges against inflation[2]—the real yield on index bonds tends to be below that on nominal bonds to the extent that real returns on equity and human capital are negatively correlated with inflation; that, in the absence of human capital and with no relative price uncertainty, all private lending and borrowing would take place through indexed bonds; and that, with human capital, both types of bonds would in general be expected to exist. I noted that the analysis did not throw much light on the nonexistence of indexed bonds in most major capital markets.

The nonexistence of privately issued index bonds in the United States is a phenomenon requiring explanation for two main reasons. First, the tying of contracts to the price level is not unknown nor even especially unusual in the United States: labor contracts, certain aspects of insurance contracts, and the prices to be paid for future delivery of manufactured products have all been tied to the price level.[3] Second, there has been no dearth of innovation in the financial area over the years, although those innovations taking the form of the issue of new types of securities by existing firms—such as the certificate of deposit and the floating rate note—have been undertaken mainly by banks.

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Are Markets Learning? Behavior in the secondary market for brady bonds

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Abstract

This paper analyzes some aspects of the workings of the Brady bond (restructured LDC debt) market. It concentrates on the effects of the Mexican crisis on the risk assessment (as measured by the stripped spread) of other Brady countries (particularly Poland). The main findings are: i) *the risk premium (on a single country) has one unit root; this is consistent with the hypothesis that risk premia reflect new information accruing to the market*; ii) *comovements among stripped yields were stronger during the high volatility period of the Mexican crisis; in particular, in our case-study on Mexico and Poland, we do not reject cointegration for the period July 94-July 95, but we do reject it for the period July 95-July 96.* iii) *the crisis has had a strong permanent effect on the risk assessment on Mexico (about 550 bs. pts.);* iv) *different Brady bonds responded differently to the Mexican crisis: countries with similar pre-crisis mean and volatility reacted in a similar way (in terms of both absolute deviation and degree of comovement with the Mexican bonds). Other factors (regions, oil producers, date of Brady deal) do not explain the observed patterns.* v) *there was convergence of volatility during the high volatility period of the Mexican crisis.*

These results suggest that the behavior of the traders when assessing the sovereign risk of Brady countries is not constant over time and in particular responds to the level of uncertainty in the market. Herd behavior increases with risk, leading to even higher volatility. Moreover, traders have poor experience and limited information on developing countries, therefore *learning spillovers* are likely. The decrease in sovereign risk premium comovements in the second period of our sample could be an indication of the fact that *markets are learning*, i.e. acquiring experience and gathering information on the developing countries, so that learning spillovers are less relevant; but it could also signal the absence of any relevant shock to generate such spillover effects, while in fact the market is still vulnerable to country-specific shocks. On this issue further research is needed.

1. Introduction

In the fall of 1982 the Mexican government announced that Mexico was no longer able to fulfill its external commitments. A run out of developing country debt ensued. It was the first major default of a sovereign country after the crisis of the 1930s, and the event was unexpected, despite the high real interest rate and falling commodity prices that obtained at the time. Most of the debt was held only by several hundred commercial banks.

One of the main inefficiencies associated with the negotiation process that followed was that the "rules of the game" were not clear or predictable. Different strategies were proposed in the 1980s, ranging from the "involuntary lending" of the early 1980s to the Brady agreements of the past few years. One important milepost in the debt crisis was the introduction of a secondary market in 1985. Since most claims were held by a relatively small group of banks, the market was initially thin. The process of securitization of the developing countries debt, though, accelerated in the last few years.

The Brady agreements are based on the exchange, on a voluntary basis, of commercial debt for a menu of options including bonds or new money - the bond option being the most popular one. Brady agreements have involved debt reductions and have usually been implemented when the debtor country was already undergoing economic reforms. Debt reductions and economic reforms have relaxed the credit constraints that were binding for most of the debtors in the 1980s, thereby providing the new market instruments with a relevant degree of liquidity.

As a consequence, the *Brady bond* market developed very quickly in the past few years. The Emerging Market Trading Association was founded in 1990 (a successor to the earlier "LDC Debt Traders Association"), and by now most bonds are traded continuously all over the world. Trading volumes in 1994 reached US$2.8 trillion (from US$100 billion in 1990), the total amount outstanding of the US dollar-denominated Brady market in 1994 had an approximate face value of US$138 billion, and future and option market are now traded for all major Bradies.[1]

This impressive development of the secondary market largely resulted from the new approach introduced by the Brady plan. Brady agreements have aimed at and actually led to a securitization of the external debt, to a relaxation of credit constraints and to a restored access to the international financial market. This approach has been consistent with the view that international financial market can be a fair and relatively certain environment to satisfy the financial needs of middle-income countries, probably a better environment than the lasting "bargaining process" that prevailed in the 1980s.

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[1] The reader interested in knowing more (daily prices , futures and options, analysis and ratings, news and forum) can now browse the pages of the BradyNet (http://www.2020tech.com/bradynet).

On December 20, 1994 the Mexican peso was devalued by 15% and two days later it was allowed to float. At the end of December the Mexican government was forced to cancel a Tesobono refinancing auction because investors were no longer willing to bear the sovereign risk at rates acceptable to the Mexican authorities[2]. The perception of sovereign risk - as reflected for example in the Brady bonds prices (see the plots of the Mexican and Polish Par and Discount bond prices in figure 1 and 2) - jumped dramatically during the crisis. Even though the Mexican crisis reflected mainly internal problems, it immediately affected the perception of the sovereign risk in other debtor countries. In particular the yield on most emerging market bonds jumped along with Mexico's. As an example, we report in figure 3 a plot of the *stripped spreads*[3] of the Mexican and Polish Brady Discount bonds, and in figure 4 an analogous plot for the Par bonds.

Mexican and Polish Discount Bond Prices

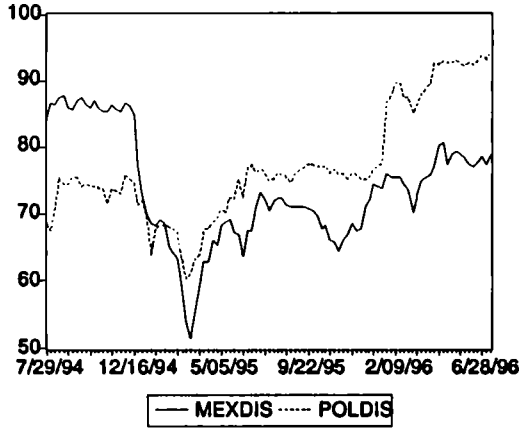

Figure 1

Mexican and Polish Par Bond Prices

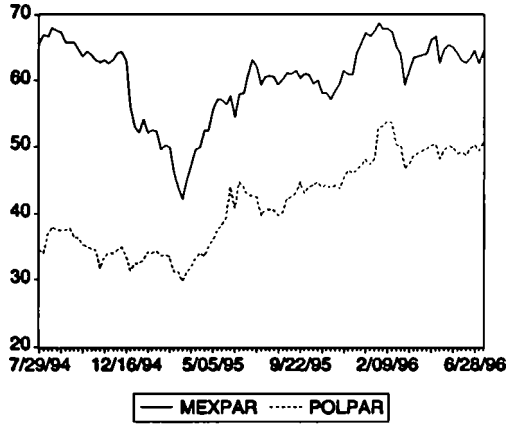

Figure 2

In 1981, the choice not to differentiate among different debtors might have been a rational response to the crisis - considering the political and international dimension that that crisis soon reached. This statement could certainly be questioned at end-1994. As long as the international community and the traders believe in the process of debt securitization one would expect that, over time, only country specific elements or international shocks should affect the risk premium of a sovereign country. This paper originated from the initial observation that for the 1994 Mexican crisis there is evidence of *spillover effects* in the assessment of the sovereign risk premium for different countries. The questions we will try to address are the following: Are there comovements (not due to international shocks) in the sovereign risk premium of different debtor countries? If there are, what is the nature and the dimension of these comovements? To what extent can a leader country like Mexico affect the risk perception on other debtor countries?

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[2] For an assessment of the Brady deal on Mexico the reader can see Claessens, S., D. Oks and S. van Wijnbergen (1993). For an account of the 1994 Mexican debacle see Calvo, G.A. (1996).

[3] The reader not familiar with this term can refer to the Appendix.

Why should the developing country debt market be affected by these spillovers? And why should it be more affected than the industrial countries debt market? What can we learn on traders' behavior in the Brady bond market?

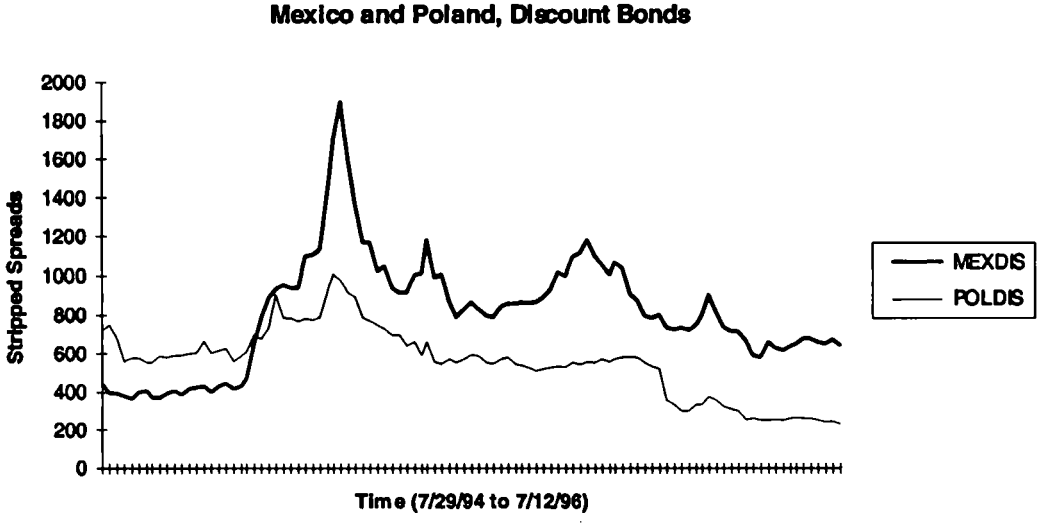

Figure 3

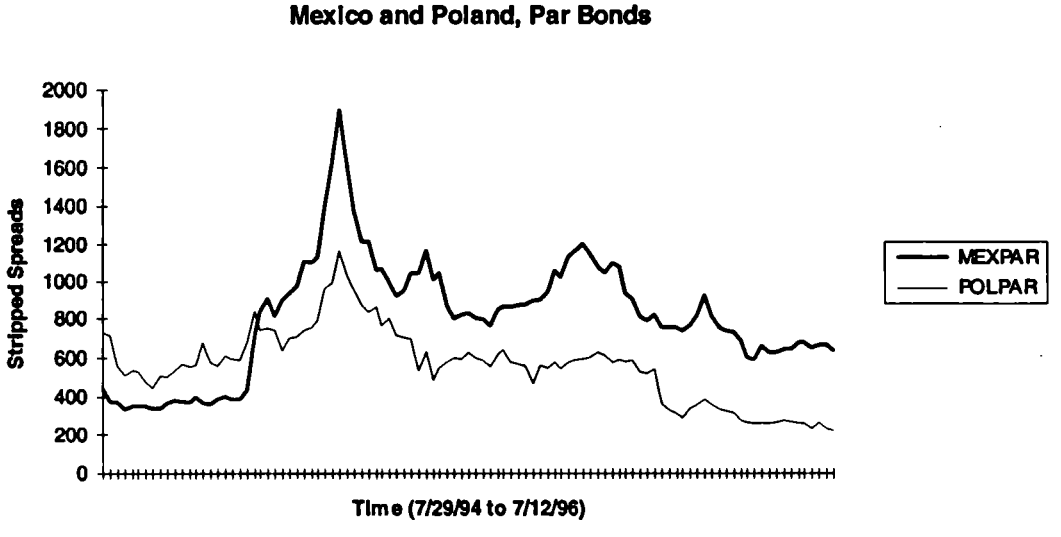

Figure 4

A finding of relevant spillovers would have many implications and would be especially important to the countries that have a substantial commitment to the reform process. If the payoff - in terms of costs of external financing - of a serious commitment to a reform process can be substantially reduced by spillover effects, the incentives to stick to the reform process can be reduced as well.

The paper is organized as follows. Section 2 provides a brief review of the literature. Section 3 describes the data set. Section 4 reports the analysis of comovements, focusing on the case of Mexico and Poland. In section 5 we develop an interpretation of the results of Section 4 and in Section 6 we test this interpretation. Section 7 concludes.

2. Pricing risky debt

In this section we briefly review the existing literature on the Brady bond market. We do so by dividing the literature based on the three different approaches generally used to price risky debt: option theory, fundamentals and spillover effects. The option theory approach is the most widely used (also by traders) to price corporate (i.e. risky) debt and constitutes a complete theory on its own. On the other hand the approaches based on fundamentals and spillover effects should be thought as complementary, as it will result clear in the following sections.

Option theory. Option theory is generally used to price the debt of corporate companies. Let D denote the market value of the corporation's promise to pay the amount F in t years, let S denote the market value of the firm's common stock, and let A denote the current market value of the assets of the corporations. The Modigliani-Miller[4] theorem asserts that:

$$A=D+S \qquad - \qquad (1)$$

Given this structure, it is easy to see that the corporation's common stock can be interpreted as a *call option* on the assets of the corporation, with an exercise price of F and time of expiration of t. In fact, when the debt matures, the stockholders can either pay F to the creditors (exercise the option) and keep control over the assets, or default on the debt (not exercise the option) and let the creditors take control over the assets of the corporation.

Because the common stock of the corporation looks like a call option, we can apply the Black and Scholes options pricing model to find a theoretical value for S. Given (1), we can get a theoretical price for D which will depend on the following variables: A (the current market value of the assets of the corporation), F (the face value of the debt), t (the time remaining to the maturity of the debt), the risk-free interest rate and the volatility of the value of the assets of the corporation. At the maturity date the option will be exercised if A is greater than F. So, before the maturity

[4] Modigliani and Miller (1958) first asserted that the value of a firm should be independent of its capital structure.

date, the ratio A/F, the volatility of A and the time remaining to the maturity of the debt (together with the levels of A, F and, of course, the risk-free interest rate) enter the determination of the price. An application of this approach to the debt of a sovereign nation has been proposed by Claessens and Van Wijnbergen (1993), who use option theory to price the bonds of the Mexico Brady deal.[5]

Fundamentals. A different approach tries to relate secondary market debt prices to a set of explanatory variables, such as debt to export ratio, reserves to import ratio, inflation, etc. (e.g. Cohen (1989), Ozler and Huizinga (1991)) or on the past history of repayments (e.g. Hajivassiliou (1989), Ozler (1993)). These studies have generally tried to identify variables that best explain repayment capacity by conducting econometric tests on goodness-of-fit. It is in fact extremely difficult to have a well specified and testable theory on the likelihood of repayment as a function of the fundamentals: the likelihood of repayment will depend on factors that affect both the ability and willingness to pay, as well as the bargaining power in case of rescheduling or recontracting. A very rich theoretical literature, started by Eaton and Gersovitz (1981), has pointed out the complexity of the strategic issues involved in lending to a sovereign country. Furthermore, these analyses usually make the implicit assumption that bonds of different countries traded on the secondary market are directly comparable so that the available prices can be used in cross country regressions. This is true if we restrict the attention to Par and Discount Brady bonds, as we do. But most of the cited studies use typically pre-Brady or non-Brady prices.

Spillover effects. The approach based on spillover effects simply states that the level or the variation of the price of a particular bond in the market depends on the behavior of *similar* bonds. For example, the IMF (1995) reports tests of causality that support the null hypothesis that the price of the Mexican Brady bonds Granger causes the price of other Brady countries, like Venezuela and Brazil. Similarly, Doukas (1989) and Calvo and Reinhart (1996) argue that there is evidence of 'contagion effects' on Brady bonds returns following news on the production or shocks like the Mexican crisis respectively. Eichengreen (1989) concludes in his study 'The U.S. Capital Market and Foreign Lending, 1920-1955' that "evidence from bond prices in the 1930s and from the volume and composition of lending in the 1940s and 1950s suggest that at least some of the cost of default spilled over among debtor countries." Certainly spillover effects can only partially explain bond prices and in this sense they are complementary to fundamentals in the explanation of bond prices and returns.

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[5] The value of A for a sovereign country is not obvious, and an estimate of that value is going to be approximate and subjective. Claessens and van Wijnbergen assume a stochastic behavior for the value correspondent to A. They assume a Brownian motion, that is a continuous version of a random walk, but there is no clear evidence for such a behavior of the underlying stochastic element. It should also be noted that the option theory approach subsumes all the information on the fundamentals in the value of A (which should represent the capacity or willingness to pay in case of default) and in its stochastic behavior. It does not model explicitly the effects of the fundamentals or of possible spillover effects.

In this paper we focus on spillover effects in the Brady bond market. A lot can be learnt from a careful analysis of these effects. As in the introduction, these are the question we will assess: Are there comovements (not due to international shocks) in the sovereign risk premium of different debtor countries? If there are, which is the nature and the dimension of these comovements? To what extent can a leader country like Mexico affect the risk perception on other debtor countries? Why should the developing country debt market be affected by these spillovers? And why should it be more affected than the industrial countries debt market? What can we learn on traders' behavior in the Brady bond market?

3. The data set

We will focus on the sovereign credit risk as measured by the *sovereign (stripped) spread*.[6] The sovereign spread is a measure that analysts use to assess the risk of a bond and it is given by the yield differential of a developing country bond with respect to an analogous (in terms of type of contract and maturity) US Treasury Bond, which is considered a riskless asset[7].

[6] Risk is often defined as the probability associated with a loss. In general risk can take many forms: credit risk (estimates potential losses due to the inability of the counterpart to meet its obligations), operational risk (results from the errors that can be made in instructing payments or settling transactions), liquidity risk (associated with the inability of the debtor to fund illiquid assets) and market risk (uncertainty of earnings resulting from changes in market conditions such as prices, interest rates, volatility).
For stocks and bonds in industrial countries the relevant risk usually is the *market risk*: the volatility of the prices measures the risk of holding a stock (which has no maturity), while expected changes in interest rates define the shape of the yield curve for bonds. For developing countries (as well as for all issuers with a low credit rating) the most important risk is the *credit risk*: this is because a sovereign country by definition cannot be legally forced to comply with its external commitments.

[7] To be rigorous the credit risk should be split into two parts: one is the probability of default and the other is the amount of loss in case of default. For example, it would be of interest to compute the internal rate of return (yield) on a bond based on what are the *expected payments* instead of the *contractual ones*. The differential to an analogous riskless asset would than be a proper measure to infer the probability of default. The authors that have attempted to differentiate between the two elements (i.e. the probability of default and the amount of loss in case of default), however, are forced to make strong assumptions on the probability of default and on the expected repayment in case of default. For example Cumby, R.E. and D.D. Evans (1993) assume that in case of default the repayments are zero forever. Claessens, S. and G. Pennacchi (1992) assume that the probability of default follows a Brownian motion . An interesting finding of Cumby and Evans (1993) though - on which we will return below - is that the hypothesis of an expected decreasing default probability is consistent with their data set (Brady bonds prices starting 1990 for Mexico, Venezuela and Costa Rica).

TABLE 1. Sample description.

Country[8]	Bond	Terms Announced	Issue Date	Maturity Date	Ratings[9]	Liquidity[10]
1) Argentina (18%)[11]	Pars	Apr 1992	4/07/93	3/31/23	B1, BB-	L1
	Discounts		4/07/93	3/31/23		L2+
2) Brazil (35%)	Pars (A, B)	Jul 1992	4/15/94	4/15/24	B1, B+	L1-
	Discounts (A, B)		4/15/94	4/15/24		L2
3) Mexico (19%)	Pars (A, B)	Jan 1990	3/28/90	12/31/19	Ba2, BB	L1
	Discounts (A, B, C, D)		3/28/90	12/31/19		L2+
4) Venezuela (12%)	Pars (A, B)	Jun 1990	12/18/90	3/31/20	Ba2, --	L1-
	Discounts		12/18/90	3/31/20		L3
5) Ecuador (1.8%)	Pars	May 1994	2/28/95	2/28/25	n.r., n.r.	L2
	Discounts		2/28/95	2/28/25		L2
6) Bulgaria (4%)	Discounts (A)	Mar 1994	7/28/94	7/28/24	n.r., n.r.	L2
7) Poland (6%)	Pars	Mar 1994	10/27/94	10/27/24	Baa3, BBB-	L2
	Discounts		10/27/94	10/27/24		L2+
8) Nigeria (0.9%)	Pars	Oct 1991	1/21/92	11/15/20	n.r., n.r.	L2
9) Philippines (3%)	Pars (B)	Feb 1992	12/01/92	12/01/17	Ba2, BB	L2-

[8] Up to now, the other Brady agreements are: Costa Rica (Terms announced: May 90, Issue date: 5/21/90), Uruguay (Terms announced: Nov 90, Issue date: 2/18/91), Jordan (Terms announced: Jan 93, Issue date: 12/23/93) and Dominican Republic (Terms announced: Aug 93, Issue date: 8/30/94).

[9] Moody's, Standard and Poor's respectively. The rating are as June 21, 1996. The following table summarizes the grade rank:

Investment grade		Speculative grade	
Moody	S&P	Moody	S&P
Aaa	AAA	Ba1	BB+
Aa1	AA+	Ba2	BB
Aa2	AA	Ba3	BB-
Aa3	AA-	B1	B+
A1	A+	B2	B
A2	A	B3	B-
A3	A-		
Baa1	BBB+		
Baa2	BBB		
Baa3	BBB-		

n.r. = not rated. Note: Baa1/BBB+ or below is the rating requirement designed by JPMorgan to define an "emerging market" in the context of external debt market. *Source*: JPMorgan, *Emerging Market Analytics*, June 21 1996.

[10] The liquidity rating for Brady bonds provided by JPMorgan is:

L1 Benchmark	Average bid/offer<3/8 and bond *quoted* by the *main brokers*.
L2 Active	Average bid/offer<3/4 and bond *quoted* by at least half of the *main brokers*.
L3 Traded	Average bid/offer<2 and bond *quoted* by at least one *main broker*.
L4 Mostly Illiquid	Average bid/offer<3 and bond *quoted* by at least one *main broker*.
L5 Illiquid	Bond rarely or never *quoted* by *main brokers*.

Note: A bond is considered *quoted* in categories L1, L2 and L3 if it is priced 75% of the time; it is considered quoted in category L4 if it is priced 25% of the time. The *main brokers* designed by JPMorgan are: Eurobrokers, Tullets, Tradition, Cantor, Chapdelaine and RMJ. *Source*: JPMorgan, *Introducing the Emerging Markets Bond Index Plus*. July 12, 1995.

[11] % of total amount outstanding in the Brady Market in parenthesis. *Source*: Merril Lynch, *The 1995 Guide to Brady Bonds*, 12/06/94.

The data set is summarized in Table 1 and figure 5. We took fifteen Par and Discount Brady bonds for nine major Brady agreements. The choice of bonds has been driven by criteria of liquidity (see the last column of the Table 1) and homogeneity.[12]

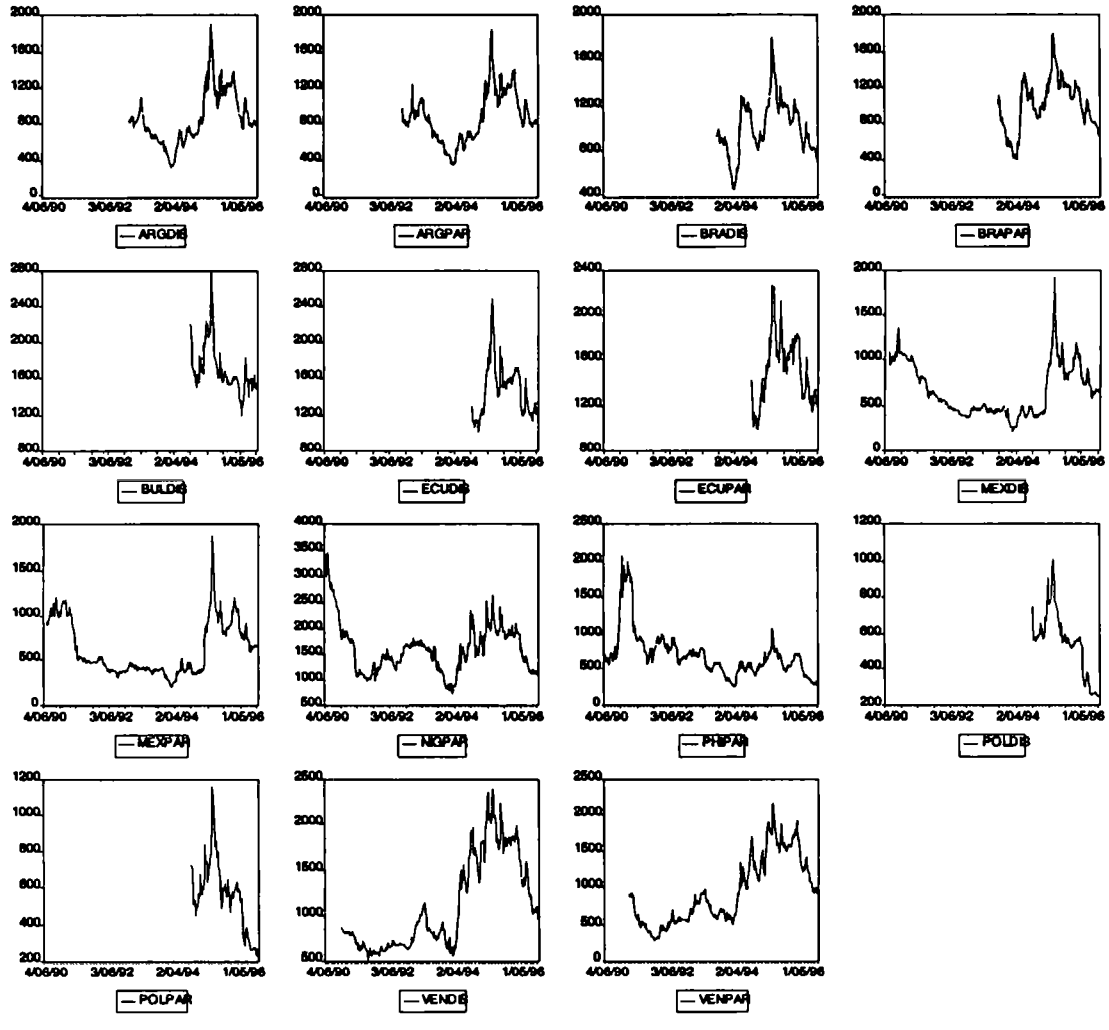

Figure 5

We concentrate on the *sovereign (stripped) spreads* for several reasons. First, we want to exclude the effects of changes in the (same maturity) US interest rates on yields comovements. Note that, if the solvency of a country is in doubt, an increase in the US interest rate can have an effect on the sovereign premium as well. But we would expect

[12] The data are provided by Salomon Brothers and are based on weekly (usually Wednesday) close of the day bid prices quoted in NY. We have data beginning on the week Salomon Brothers has started trading on the loans included in the Brady agreements, even though the bonds have been in all cases formally issued few months later. At this point we suggest to the reader not familiar with the Brady bond market to have a look at the Appendix.

this effect to be of second order and not homogeneous among the different countries of our sample. Moreover, the US interest rate has been much more smooth than the risk premiums over the period of our study, as figure 6 shows for Mexico and Poland.

Mexican and Polish Discount and Par Bonds, stripped spreads and US interest rate

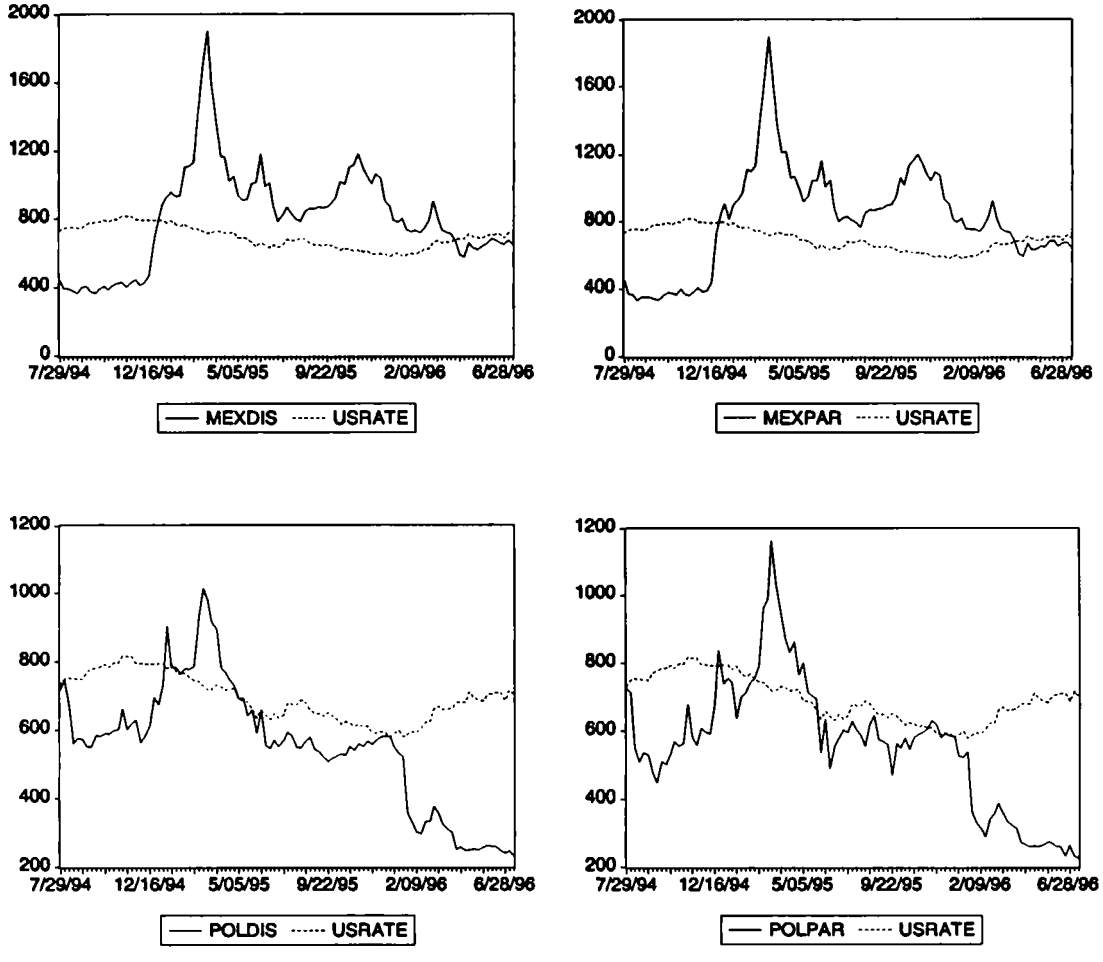

Figure 6

Second, even if the stripped spread is a rough measure of the country risk, we are in fact interested in cross-country comparisons. For us, it is more important to have a very homogeneous measure, as we believe it is the stripped spread on the most liquid Brady bonds.

Third, it would be ideal to have time series of the risk spread for given maturity instead of following the same bonds over time. However, the Brady market has not reached the dimension to make this possible. The point is that yields spreads may not provide a valid way of comparing the relative risks of bonds with different maturities. But the

maximum maturity difference for the Mexican Brady bonds is slightly more than 5 years (with the last Brady, Ecuador) over a period of 24 years. The effect of a different maturity is important for short maturities and it is a much less relevant factor over such a long time horizon.

4. Mexico and Poland

It is our opinion that the case of Mexico and Poland is the most suitable for the analysis of spillover effects in the Brady bond market: Mexico at the time of the crisis was a relatively stable country; Poland was stabilizing and had a relatively short record of economic reforms. The December 94 shock was substantial, but truly originating from the Mexican economy and in this sense it was exogenous to the Poland economy. This can be thought as a good approximation of an experiment: the Mexican fundamentals were dramatically changed while Poland's were not.

We will concentrate on the discount bonds: discount bonds are 30 years maturity floating market interest rate, issued at a discount to the original face value of the previously rescheduled loans. Because they are floating market interest rate, discount bonds do not involve market risk (the risk of a change in the interest rate), so that the measure of country risk given by the stripped spread on discount bonds is more accurate than the one given by the stripped spread on the Par bonds.

4.1 Univariate time series description

In this section we report the time series analysis on the variable MEXDIS (the stripped spread on the Mexican discount bonds (series A,B,C,D)), and on the variable POLDIS (the stripped spread on the Poland discount bonds). The goal is to have a preliminary understanding of the behavior of the stripped spread, that is the measure that traders use for the risk premium on a sovereign country bond. The main finding is that we cannot reject the null hypothesis of unit root for both variables, even if also a different (and stationary) model fits well the data.

i) *MEXDIS* (the sample goes from 5/18/90 to 7/12/94)

1) The first model is an AutoRegressive with four lags - AR(4) - with one unit. The Augmented Dickey-Fuller Test on the whole sample is -1.134891, so we do not reject the null of unit root even at a 10% confidence level.[13] An AR(4) with one unit root behaves like a random walk in the sense that the shocks have a permanent effect; in the case of the AR(4), the shocks are translated permanently into the variable after 4 periods. To decide on the model specification for the Augmented Dickey-Fuller (ADF) test for unit root, we performed an F test - the values are

[13] We reject the null of autocorrelation of the residuals based on the Breusch-Godfrey Serial Correlation LM Test.

tabulated in Dickey and Fuller (1981) - on the joint hypotheses of unit root with no drift and no trend. We cannot reject the null of unit root without drift and trend.

LS // Dependent Variable is MEXDIS
Sample: 6/15/90 - 7/12/96
Included observations: 318

Variable	Coefficient	Std. Error	T-Statistic	Prob.
MEXDIS(-1)	1.251215	0.055527	22.53350	0.0000
MEXDIS(-2)	-0.222751	0.088032	-2.530349	0.0119
MEXDIS(-3)	-0.193206	0.087332	-2.212301	0.0277
MEXDIS(-4)	0.159970	0.054736	2.922590	0.0037

R-squared	0.964241	Mean dependent var	657.8306
Adjusted R-squared	0.963899	S.D. dependent var	282.6279
S.E. of regression	53.69972	Akaike info criterion	7.979314
Sum squared resid	905469.2	Schwartz criterion	8.026636
Log likelihood	-1715.933	F-statistic	2822.343
Durbin-Watson stat	1.969546	Prob(F-statistic)	0.000000

This model is, in our opinion, consistent with the nature of the variable we are studying: it would be difficult to argue that the stripped spread should have a drift and/or a trend. On the other hand, the finding of unit root is consistent with the hypothesis that there is a learning process underlying risk premium movements: we can think of a shock as new information accruing between one period and the following; based on the new information traders update their prior on the probability of default, and set the risk premium based on the posterior probability. So the new information affects permanently the risk premium and its mean value. This is a layman's explanation of a unit root.[14]

[14] While the evidence of one unit root - we tested also the possibility of more than one unit root using the procedure proposed by Dikey and Pantula (1987); the null of two unit root is rejected - is strong on the complete sample, we wanted to check if the December 1994 crises represent a structural break that can cause a bias in our estimate of the unit root. We divided the sample in two (4/06/90 to 12/16/94 and 12/23/94 to 7/12/96) and performed unit root test on the two sub-samples. For the first sub-period, using F tests as tabulated by Dikey and Fuller (1981), we could not reject (at the 5% confidence level) the null of one unit root with no drift and no trend. If we maintain our hypothesis of no drift and no time trend, there is strong evidence of unit root also for the second sub-period. However, we performed an F test on the joint hypothesis of unit root with no drift and no trend and we rejected it. An ADF with drift and trend leads to rejection of unit root at the 5% critical level - but to not rejection at the 1% critical level .

In conclusion, the hypothesis of unit root is strong on the complete sample. On the two sub-samples it is less strong. But under the hypothesis of no drift and no trend, in both cases we could not reject (at the 5% critical value) the null of unit root.

To gain more information on the possibility of unit root, we constructed two dummy variables: one (*d1*) takes value one after 12/16/94 and zero before that date; the other (*dp*) takes value one for (the four observations of) the month of December 1994 and zero otherwise. We regress MEXDIS on four lags of itself and on *d1*; in a second regression we regress MEXDIS on the same four lags and on *dp*. The idea is that, if the true model is a stationary process with a structural change in the mean after December 1994, *d1* should be significant. But it is not. While, if the true model is non stationary and there is a one time extra-shock in a unit root process (a single *pulse* in the dummy variable will have a permanent effect on the mean value of the sequence), *dp* should be significant. In fact it is.

2) The second model assumes that the variable is stationary with a change in the mean after 12/16/94. This is suggested by inspection of the plot of MEXDIS. The variable can be described by a decreasing trend with a change in the constant after the December crisis. We estimated the following model, where the dummy *d1* takes value one after 12/16/94 and zero before that date:

$$MEXDIS = c + \alpha t + \beta d1 + \sum_{i=1}^{4} \gamma_i \, MEXDIS(-i) \qquad (2)$$

The results are:

LS // Dependent Variable is MEXDIS
Sample: 6/15/90 - 7/12/96
Included observations: 318

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	78.52782	19.52125	4.022684	0.0001
T	-0.253105	0.075648	-3.345822	0.0009
D1	72.04601	18.44906	3.905132	0.0001
MEXDIS(-1)	1.186698	0.056149	21.13472	0.0000
MEXDIS(-2)	-0.204627	0.085975	-2.380075	0.0179
MEXDIS(-3)	-0.185268	0.085210	-2.174256	0.0304
MEXDIS(-4)	0.118871	0.054331	2.187901	0.0294

R-squared	0.966303	Mean dependent var	657.8306
Adjusted R-squared	0.965653	S.D. dependent var	282.6279
S.E. of regression	52.37935	Akaike info criterion	7.938791
Sum squared resid	853258.4	Schwartz criterion	8.021604
Log likelihood	-1706.490	F-statistic	1486.385
Durbin-Watson stat	1.971090	Prob(F-statistic)	0.000000

The drift, the trend and the dummy *d1* are very significant. An ADF based on this model suggests the rejection of the null of unit root.[15]

ii) ***POLDIS*** (sample: 7/29/94 to 7/12/96).

1) The first model is a simple random walk, that is an AR(1) with one unit root. The evidence for unit root is very strong.[16] The value of the Dickey-Fuller Test Statistic is -1.264866, while the 10% critical value is -1.6174.

[15] In order to perform a proper test, we split the sample as before: 4/06/90 to 12/16/94 and 12/23/94 to 7/12/96. For the first sub-period the drift and the trend are not significant and there is strong evidence of unit root. For the second period, drift and trend are significant and we can reject the null of unit root at the 5% critical level.

[16] The evidence of unit root is maintained if we split the sample at 12/16/94 as for MEXDIS.

LS // Dependent Variable is POLDIS
Sample: 8/05/94 - 7/12/96
Included observations: 102

Variable	Coefficient	Std. Error	T-Statistic	Prob.
POLDIS(-1)	0.990426	0.007569	130.8552	0.0000

R-squared	0.941135	Mean dependent var	551.8529
Adjusted R-squared	0.941135	S.D. dependent var	184.4645
S.E. of regression	44.75499	Akaike info criterion	7.612161
Sum squared resid	202303.9	Schwartz criterion	7.637896
Log likelihood	-531.9520	Durbin-Watson stat	2.008243

2) The second model is similar to the second one for MEXDIS:

$$POLDIS = c + \alpha t + \beta\, d1 + \gamma\, POLDIS(-1) \qquad (3)$$

The results are:

LS // Dependent Variable is POLDIS
Sample: 8/05/94 7/12/96
Included observations: 102

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	504.6681	127.1812	3.968103	0.0001
T	-1.665897	0.419320	-3.972849	0.0001
D1	75.10052	21.39856	3.509606	0.0007
POLDIS(-1)	0.802494	0.050719	15.82226	0.0000

R-squared	0.949392	Mean dependent var	551.8529
Adjusted R-squared	0.947843	S.D. dependent var	184.4645
S.E. of regression	42.12772	Akaike info criterion	7.519838
Sum squared resid	173925.0	Schwartz criterion	7.622778
Log likelihood	-524.2435	F-statistic	612.8235
Durbin-Watson stat	1.960488	Prob(F-statistic)	0.000000

where *d1* is defined as above (dummy with ones after 12/16/94). An ADF on the complete sample based on this model (i.e. with drift and trend) suggests the rejection of the null of unit root at the 5%.[17]

[17] In order to perform a proper ADF test, we split the sample as above: 7/29/94 to 12/16/94 and 12/23/94 to 7/12/96. For the first period we cannot reject the null of unit root even at the 10% level. For the second period, we reject the null of unit root at the 5% critical level.

Conclusions. The results for POLDIS are very similar to the ones for MEXDIS: the same two models fit the data well, with strong evidence of unit root in the first sub-period (before the crisis) and evidence of a possible stationary negative trend after December 1994. The fact that these two series behave in this similar way is in itself a result. However, in our opinion the unit root hypothesis is better supported by the evidence. The two main reasons are the following.

First, under the assumption of no drift and no trend, which seems reasonable for the risk premium, the hypothesis of unit root cannot be rejected on the whole sample and on the two sub-samples as well for both MEXDIS and POLDIS. Under the assumption of drift and trend, the fit is good on the complete sample; but for both MEXDIS and POLDIS in the first sub-period the drift and the trend are not significant and the null of unit root cannot be rejected. This is a strong evidence in favor of the hypothesis of unit root.

Second, the trend stationary model is very dependent on the date on which we decide there is a change in the constant (i.e. after which date the dummy begins to have value 1). The 16 of December 1994 is a reasonable choice, but we could make other choices as well (e.g. for Poland a reasonable choice could be the date in which the country received investment grade rating). There is no evidence of a structural break in data generating process on the 16 of December 1994 and so the dummy *d1* is not needed. The dummy *d1* is simply capturing the effect of a shock bigger than others, which - as the others - has a permanent effect.

Our interpretation of the unit root evidence is the following: traders update their priors on the default probability as new information accrues, and the new information can be interpreted as the shock. For the variable POLDIS we cannot reject the hypothesis of a random walk, that is a process in which the error term is a white noise. For MEXDIS we find an AR(4) with unit root, which means that the news have a permanent effect (with a lag of four weeks) and that the process has memory: the value of the risk premium at time *t* depends on four lags of itself and on a white noise residual.

Is this interpretation of POLDIS and MEXDIS consistent with the evidence of a possible negative trend after December 94? Is this just the consequence of a sequence of good shocks after a big bad one, or it is a process showing mean reversion from a high level of the risk premium? It is evident that, while in principle the risk premium can go to infinitum[18], it is in effect bounded from above. A very high risk premium (like the almost 2000 basis point on the Mexican bonds in December 1994) is not sustainable even in the very short term: a country in a period of crisis - like Mexico in December 1994 - can either go on default (which corresponds to an infinite risk premium) or be rescued by an international support package. This is why we find possible evidence of mean reversion after the

[18] This implicitly happened on December 27 1994, when the Tesobono auction was canceled because the risk premium asked by the investors was not acceptable to the Mexican authorities.

Mexican crisis. But when we are not close to this threshold level, the behavior of the risk premium is very much like a random walk.

In conclusion, we find the unit root model for the stripped spread more consistent with the data, as argued above. The results are consistent also with our opinion that a proper model for the risk premium cannot have a drift and/or a trend, which would imply a divergent behavior in the long run. The autoregressive model without dummy gives a way to model all the variables in a symmetric way, without relying on our discretion to decide which shock can be thought as a change in the mean of an otherwise stationary process.

4.2 Comovement analysis

The main finding of the previous section is that we cannot reject the null of one unit root on MEXDIS and POLDIS. With non stationary time series the standard asymptotic theory does not hold and OLS estimates can be misleading. Engle and Granger (1987) introduced the concept of *cointegration*: a group of non-stationary time series is cointegrated if there is a linear combination of them that is stationary; the parameters of the linear combination are called the *cointegrating vector*. If two or more variables are cointegrated, the cointegrating vector can be "super-consistently" estimated by OLS. Usually the cointegrating equation is interpreted as a long run equilibrium relationship.

A very useful way to understand cointegration relationships is the Stock and Watson's (1988) observation that cointegrated variables share common stochastic trends (i.e. random walk components). A unit root process can be decomposed into a random walk plus a stationary (but not necessarily white noise) component. Hence, a linear combination of two non-stationary variables is stationary if and only if the random walk components are the same (up to a multiplicative scalar) for both variables. Therefore, we interpret cointegration not only as a "measure" for comovements, but also as a test for the hypothesis that different variables share the same innovation (random walk) process.

To begin our analysis on the comovements of MEXDIS and POLDIS, let us consider figure 7, which plots the difference (DIFF) between the two variables MEXDIS and POLDIS. The variable DIFF looks stationary with a shift in the mean from -200 bs.pts. to +350 bs.pts. *after* the Mexican crisis of December 1994. A preliminary estimate of the cointegration relationship is obtained regressing MEXDIS on: a constant, POLDIS and the dummy *d2* (dummy with ones after 1/20/95, i.e. after the US support package was announced on 1/12/95):

LS // Dependent Variable is MEXDIS
Sample: 7/29/94 - 7/12/96
Included observations: 103

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	-207.4990	49.24584	-4.213533	0.0001
D2	554.0909	28.96765	19.12792	0.0000
POLDIS	1.080204	0.067715	15.95221	0.0000

R-squared	0.834172	Mean dependent var	809.9767
Adjusted R-squared	0.830855	S.D. dependent var	297.5443
S.E. of regression	122.3717	Akaike info criterion	9.642820
Sum squared resid	1497483.	Schwartz criterion	9.719560
Log likelihood	-639.7559	F-statistic	251.5167
Durbin-Watson stat	0.451944	Prob(F-statistic)	0.000000

All variables are very significant and the estimated coefficient of *d2*, 550, shows the dramatic change in the mean of the relation after 1/20/95. Thus, we generated the variables MEXDIS1=MEXDIS-550**d2* and DIFF1=MEXDIS1-POLDIS to perform tests of cointegration. The idea is that, except for a change in the mean of the relation, the two variables are cointegrated, i.e. have the same random walk component. As we will discuss in section 5, the change in the mean of the relation can be interpreted as the change in the relation between Mexico's and Poland's fundamentals induced by the Mexican crisis.

To test properly for cointegration, we consider the following Error Correction Model (ECM)[19]:

$$\begin{aligned}\Delta MEXDIS1_t &= \alpha_M (c + MEXDIS1_{t-1} + \beta\, POLDIS_{t-1}) + \delta_M \Delta MEXDIS1_{t-1} + \gamma_M \Delta POLDIS_{t-1} + \varepsilon_{Mt} \\ \Delta POLDIS_t &= \alpha_P (c + MEXDIS1_{t-1} + \beta\, POLDIS_{t-1}) + \delta_P \Delta MEXDIS1_{t-1} + \gamma_P \Delta POLDIS_{t-1} + \varepsilon_{Pt}\end{aligned} \qquad (4)$$

[19] In order to test for cointegration and to have a proper estimate of the cointegration vector we have to specify an error-correction model (ECM). This is because cointegration tests are usually performed on the error-correction representation. Note that, if two or more variables are cointegrated, it is guaranteed that an error-correction model representation exists. This is the so called *Granger representation theorem*: for any set of *I(1)* variables, cointegration and error-correction are equivalent representations. Moreover, the most common procedure to test for the lag length is to estimate a Vector Auto Regression (VAR) using data in *levels*. We consider VARs with 2 or more lags: the VAR with one lag presents evidence of autocorrelation in the . The Akaike Information Criterion suggests a specification with 2 lags and the Chi test suggested by Sims (1980) does not reject the null of a lag length of 2 versus 3 or more lags .

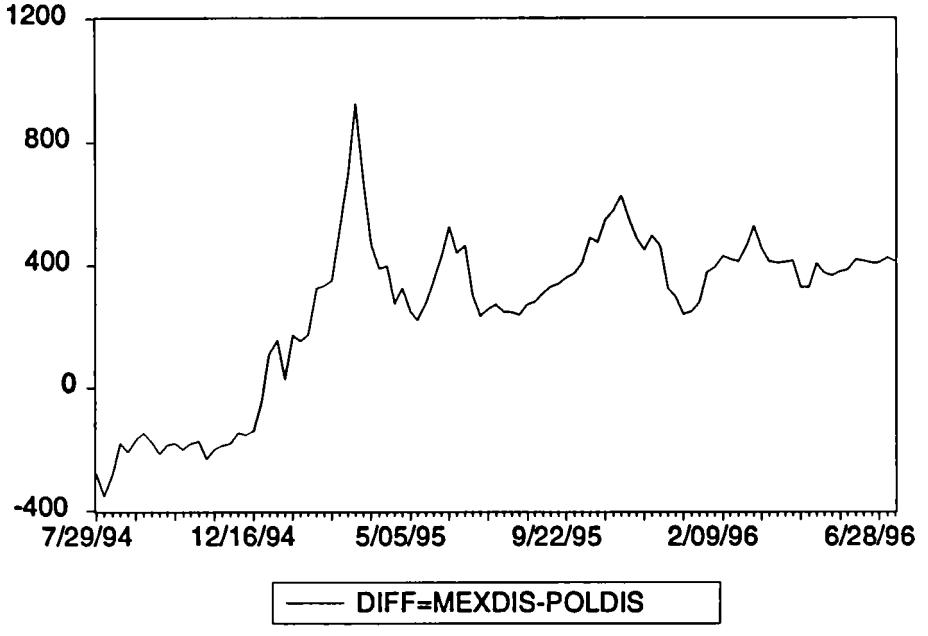

Figure 7

The Johansen Cointegration Test is reported below:

Sample: 7/29/94 - 7/12/96
Included observations: 101
Test assumption: No deterministic trend in the data
Series: MEXDIS1 POLDIS
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.259056	32.22498	19.96	24.60	None
0.019045	1.942089	9.24	12.97	At most 1

L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

MEXDIS1	POLDIS	C
0.000880	-0.000924	0.152483
-5.53E-05	-0.000259	0.084977

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

MEXDIS1	POLDIS	C
1.000000	-1.050131	173.3165
	(0.10657)	(62.6566)

(Log likelihood -1273.927)

The cointegration hypothesis is not rejected even at 1% critical level.[20] Moreover, we cannot reject the null that the (normalized) cointegration vector is (1, -1), which implies that the series have exactly the same random walk (stochastic trend) component.

Next, we split the sample (two years from 7/29/94 to 7/12/96) in two: the first sub-sample goes from 7/29/94 to 7/28/95 (51 observations) and includes the period of the Mexican crisis; the second one goes from 7/28/95 to 7/12/96 (51 observations). We report below the results for the cointegration tests on the two sub-samples.

1) First sub-period (7/29/94 to 7/28/95):

Sample: 7/29/94 - 7/28/95
Included observations: 51
Test assumption: No deterministic trend in the data
Series: MEXDIS1 POLDIS
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.343390	24.04490	19.96	24.60	None
0.049535	2.590984	9.24	12.97	At most 1

L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

MEXDIS1	POLDIS	C
0.001156	-0.001715	0.561364
-1.78E-05	0.001175	-0.757838

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

MEXDIS1	POLDIS	C
1.000000	-1.483337	485.6730
	(0.19940)	(138.440)

(Log likelihood -628.7797)

[20] Note that we performed the tests for the lag length on a VAR in levels. The ECM is specified in first differences, so the lag length should be reduced by one.

2) Second sub-period (7/28/95 to 7/12/96):

Sample: 7/28/95 - 7/12/96
Included observations: 51
Test assumption: No deterministic trend in the data
Series: MEXDIS1 POLDIS
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.185747	11.99515	19.96	24.60	None
0.029278	1.515477	9.24	12.97	At most 1

L.R. rejects any cointegration at 5% significance level

Unnormalized Cointegrating Coefficients:

MEXDIS1	POLDIS	C
0.001493	-0.001499	0.176611
-0.000671	7.73E-05	0.044013

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

MEXDIS1	POLDIS	C
1.000000	-1.003506	118.2626
	(0.20818)	(93.4870)

(Log likelihood -558.2001)

The null hypothesis of cointegration is not rejected in the first sub-sample, but it is rejected on the second one. Note also that, for the first sub-sample, the estimated coefficient on POLDIS is significantly greater than one.[21]

We can reach two main conclusions from these results:

1) First, *comovements were stronger during the high volatility period of the Mexican crisis.* In fact, we reject the null hypothesis of cointegration for the last year, when the crisis was perceived as overcome.

2) Second, the Mexican crisis has caused a change in the mean of the cointegration relation of approximately 550 bs.pts.. That is, *the crisis has had a strong permanent effect on the risk assessment on Mexico.*

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[21] To confirm the results, we perform the cointegration test on the original variable MEXDIS (instead of MEXDIS1). The results of the cointegration tests for the two sub-periods - from 1/20/95 to 7/12/96 (78 observations), and from 7/28/95 to 7/12/96 (51 observations) - confirm that there is strong evidence of cointegration on the whole sample, while the variables are not cointegrated for the period 7/29/94 to 7/12/96 (the last year).

We study next the properties of the ECM on different sample periods in order to answer the following questions: Can we quantify the response of POLDIS to a shock to MEXDIS? To which extent the volatility of POLDIS is due to the volatility of MEXDIS?

These questions can be answered through what is generally referred to as *innovation accounting*, i.e. the *impulse response function* and the *forecast error variance decomposition*. The impulse response function uses the estimated parameters of the model to trace out the effects of one standard deviation (SD) change in the errors on the time path of MEXDIS and POLDIS sequences; the forecast error variance decomposition uses the estimated parameters and indicates the proportion of the forecast errors on a variable which is due to its own shocks (residuals) as opposed to shocks (residuals) to the other variable.[22]

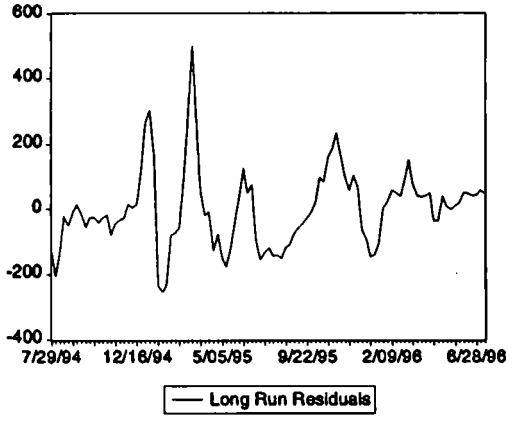

Figure 8

The impulse response function in figure 9 shows that: 1) a one standard deviation innovation to MEXDIS1 (the SD of the residuals on MEXDIS1 being of 91 bs. pts.) has a permanent effect of *36 bs. pts* on MEXDIS1 and of *35 bs. pts.* on POLDIS; 2) a one standard deviation innovation to POLDIS (the SD of the residuals on POLDIS being of 44 bs. pts.) has a permanent effect of *29 bs. pts.* on MEXDIS1 and of *27 bs. pts.* on POLDIS. We can conclude that a

[22] The only problem with this methodology is that an estimated VAR is underidentified: an additional restriction must be imposed on the two variable VAR system in order to identify the impulse responses and variance decomposition. The usual restriction is given by the assumption that one error has a contemporaneous effect on both variables, while the other one has a contemporaneous effect only on its own variable. This assumption is said to imply an *ordering* of the variables.

We assume that ε_{Mt} has a contemporaneous effect on both variables, while ε_{Pt} does not. This is not an innocuous assumption: the correlation coefficient on the estimated residuals is above 0.7, so the ordering matters. Our assumption is based on several considerations. The first one is that, at least for the first year of our sample (when the evidence of cointegration is stronger), all the relevant volatility was coming from the news on Mexico and not on Poland. Second, we regressed the residuals from the cointegration relation (the "long run" residuals, LRER in figure 8) on the standard deviation of MEXDIS (MSIG) and on the standard deviation of POLDIS (PSIG): not only MSIG is more significant than PSIG and with the right sign, but the negative sign of PSIG suggests that the volatility of MEXDIS dominates. Finally, and consistently with our belief that Mexico is a leader in the Brady market, the IMF (1995) finds evidence of Granger causality from Mexico to other countries using daily bond prices.

shock to MEXDIS1 has a stronger permanent effect on both variables than a shock to POLDIS (even though the residuals on MEXDIS1 are more volatile).

From the analysis of the *impulse response function* we can reach another important conclusion: on the basis of the estimated coefficients of the Vector Error Correction model, a one standard deviation innovation to MEXDIS has a permanent effect on POLDIS of 35 bs. pts. (out of 91 bs. pts.) or of 44 bs. pts. (out of 118 bs. pts.) depending on the sample period - in both cases 38% of a shock to MEXDIS has a permanent effect on POLDIS.

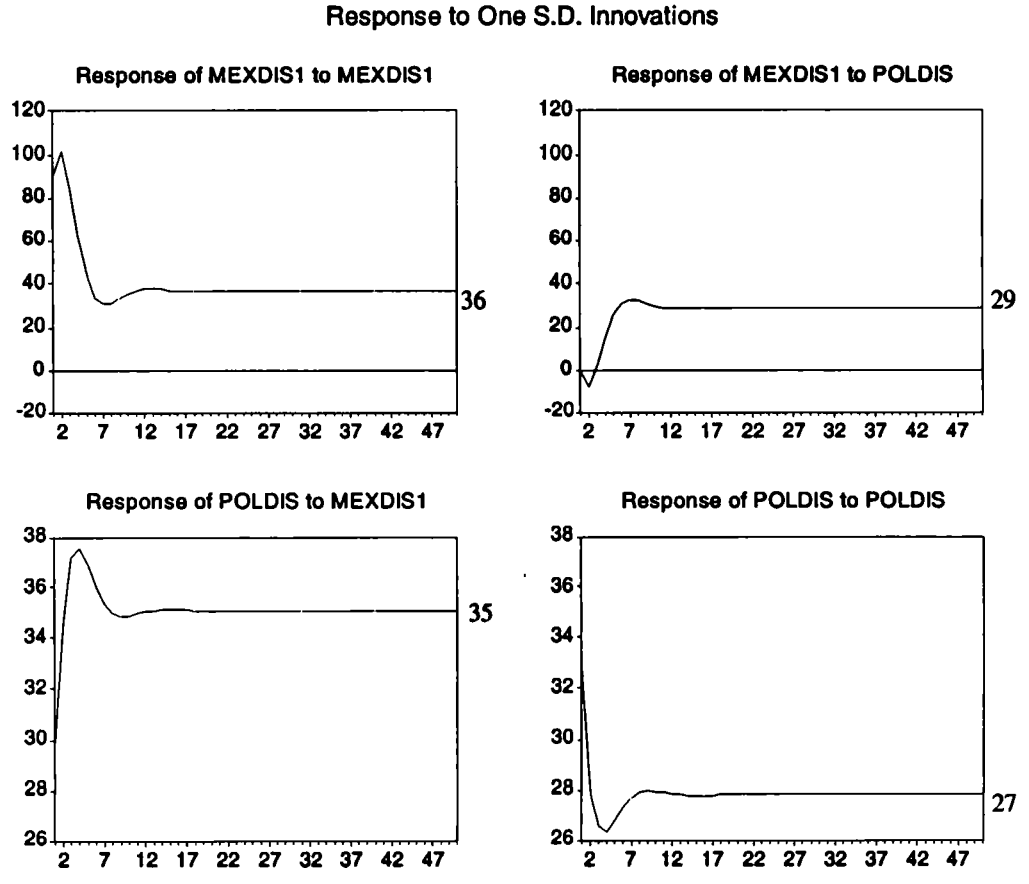

Figure 9

The forecast error variance decomposition reported in figure 10 shows that: 1) the long run forecast error on MEXDIS1 is due for *70%* to innovations to MEXDIS1 and for *30%* to innovations to POLDIS; 2) the long run forecast error on POLDIS is due for *61%* to innovations to MEXDIS1 and for the remaining *39%* to innovations to

POLDIS. We note a significant asymmetry in the behavior of the two variables, with *61%* of the variability of POLDIS coming from the variability of MEXDIS1.[23]

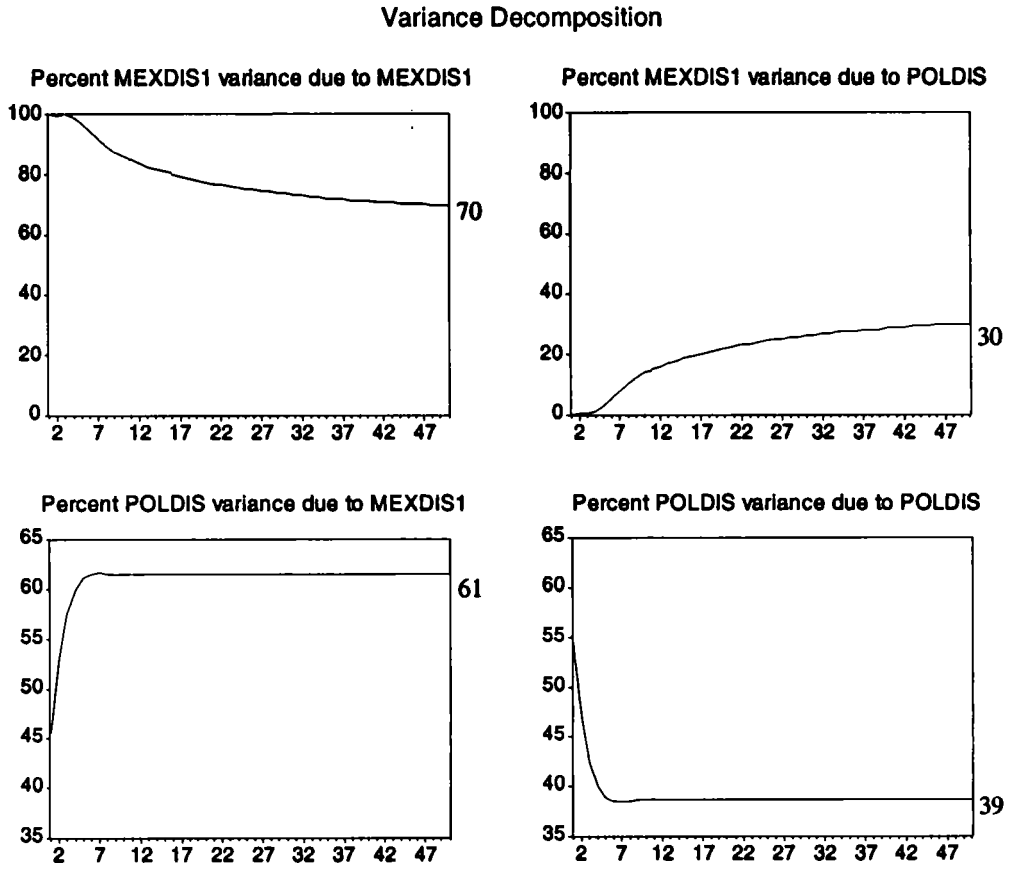

Figure 10

In the following section we present our interpretation of the empirical evidence reported so far. In particular, we introduce *learning spillovers* as a potential explanation of the link between the sovereign risk premia of different countries. But at this stage we also want to stress how strong these links are: on the basis of our estimates, 38% of a shock to MEXDIS has a permanent effect on POLDIS; in section 6 we will report that the volatility increased for most bonds two to four times after the Mexican crisis. Therefore, in what follows, we maintain the implicit assumption that *learning spillover* effects cannot *by itself* explain such excessive responses.

[23] We have estimated the ECM for MEXDIS1 and POLDIS on the period 7/29/94 to 7/28/95, i.e. the period comprising the Mexican crisis and during which the comovements are stronger. The results are confirmed: in particular, the variability of POLDIS is now even more dependent on the variability of MEXDIS1 (68% versus 61%) and the amount of the permanent effect on MEXDIS1 due to innovations on both variables has increased relative to the increase in the standard deviations of the residuals (the permanent relative response to MEXDIS1 innovations has shifted from 0.4 to 0.55, whereas the permanent relative response to POLDIS innovations has shifted from 0.66 to 0.82). Finally, the ECM estimates for MEXDIS (instead of MEXDIS1) and POLDIS for the sample 1/20/95-7/12/96 are substantially the same.

5. What causes the spillover effect?

It is reasonable to assume that traders' investment decisions are based essentially on two elements: their private information on fundamentals; and the behavior of other traders. The private information on fundamentals provides traders with a belief on the probability of default of a debtor country. The behavior of other traders is important not only because it conveys some additional information, but also because traders' reputations (in the labor market) are based both on their success in terms of profitable investments *and* on whether their decisions were similar to or different from those of other traders.[24] In this section we argue that this two elements can explain spillover effects.[25]

Private information on fundamentals is the leading force behind an investment decision *and* assume that news on a particular *developing* country conveys some information on other *developing* countries.[26] This could be due, for example, to the fact that different countries are applying reform programs - like Brady plans - that are perceived as similar. Thus, the Mexican crisis can be a signal that the Brady plan on Mexico is not feasible or that the Mexican government finds the commitment to the plan not rewarding enough. Therefore, we might think that also the Brady plan for Poland is not feasible or that Polish government may not have enough incentive to abide to the Brady plan.

At this point an important aside is in order to understand why we introduce the hypothesis of *learning spillover* and do not consider the possibility that comovements were due simply to similar movements in fundamentals. Assume that the probability of default $(1-\pi)$ is a function of fundamentals "observable" Z_{obs} (as budget deficit, exchange rate, etc.) and fundamentals "not-observable" $Z_{not\text{-}obs}$ (as the government commitment to the reform program or the feasibility of the program itself), that is: $(1-\pi) = f(Z_{obs}, Z_{not-obs})$. The Mexican crisis has substantially changed Z_{obs} for Mexico, but not for other countries as Poland. Therefore, the jump in the probability of default and thus in the risk premium cannot be due to a change in Z_{obs} for the Brady countries other than Mexico; it has to come from the change in $Z_{not\text{-}obs}$. This effect trough $Z_{not\text{-}obs}$ is what we define as *learning spillover.*

The interesting point in analyzing the period of the Mexican crisis is that we can assume Z_{obs} didn't change for all countries except Mexico and it cannot be argued that comovements were due to a similar change in observable fundamentals. As an example on Mexico and Poland, let's consider the exchange rate: the Polish currency (the zloty) appreciated in real terms during the Spring of 1995. Moreover, the change in the mean of the cointegrating relation

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[24] Scharfstein and Stein (1990) argue that "Under certain circumstances, (fund) managers simply mimic the investment decisions of others managers, ignoring substantive private information. Although this behavior is inefficient from a social standpoint, it can be rational from the perspective of managers who are concerned about their reputation in the labor market."

[25] It is our opinion that the explanations of spillover effects in the Brady bond market based on trade agreements or technological spillovers can not account for the very short period spillovers of the Brady bond market.
Institutional factors concerning the structure of big funds could be another explanation. An emerging market fund, for instance, could expect a higher amount of redemptions following a large adverse shock (as the Mexican crisis) and could sell off assets in several emerging market to generate cash. This story, though, does not explain why the fund manager should prefer to sell off the assets instead of rising cash trough borrowing.

[26] The information available on a country and the experience in that country's market are usually much less for developing and middle income countries than for industrialized ones. In our opinion this is the reason why spillover effects are not relevant for developed countries.

between Mexico and Poland discussed in section 4 is consistent with the hypothesis that the Mexican crisis changed the relation between the fundamentals of Mexico and Poland. Finally, the fact that the null of cointegration for the second year of our sample (July 95-July 96) is rejected proves that comovements during the Mexican crisis were not due to similar fundamentals.

The behavior of other traders is another leading force in investment decisions. Scharfstein and Stein (1990) argue that this is the case because traders are concerned about their reputation in the labor market. If a trader decides to 'go against' the market, his or her reputation is much more damaged by under-performing than it is strengthened by over-performing: *"...smart managers tend to receive correlated signals (since they are all observing a piece of the same "truth"), while dumb ones do not (they simply observe uncorrelated noise). Consequently, if one manager mimics the behavior of others, this suggests to the labor market that he has received a signal that is correlated with theirs, and is more likely to be smart. In contrast, a manager who takes a contrarian position is perceived as more likely to be dumb, all else being equal."*[27] Thus traders face an asymmetry in investment decisions which leads them to follow the herd.

Note that *herd behavior* is an explanation for *excess price volatility*: *" By mimicking the behavior of others (i.e., buying when others are buying, and selling when others are selling) rather than responding to their private information, members of a herd will tend to amplify exogenous stock price shocks."*[28] But herd behavior is not by itself an explanation of spillover effects. Herd behavior implies that traders tend to hold the same portfolio and tend to follow the same asset allocation strategy, but does not explain which this portfolio or asset composition is. In particular, it does not explain why a shock on Mexico should lead to a reduction of the exposure on Poland.

It is our opinion that *learning spillovers* and *herd behavior* are complementary in the explanation of spillover effects: a negative shock can be a source of spillover effects and also cause an increase in traders' *expected volatility*; higher *expected volatility* leads to herd behavior, which in turn amplifies the original spillover effects and increases *actual volatility*.

Why should a negative shock increase traders' *expected volatility*? To understand this point define $(1-\pi)$ the probability of default and consider an asset that has zero return in case of default and has x as return in case of no default; the variance of this asset can be written as $x^2\left[\pi\ (1-\pi)\ \right]$, which is a parabola with a maximum for $\pi=1/2$.[29] Therefore, a negative shock that shifts the probability of default toward middle values (for example from .1

[27] Scharfstein and Stein (1990), page 466.
[28] Scharfstein and Stein (1990), page 477.
[29] The assumption of two possible outcomes(default or not) is simplifying but not simplistic. The general case would be to consider the entire distribution of returns. This distribution, though, would have two mass points: one at the return in case of no default and one at the expected return given the default . So we would have a bimodal distribution.

to .3, i.e. closer to the value $\pi=1/2$ for which the *expected volatility* is at the maximum)[30] causes an increase in the *expected volatility* of returns.

Higher *expected volatility* means that traders are more uncertain on bonds' return and face the possibility of big losses: uncertainty on returns and possibility of big losses increase herd behavior and *actual volatility*. Therefore, *actual volatility* is an increasing and monotone function of *expected volatility* and it can be represented as $\sigma(\pi)$ in figure 11.

The fact that comovements of the risk premium were stronger during the high volatility period of the Mexican crisis is consistent with the idea that during *periods of high uncertainty* (defined as periods when the probability of default move towards 1/2 - and news have a very informative content, i.e. lead to a relevant update of the prior belief - so that the *expected volatility* of returns is high) herd behavior is stronger than during *periods of relative calm* (defined a periods during which the probability of default is close to the extremes - and news do not have a very informative content, i.e. do not lead to a relevant update of the prior belief - so that the *expected volatility* of returns is low).

However, another element could lead to excess volatility. We know that the risk premium reflects mainly the probability of default of a sovereign country. A negative shock which substantially shifts the probability of default towards middle values, will lead to lower prices and also increase the *expected volatility* of returns. Risk averse agents will require a premium for this increase in the *expected volatility* of returns, and the price of the bond will further decrease. Thus, if agents are risk averse, a bad news will depress prices more than the expected value of returns, thereby increasing the *actual volatility* of the risk premium.

Both herd behavior and risk aversion lead to excess volatility in response to a negative shock. Which of the two is more relevant is an empirical question. Our belief is that the risk (aversion) premium cannot account for increases in volatility of 100 to 200 bs. pts. as we observed during the Mexican crisis. For our purposes it is important that both mechanisms lead to excess volatility following a negative shock that moves the probability of default toward 1/2, thus amplifying the 'spillover effects'. Moreover, both mechanisms imply that *expected volatility* and *actual volatility* are positively correlated and that both reach a maximum for values of the probability of default close to 1/2. Figure 11 summarizes our argument. It represents also the mean of the risk premium μ as a function of the probability of default ($1-\pi$), which is convex for the following reason: define the risk premium as *RP* and *r* the US interest rate; arbitrage condition implies that $(1-\pi)0+\pi(RP+r)=r$, from which $RP=(r/\pi)-r$. Note also that $RP=0$ when $\pi=1$.

[30] Cumby and Evans (1993) estimate a probability of default well below 10% for Mexico and Venezuela (below 15% for Costa Rica) over the period 12/90-12/92. Thus it seems appropriate to assume in our arguments that the probability of default was, before the crisis, close to the lower bound of 0.

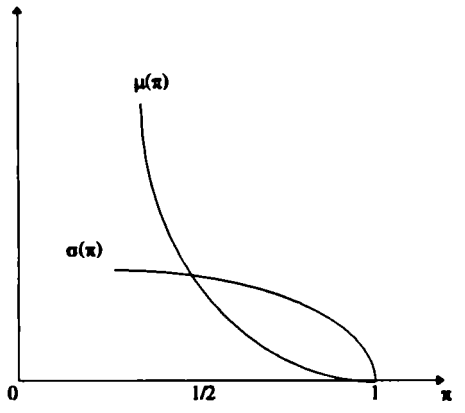

Figure 11

From figure 11 we can derive three important implications which will be tested in the next section:

1) first, the concavity of the volatility with respect to the probability of default implies that, during periods of crisis in which the probability of default for all countries moves towards 1/2, we should observe a convergence in the levels of volatility: countries with low volatility - low probability of default - should have an absolute and relative increase in volatility higher than countries with high volatility - probability of default close to 1/2.

2) second, the mean and the volatility of the risk premium should have a positive (and concave) relation on the relevant range (the relevant range is for the probability of default between zero and 1/2).

3) third, the volatility should be concave when plotted against the probability of default.

Finally, we have found no evidence of comovements in the aftermath of the Mexican crisis, which can be considered a *period of relative calm*. In fact, in periods of relative calm there is not much room for learning spillovers and, even if there is herd behavior on single assets, this cannot by itself cause *co*-movements.

6. How did other countries respond to the crisis?

In this section we will test our interpretation on the bonds of the other countries in our sample: Argentina, Brazil, Ecuador, Venezuela, Bulgaria, Nigeria, Philippines. We will not perform cointegration tests for all countries and for different periods. The case of Mexico and Poland has been informative enough on the unit root and cointegration hypothesis. In this section we will: 1) look at how the risk premium of the other countries in our sample responded to the *Mexican crisis*; 2) test, on a cross-country basis, the three implications we have derived from figure 11.

1) Figures 12-15 report the plots of the risk premium for the South American countries and Nigeria on the period of the Mexican crisis (7/29/94 to 7/28/95)[31]: the plots show that all five countries had a significant response to the crisis. Moreover, NIGPAR is affected by the peaks of MEXPAR but it follows a much more volatile path, and it has a behavior very similar to VENPAR.

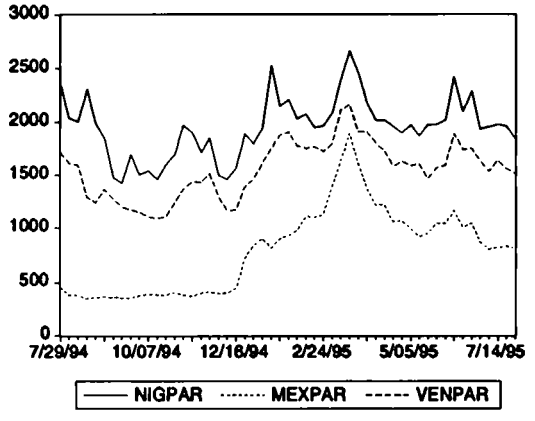

Figure 12

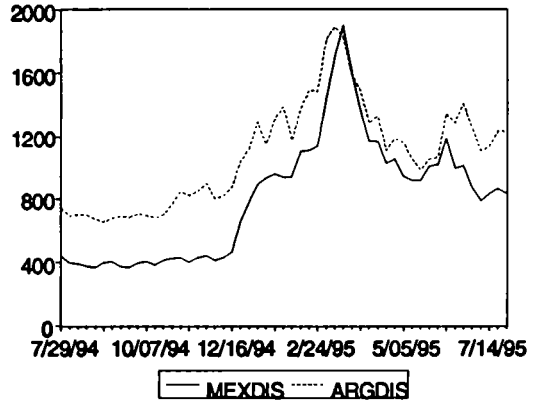

Figure 13

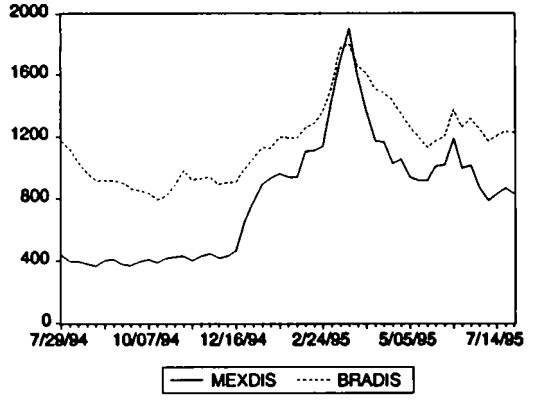

Figure 14

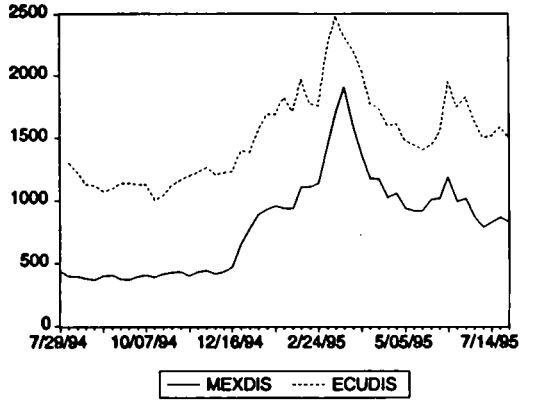

Figure 15

Consider now the other countries in our sample, Philippines and Bulgaria, in figure 16-18 . Note how similar to Poland's is the behavior of the Philippines' bond: the difference between MEXPAR and PHIPAR (DIFF) shows the

[31] A first glance at the plots in figure 5 shows that there is no strong evidence of comovements in the risk premium except during periods in which one of the countries experiences a relevant crisis. We have divided the countries in *groups* on the basis of different factors to see if there was any evidence of comovements in the sub-groups. First, the *oil producers*: Mexico, Venezuela and Nigeria; while Venezuela and Nigeria move together during the Mexican crisis (7/29/94 to 7/28/95), on the whole sample the three series have a very different behavior. Second, the *South American countries*: Mexico, Brazil, Argentina, Ecuador and Venezuela; again, during the Mexican crisis the comovements are evident, but this is not the case for the whole sample. The same conclusion holds if we divide the countries on the basis of the *date in which the Brady deal was announced* or actually *implemented*.

same shift in the mean of an otherwise stable relationship, as in the Poland case. On the other hand, BULDIS remains above MEXDIS (even if the distance between the two decreases) and follows a behavior similar to ECUDIS. [32]

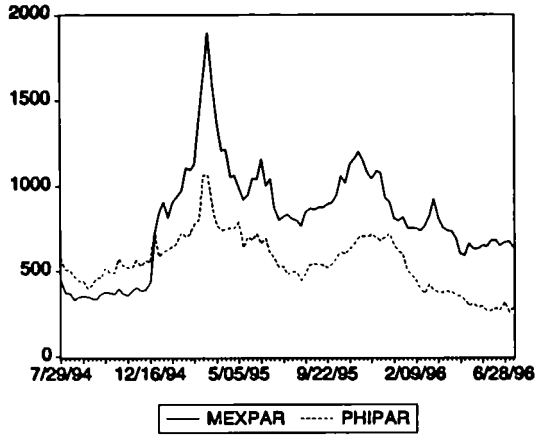

Figure 16

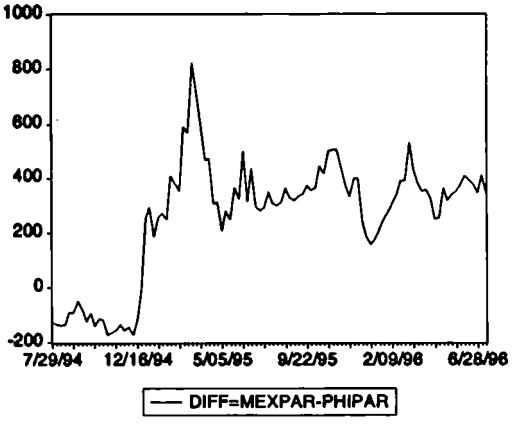

Figure 17

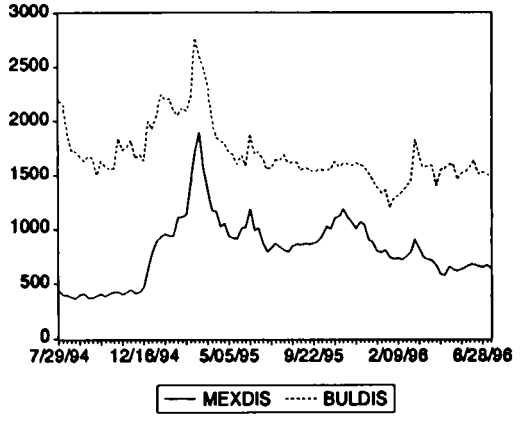

Figure 18

From this brief analysis we reach two conclusions:

i) there is evidence of comovements during the Mexican crisis (and for the Venezuelan crisis, even if in this case the evidence is less strong);

[32] We could do a similar exercise for the political crisis that hit Venezuela in 92/93. A military coup failed in February 1992 and a second military coup was attempted in November 1992. The political crisis continued for the entire year 93 until the December 93 elections, but it was less acute after the summer when an interim government was appointed after the suspension from office of president Perez on May 20. By January 92 the Brady bonds already issued were those of Nigeria and Mexico. The date of issue for Argentina was 4/93 and for Philippines was 12/92. Note that before January 92 the Venezuelan bonds were the less volatile and with the lowest mean among the Brady bonds. The data suggest that: NIGPAR reacted to the crisis in such a way that it is not easy to trace out comovements of the two variables; MEXDIS, which was a relatively stable title at the time, is only slightly affected by the crisis; on the other hand, the newly issued bonds of Argentina and Philippines show signs of comovements with VENDIS and VENPAR respectively.

ii) different Brady bonds responded differently to the Mexican (and Venezuelan) crisis; countries with similar *pre-crisis* mean and volatility reacted in a similar way, in terms of both absolute deviation and degree of comovement with the Mexican bonds: low mean and volatility bonds (as Poland and Philippines) seem to have responded in a similar way to the crisis; similarly high mean and volatility bonds (Nigeria and Venezuela) or in-between bonds (as Brazil and Argentina, or Ecuador and Bulgaria).[33]

Given the interpretation we have presented in the previous section, the mean and the volatility of a bond are good proxies for the probability of default, which is the key element to determine how the risk premium will respond to a negative shock. In what follows we will test the three implications we have derived in the previous section.

2) To test the three implications we define a 'crisis' period and a 'pre-crisis' period. The 'pre-crisis' period goes from 8/05/94 to 12/09/94, the 'crisis' period from 12/16/94 to 4/21/95.[34] We then compute the volatility (standard deviation) of the risk premium for both the crisis and pre-crisis periods for all the bonds in our sample. The *absolute increase* in the volatility is given by the difference of the standard deviations on the two sub-periods, while the *relative increase* is given by the absolute increase divided by the standard deviation of the pre-crisis period.

i) To test the first implication we regress the absolute increase and relative increase on the standard deviation of the pre-crisis period. The result are plotted in figure 19 and 20 in terms of bs. pts.. The figures show that there is evidence of convergence of the volatility during the crisis, both in absolute and relative terms. The convergence of the volatility is another aspect of the 'pooling effect' during periods of high uncertainty.

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[33] An important remark is in order here. We argue that countries with similar *pre-crisis* mean and volatility reacted in a similar way to the crisis. Now, consider the function $(1-\pi) = f(Z_{obs}, Z_{not-obs})$ we introduced in section 5. If we assume that the functional form $f(.)$ is the same for all countries, in absence of spillover effects through $Z_{not-obs}$ (that is in the *pre-crisis* period, during which there were not major idiosyncratic shocks), countries with similar observable fundamentals should have had a similar probability of default $(1-\pi)$ and thus similar risk premium mean and variance. Thus, to argue that the response to the crisis depended on the *pre-crisis* mean and volatility is equivalent to arguing that the response depended on *pre-crisis* (observable) fundamentals, as we should expect.

[34] The choice of these periods is somehow arbitrary. The four months period chosen reflects the fact that by April 95 the crisis was perceived as overcome. However, the results are substantially the same for different periods, as 3 or 6 months.

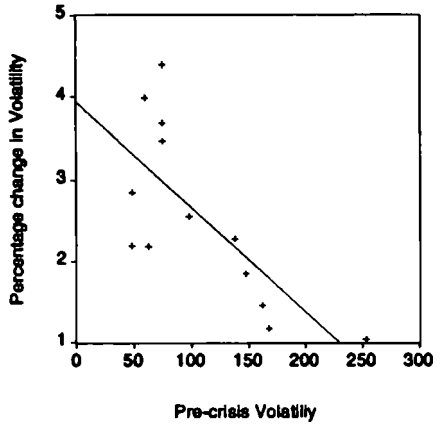

Figure 19

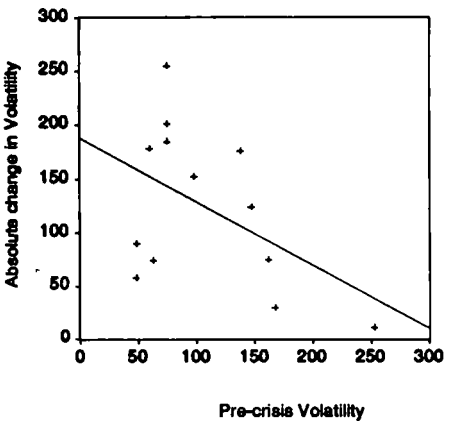

Figure 20

ii) Similarly, figures 21 and 22 below show that also the second implication holds: the mean and the volatility of the risk premium have a positive relation.

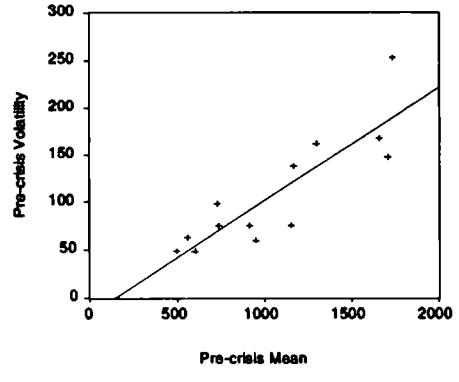

Figure 21

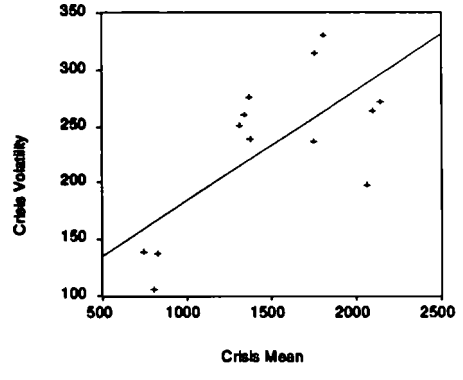

Figure 22

iii) Finally, we try the following experiment to look for evidence supporting the third implication. For both periods - pre-crisis and crisis - we rank the countries according to the *probability of default* ($1-\pi$) - proxied by the pre-crisis mean of the risk premium - and then we plot the volatility on this rank. For the pre-crisis period the ranking is (from the most likely to the less likely to default): Nigeria, Venezuela, Bulgaria, Ecuador, Argentina, Brazil, Poland, Philippines and Mexico. For the crisis period, we keep the same ranking but we move Mexico from the last to the first position. We report the plots for Par and Discount bonds in figure 23-26.

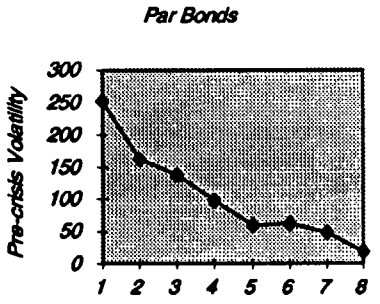

Figure 23

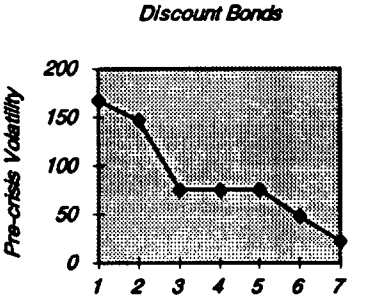

Figure 24

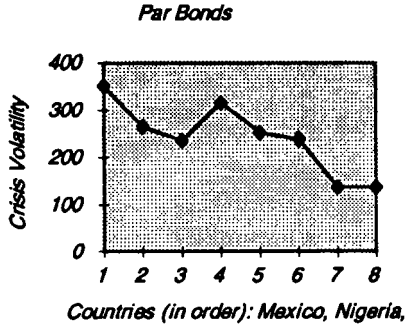

Figure 25

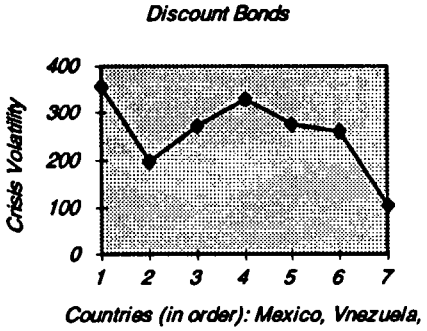

Figure 26

The plots show an evident decrease in the slope of the volatility as a consequence of the increase of the probability of default due to the Mexican crisis. Our third implication is substantially supported.

7. Conclusions and policy implications

This paper provides a preliminary understanding of the Brady bond market. The paper has studied the effects of the Mexican crisis on the risk assessment (as measured by the stripped spread) of other Brady countries. Our findings can be summarized as follows:

i) *the risk premium (on a single country) has one unit root; this is consistent with the hypothesis that the risk premium reflects new information accruing to the market*;

ii) *comovements were stronger during the high volatility period of the Mexican crisis; in particular, in our case-study on Mexico and Poland, we do not reject the null of cointegration for the period July 94-July 95, but we do reject the null for the period July 95-July 96.*

iii) *the crisis has had a strong permanent effect on the risk assessment on Mexico (550 bs. pts. circa);*

iv) *different Brady bonds responded differently to the Mexican crisis: countries with similar pre-crisis mean and volatility reacted in a similar way (in terms of both absolute deviation and degree of comovement with the Mexican bonds). Other factors (regions, oil producers, date of Brady deal) do not explain the observed patterns.*

v) *there was convergence of volatility during the high volatility period of the Mexican crisis.*

These results suggest that traders' behavior when assessing sovereign risk of Brady countries is not constant over time and that it responds to the level of uncertainty in the market. Herd behavior increases with risk, leading to even higher volatility.[35] Traders have limited information on developing countries, therefore *learning spillovers* are likely. The joint effect of these two forces can be powerful, as the example of Poland suggests.

The main policy implication of this paper is that *systemic risk* in the market for developing countries external debt has not completely disappeared. While excess volatility is intrinsic to financial markets when there is herd behavior, comovements are the consequence of poor information only. However, the reaction of the Brady bond market to the Mexican crisis and its aftermath proved its liquidity.[36]

To conclude, the decrease in sovereign risk premium comovements in the second period of our sample could be due to the fact that *markets are learning*, i.e. acquiring experience and gathering information on the developing countries, so that learning spillovers are less relevant; but it could also signal the absence of any relevant shock to generate such spillover effects, while in fact the market is still vulnerable to country-specific shocks. On this issue further research is needed. [37]

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[35] An interesting possibility for future research is to look at data on portfolio holdings to see whether there is a convergence in the allocation of funds during periods of high volatility.

[36] "It was the middle of October 1991 that the market received the sudden shock that the price rises of the previous 18 months were not immune to gravity. [...] massive selling of Brazilian paper one Friday morning, inspired by JPMorgan in NY, while a massive coup for the bank, left a number of financial institution reeling. Within three weeks the debt was trading at 22% of face value, and managed to bring down prices across the board. 'What upset the market is that some traders would not come to the phone, and if they did, the prices were wholly unrealistic', says Russell Hanlon, vice president at Chartered WestLB in NY." by Rupert Wright, Trade Finance September 1992 (page 64). But in 1995, after the Mexican crisis: "'One thing is that this market demonstrated its resiliency and liquidity. The worst scenario would have been an illiquid market, but people who wanted to sell could', said Michael Chamberlin, executive director of the Emerging Markets Traders Association." by Paul Kilby, Latin Finance N. 70 (page 34).

[37] There is a recent growing literature on exchange rate correlations that analyses to what extent such correlations are explained by a set of fundamentals (for example B. Eichengreen, A.K. Rose and C. Wyplosz (1996), J. Sachs, A. Tornell and A. Velasco (1996)). Having a longer time serie spanning well beyond the period of the Mexican crisis, it would be extremely interesting to do a similar exercise on the sovereign risk premium: regressing cross-country risk premium correlations on a set of fundamentals would let us assess how much of these correlations is explained by *observable fundamentals*.

BOX 1 - Brady Bonds: a primer

Par and Discount bonds have been by far the most popular options in several Brady agreements. Par bonds are 30 years maturity (25 for Philippine Pars) issued at "par", i.e. for the original face value of the loans for which they were exchanged. Par bonds carry a fixed, below market interest rate (relative to the interest rate environment at the time of the issuance). Discount bonds are 30 years maturity floating market interest rate, issued at a discount to original face value of the previously rescheduled loans.

In general, both security types are collateralized as to principal at maturity by US Treasury zero coupon bonds. Par and Discount bonds may possess additional collateral in the form of a cash collateral account usually maintained at the Federal Reserve Bank of NY. The funds in these accounts, which are allowed to be invested in securities rated AA- or better, are maintained in order to pay interest for a specific number of months (usually from 12 to 18 months depending on the country) in the event that the sovereign debtor suspends the interest payments. In effect the collateral provides a "rolling" interest payments guarantee, meaning that if each successive interest payment is made and the collateral is not utilized, it is "rolled" or applied to guarantee the nearest dated unsecured semi-annual interest payment. If the collateral is drawn upon, it is not required to be replaced.
Certain Par and Discount bonds also carry "value recovery" warrants, which give bondholders the opportunity to "recapture" some of the debt and debt service reduction provided in the exchange if the future economic performance and/or the debt servicing capacity of the sovereign debtor improves. For example, in our sample Mexico, Venezuela and Nigeria bonds carry warrants linked to indices of oil export prices or of national oil export receipts.

The value assigned to the principal on Par and Discount bonds is simply the present value of the security used as a collateral. For dollar denominated bonds, the principal is discounted by the risk-free rate of a comparable maturity US Treasury zero-coupon bond.
The interest collateral of a Brady bond is a more complicated component to value since it is uncertain when, if ever, it will be used. This provides an occasion for differences in valuation approaches which arise from assumptions about the probable life of the "roll" of the collateral. One method assumes the limiting case, which ascribes the minimal value to the collateral's current market value, effectively treating it as if there was no life to the "roll" (i.e. default occurs today and collateral is utilized and exhausted to pay the nearest 2 or 3 semiannual interest coupons). Other methods rely on the use of probability models or option pricing formulas to assign probabilities to interest payment default, which are then incorporated in the valuation model.

@To obtain the stripped yield, the value of the principal and interest collateral is calculated as described above, and this notional "market value" of the collateral is subtracted from the current market price. After "stripping" out the values of the principal and interest collateral from the price, an internal rate of return is computed on the non-collateralized contractual cash flows. These non-collateralized interest flows should be discounted by a rate, the *stripped yield*, that produces a present value which, when added to the collateralized portion of the bond, equals the current market price. The internal rate of return of a Brady bond cash flow with its collateral left intact is simply the bond's implied yield-to-maturity or *blended yield.*@
The value of the "value recovery" warrants, which are linked to the value of the country's oil exports, is usually ignored in the valuation of the bonds.

Swapping floating-rate coupons for fixed rate equivalents (using either the current LIBOR-based Eurodollar swap curve or forward rate curve) places all Bradies on equal footing with other sovereign instruments. In particular it makes possible to compute the *stripped spreads* for all bonds.

Source: The 1995 Guide to Brady Bonds. Merrill Lynch, December 6 1994.

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Brady Bonds and Default Probabilities

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Abstract

This paper computes the default probabilities implicit in the prices of Brady bonds of seven developing countries and examines the factors that determine the high cross-correlation of the probability paths. The term structure of U.S. interest rates and the ratio of long-term foreign debt to GDP, together with a developing market index, explain more than 75 percent of the cross-sectional distribution of the default probabilities. The paper also demonstrates a new way to extract sovereign riskiness, implicit in traded bond prices. This allows the above results to be interpreted as explaining the cross-sectional distribution of sovereign riskiness as well.

JEL Classification Numbers: G33, G10

Keywords: Brady bonds, default probabilities, sovereign riskiness

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[1]I have received helpful comments and suggestions from Eduardo Borensztein, Arnab Das, Jose Luis Daza, Geert Rouwenhorst, and Chris Sims. All remaining errors are mine.

Contents

SUMMARY

From the start of the Brady program, more than $50 billion dollars of emerging market debt has been converted into Brady bonds. Unlike Eurodollar securities issued by the same developing countries, the Brady bonds of these debtors have enjoyed an extremely liquid market. Nevertheless, the prices and yields on these instruments seem to move together, despite the countries' quite different economic fundamentals.

To analyze the issue, this paper computes the probabilities of default on seven discount Brady bonds, using data from the IMF SMPBASE for the period January 1994 - November 1996. The levels of the default probabilities obtained are consistent with the generally perceived riskiness of the issuers, judged either by Moody's ratings or from analysis of fundamentals. By using the Mexican and Argentinian par and discount bonds, the paper finds that the default probabilities extracted from discount bonds are uniformly higher than those of par bonds, due mainly to the different characteristics and durations of the issues.

The correlation between the paths of default probabilities are surprisingly high, well in excess of 80 percent. Simple regressions of the individual default probabilities series on face-value weighted indexes of developing countries' debt prices and the face-value weighted default probabilities index have coefficients of determination in excess of 50 percent except in the case of Bulgaria, where the coefficient of determination is much lower (below 15 percent). The subsequent analysis shows that more than 75 percent of the individual variation in default probabilities is explained by the spot U.S. interest rates (a proxy for the term structure of interest rates), a developing countries' index, and the ratio of the issuer's long-term foreign debt to GDP (a proxy of the country's ability to repay its foreign obligations).

I. INTRODUCTION

From the start of the Brady program, more than 50 billion dollars of emerging market debt has been converted into Brady bonds. Unlike Eurodollar securities issued by the same developing countries, the Brady bonds of these debtors have enjoyed an extremely liquid market. Nevertheless, the prices and yields on these issues seem to move together, despite the countries' quite different economic fundamentals. This paper examines whether investors differentiate between the different Brady bonds, i.e., whether news concerning a given country affects investor interest primarily in that particular country or whether there is evidence of an emerging markets factor which drives prices and yields on the Brady bond issues.

To analyze the problem, this paper computes the probabilities of default on seven discount Brady bonds, using data from the IMF SMPBASE for the period January 1994 - November 1996. To compute the default probabilities, the paper uses a version of the Bierman-Hass (1977) specification with the added complication of non-zero recovery in case of default. The analysis in case of default is facilitated by the presence of principal and rolling interest collaterals on the discount bonds. In essence, the method presented in this paper strips the bonds of the guarantees and estimates the pure country risk (the default probability).

The levels of the default probabilities obtained are consistent with the generally perceived riskiness of the issuers, judged either by Moody's ratings or from analysis of fundamentals. By using the Mexican and Argentinian par and discount bonds, the paper finds that the default probabilities extracted from discount bonds are uniformly higher than those of par bonds, due mainly to the different characteristics and durations of the issues.

The correlation between the paths of default probabilities are surprisingly high, well in excess of 80 percent. When Bulgaria is excluded, all correlations are in excess of 90 percent. Simple OLS regressions of the individual default probabilities series on face-value weighted indexes of developing countries debt prices and the face-value weighted default probabilities index have R^2's in excess of 50 percent except in the case of Bulgaria, where the coefficient of determination is much lower (below 15 percent). The subsequent analysis shows that more than 75 percent of the individual variation in default probabilities is explained by the spot U.S. interest rates, a developing countries' index, and the ratio of the issuer's long-term foreign debt to GDP.

The rest of the paper is organized as follows. Section II discusses the data used in the paper. Section III describes the computation of default probabilities, implicit in Brady bond prices and section IV presents and analyses the results. Section V proposes and implements a new measure of sovereign riskiness based on observed price data. Section VI compares the default probabilities extracted from discount and par Brady bonds, while section VII studies the determinants of the cross-sectional distribution of

default probabilities. Section VIII suggests directions for future research and presents the conclusion.

II. DATA

The main computations in this paper use discount Brady bond prices. While section VI provides a comparison of the default probabilities obtained from both discount and par bonds, par bonds have additional features which complicate the calculations and make the results less reliable. For example, the Mexican par bonds have 17 series of Value Recovery Rights (VRR) which entitle the holder to additional payments linked to the price of oil. As there are no market instruments that would allow one to estimate the price of oil 10 or 15 years in the future, it would be better to judge investors' expectations by using discount Brady bonds.

From the beginning of the Brady program, nine countries have issued discounted Brady bonds, i.e., bonds whose principal is a reduced fraction of the original obligation (typically a 35 percent reduction) and that carry a floating interest rate (usually determined by the 6-month LIBOR on U.S. dollar deposits plus 0.1825 percent). The countries which have issued discount Brady bonds are Argentina, Brazil, Ecuador, Bulgaria, Mexico, Poland, Venezuela, Jordan, and the Dominican Republic.

For all those bonds the principal is fully collateralized by U.S. Treasury securities and, unlike corporate bonds, there is no possibility of collateral acceleration (i.e., seizure of principal collateral in case of default before the maturity date). The lack of acceleration is provided by the fact that the principal is secured by a series of discount U.S. Treasury bonds with the same date of maturity as the Brady bond. With the exception of Poland, whose bonds carry no interest collateral, the other issuers have either 12, 14, or 18 months of interest collateralized by highly liquid U.S. Treasury instruments. The issue amounts vary considerably, from 157 million for Jordan to 11.764 billion for Mexico. Table 1 summarizes the discount bond issues.

The SMPBASE, maintained by the IMF, has daily ask and bid price data on 7 of the issues: Argentina, Brazil, Ecuador, Bulgaria, Mexico, Poland, and Venezuela. Spreads between the bid and ask prices are relatively stable across time and have been typically declining since the time of issue which suggests that use of bid prices in the following analysis is appropriate.

Table 1. Summary of Discount Brady Bonds

Country	Issue date	Amount	Day	Month	Reduction
Argentina	31/03/1993	4.300	15	4	0.35
Brazil	15/04/1994	7.300	15	4	0.35
Ecuador	28/02/1995	1.435	15	4	0.45
Bulgaria	28/07/1994	1.850	28	1	0.50
Mexico	28/03/1990	11.764	30	3	0.35
Poland	27/10/1994	3.000	27	10	0.55
Venezuela	31/03/1990	1.226	18	4	0.30
Dominican republic	30/04/1994	0.329	30	5	0.35

Note: `Amount` is in billions U.S. dollars, `Issue date` is the date of issue of the bond in the format `dd/mm/yy`, `Day` is the day of the month on which the first semiannual coupons are paid, `Month` is the first coupon month, (the next is six months later), and `Reduction` is the reduction of the original face value.

Source: Merrill Lynch, *The 1995 Guide to Brady Bonds.*

All of the discount bonds have floating coupons, typically equal to the 6 months U.S. dollar LIBOR plus 0.1825 percent. To compute the expected coupons, the paper relies on weekly data on the swap curve, extracted from Bloomberg L.P. at maturities of 1, 3, and 6 months, and 1, 2, 3, 4, 5, 7, 10, 15, 20, and 30 years. Then the paper uses Bessel cubic spline interpolation to complete the swap structure across the remaining dates and maturities.[1]

To discount the future cash flows, the computations use either a flat term structure of interest rates (7 percent annual rate for all maturities) or the actual term structure, kindly provided by the Federal Reserve Bank of St Louis. In the latter case, the paper again relies on Bessel cubic spline interpolation to complete the term structure for the necessary maturities, starting from weekly data.

III. COMPUTING THE DEFAULT PROBABILITIES

Let the probability that the issuer would default on any coupon payment after time s, measured at time s, conditional on no prior default, be denoted by p_s. That is, it is assumed that the default probabilities for dates $t > s$ viewed from date s are constant. This is certainly a simplification which can be relaxed, albeit at the cost of much more intensive computations. The default probabilities are computed by using a version of the Bierman-Haas model.[2] To describe the derivation in more detail, let the forward rate from time a to b measured at time s be denoted by $f(s;a,b)$. The spot rate at time t from t to s is denoted by $r(t;t,s)$ or $r(t;s)$ for short. Further, the coupon owed at time s is denoted by c_s and the principal owed at maturity is denoted by F (and normalized by setting $F = 100$). Finally, let t denote the current period, and T be the time of maturity.

To construct the riskless yield curve, data on the U.S. Treasury yield curve, the collection $\{r(t;t+s)\}$ for $s = 1$ month, $\ldots$, 30 years$\}$ is obtained at weekly frequencies form Bloomberg L.P. The term structure for the necessary coupon dates is then constructed by using Bessel cubic spline interpolation. Further, using the spot rates, the entire structure of forward rates at t is computed in the standard fashion with discrete compounding:

$$f(t;a,b) = \frac{1 + r(t;b)}{1 + r(t;a)} - 1 \tag{1}$$

[1]Cubic splines are the preferred way to construct the complete term structure as they produce smooth and differentiable curves. The Matlab code is available upon request from the author.

[2]This is one of the methodologies by which one can compute the stripped yields on the Brady bonds.

The structure of forward rates is needed in order to compute the rolling interest collateral, an essential feature of the discount Brady bonds. With the exception of the Polish Brady bonds which have no interest collateral, all other Brady bonds have either 12, 14, or 18 months of interest collateralized by cash invested in either U.S. Treasury bonds or approved instruments (rated AA- or better). The rolling feature means that if the debtor makes a coupon payment, the collateral is "rolled over" to protect the next 12, 14, or 18 months of interest payments, all the way up to maturity or default. Therefore, denoting the value of the interest collateral at s by I_s, the expected value as of time t of I_s is:

$$\mathrm{E}_t[I_s] = \sum \frac{c_i}{[1 + f(t; s, i)]^{i-s}} \tag{2}$$

where the summation is taken over the number of periods (2, 14/6, or 3) for which interest payments are collateralized.

To compute the present value of the principal collateral, P_t, recall that there is no possibility of acceleration of the principal collateral (seizure by the creditors in case of default). Therefore:

$$P_t = \frac{F}{[1 + r(t; T)]^{T-t}} \tag{3}$$

or simply the price of a pure discount Treasury bond with remaining time to maturity of $T - t$ periods.

In order to compute the probability of default p_s, the observed Brady bond price B_s needs to be stripped of the interest and principal collateral. Clearly, the price B_t, less the value of the principal collateral P_t, should equal the present value of the expected stream of cash flows arising from the interest collateral and the coupon payments, discounted at the riskless rate. That is,

$$B_t - P_t = \sum_{s=t+1}^{T} \frac{\mathrm{E}[I_s]p_t(1 - p_t)^{s-t-1} + \mathrm{E}[c_s](1 - p_t)^{s-t}}{[1 + r(t; s)]^{s-t}} \tag{4}$$

where the first term in the numerator of (4) denotes the value of the rolling interest collateral and the second measures the cash flows from coupons, all in expected value, adjusted by the probability of default. The probability of default obtained by this valuation can be called a *risk-neutral (martingale)* probability, as we have made the assumption of risk-neutrality by discounting at the riskless rate.

To obtain the probability of default p_t, the above equation is solved numerically using the Newton-Raphson algorithm. The results from the computations are presented and discussed in the following section.

IV. RESULTS

Table 2 presents selected statistics about the estimated default probabilities, computed from (4) using bid prices. Poland and Mexico are the countries with the lowest median semi-annual default probability, 2.23 percent and 2.91 percent, respectively, while Bulgaria has the highest one, 6.76 percent. Poland is also the country with the lowest variability of the computed probability of default implicit in the Brady bond prices (standard deviation 1.21 percent), while Venezuela is the one with the highest (2.17 percent).

Figures 1 and 2 plot the paths of the default probabilities computed for the different discount bonds from the first day data is available (as early as January 3, 1994) until November 21, 1996, a maximum of 760 data points using bid prices. The estimates using the ask prices are almost identical, as the spreads between the bids and the offers are virtually constant throughout the data period. Note the sharp uniform increase in default probabilities across the seven issuers starting at the end of November 1994 through April - May 1995, the period of the Mexican crisis. The percentage increases are the highest for Mexico (over 300 percent compared to pre-crisis levels) and the other Latin American countries (200-250 percent) and much lower for Bulgaria (170 percent) and Poland (less than 75 percent). Based on these casual observations, it appears that the market has viewed Poland as one of the least risky issuers (which could be judged by the lack of rolling interest collateral as well) and Bulgaria as the most risky.[3]

The computed paths exhibit serial persistence which is significantly different from zero. This suggests that the assumption of serially uncorrelated default probabilities, made in the analysis, is not entirely appropriate. As mentioned earlier, however, this assumption can be reduced only at the expense of much higher computational costs (see section VIII).

From the computed default probabilities, the paper proceeds with examination of the factors which determine the cross-sectional distribution of the default probabilities across the seven Brady bond issuers. Before presenting the results from the analysis, however, it is important to determine whether the estimated probabilities provide a realistic risk ranking of the countries compared to *ex-ante* Moody's ratings or

[3]News about the introduction of the currency board in Bulgaria and its actual implementation have changed this picture somewhat.

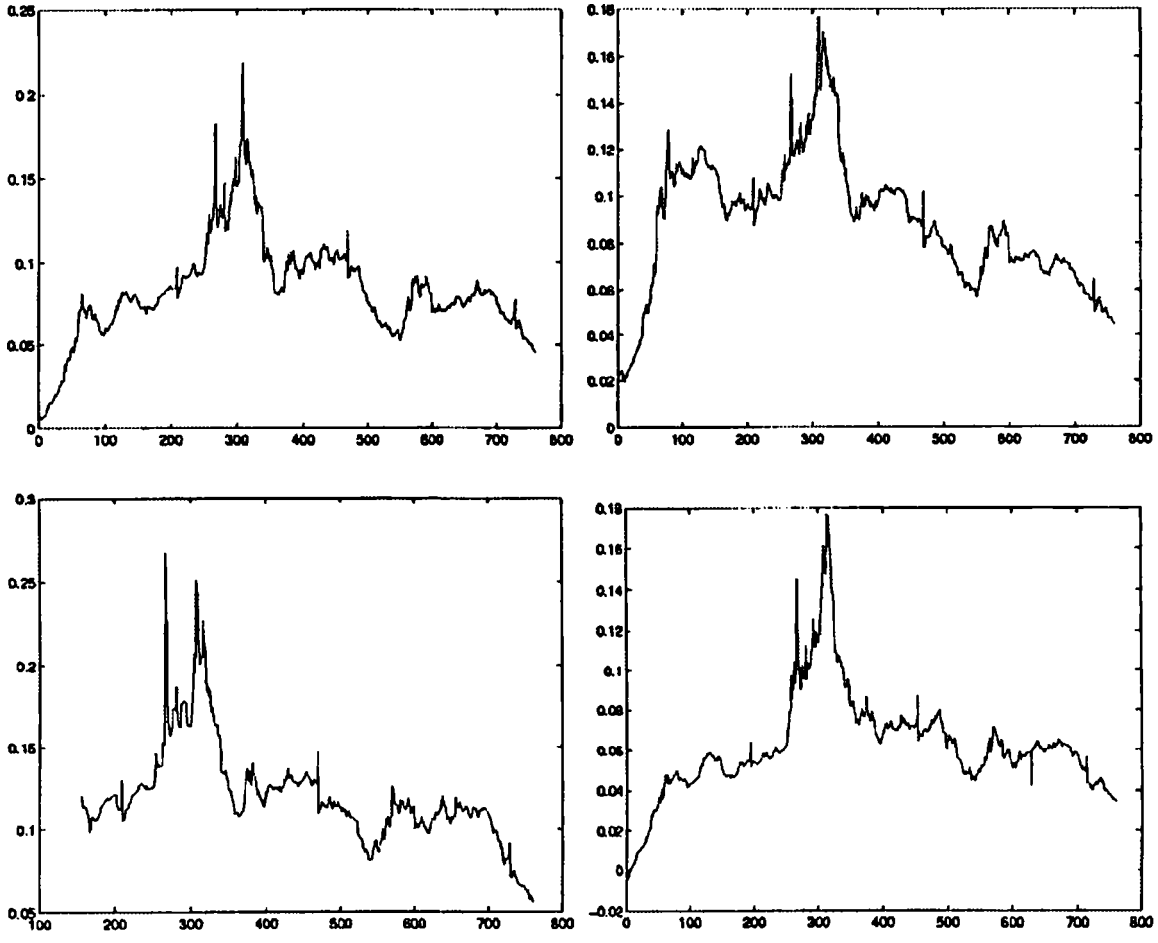
Table 2. Summary of the Computed Default Probabilities

Country	Min	Max	Mean	Median	Std	No. of obs.
Argentina	0.0028	0.1050	0.0407	0.0391	0.0146	760
Brazil	0.0096	0.0850	0.0435	0.0445	0.0137	760
Ecuador	0.0281	0.1343	0.0589	0.0566	0.0142	607
Mexico	0.0001	0.0835	0.0307	0.0291	0.0124	755
Venezuela	0.0094	0.1278	0.0614	0.0635	0.0217	760
Bulgaria	0.0416	0.1340	0.0714	0.0676	0.0151	612
Poland	0.0055	0.0616	0.0247	0.0228	0.0121	613

Note: The first column lists the issuing country, the second and the third columns, `Min` and `Max`, give the minimum and maximum of the default probability over the estimated path, `Mean` and `Median` compute the mean and median over the path, `Std` presents the standard deviation of the default probabilities, and the last column gives the number of consecutive price observations available and used in the computations. Results are computed from bid prices starting as early as January 3, 1994 up to November 26, 1996, a maximum of 760 tradings days.

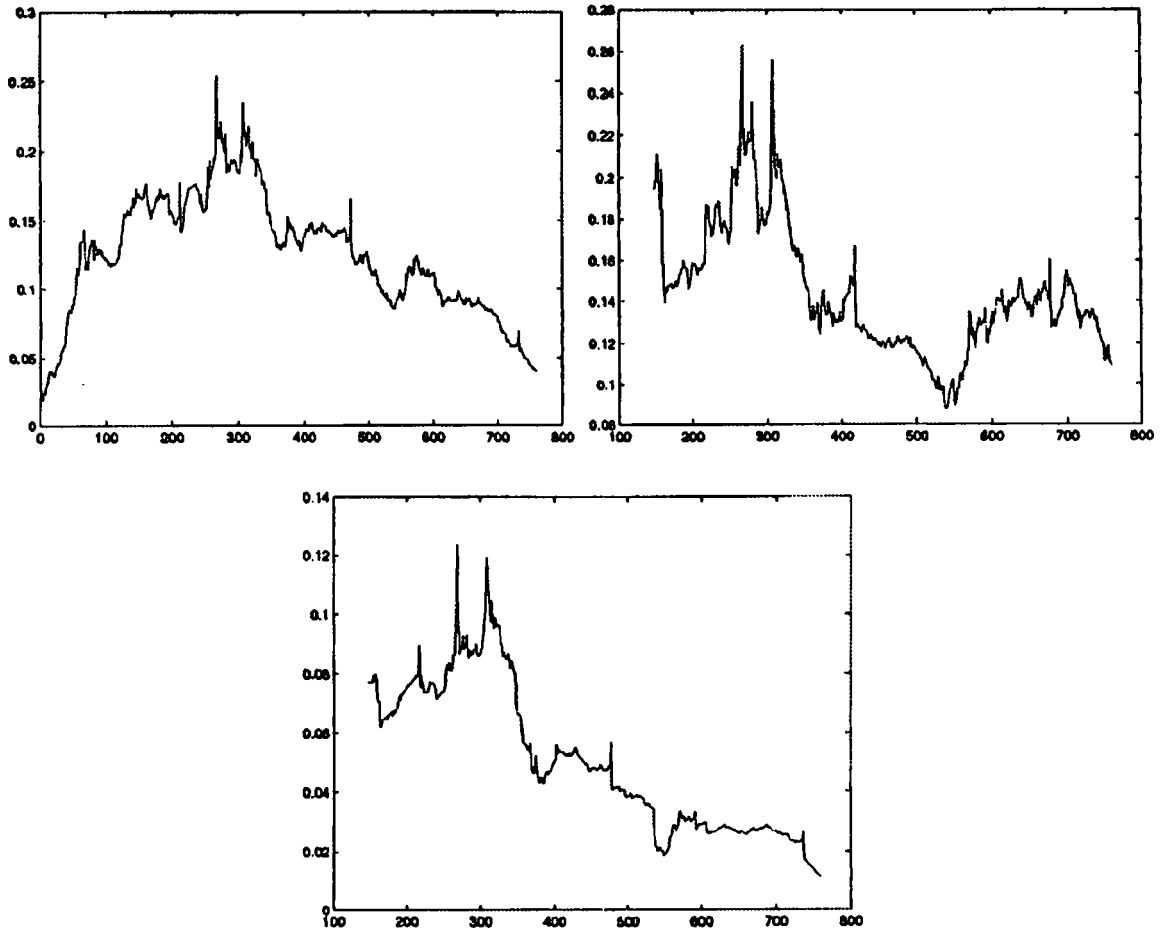
Source: the SMPBASE maintained by the Emerging Markets Division, Research Department, International Monetary Fund.

Figure 1. Estimated Risk-Neutral Probability of Default



Note: Estimated semi-annual probability of default using daily data, January 1994 - November 1996. Argentina and Brazil (top row), Ecuador and Mexico (bottom row).

Figure 2. Estimated Risk-Neutral Probability of Default



Note: Estimated semi-annual probability of default using daily data, January 1994 - November 1996. Venezuela and Bulgaria (top row), Poland (bottom row).

a sovereign riskiness rating obtained from the whole distribution of default probabilities, as discussed in the following section.

To obtain ratings of the countries using the estimated default probabilities, the probability density function of these estimates is computed nonparametrically. A normal kernel and an adaptive algorithm for the determination of the smoothing parameter is used to obtain the probability density functions (pdf's) plotted in figures 3 and 4. With the exception of Poland, all pdf's are unimodal with most of the probability mass concentrated around the mean. The next subsection constructs the empirical cumulative distribution function for each of these pdf's and uses it to obtain a relative market rating of the individual Brady bonds based on the concept of first-order stochastic dominance.

V. SOVEREIGN RISKINESS

One way to appraise the market's assessment of sovereign riskiness of the Brady bond issuers is to use the mean default probabilities, computed and presented in the previous section. While intuitive, this method utilizes only one moment of the distribution of the probability of default. This section introduces another possibility, based on the concept of stochastic dominance.

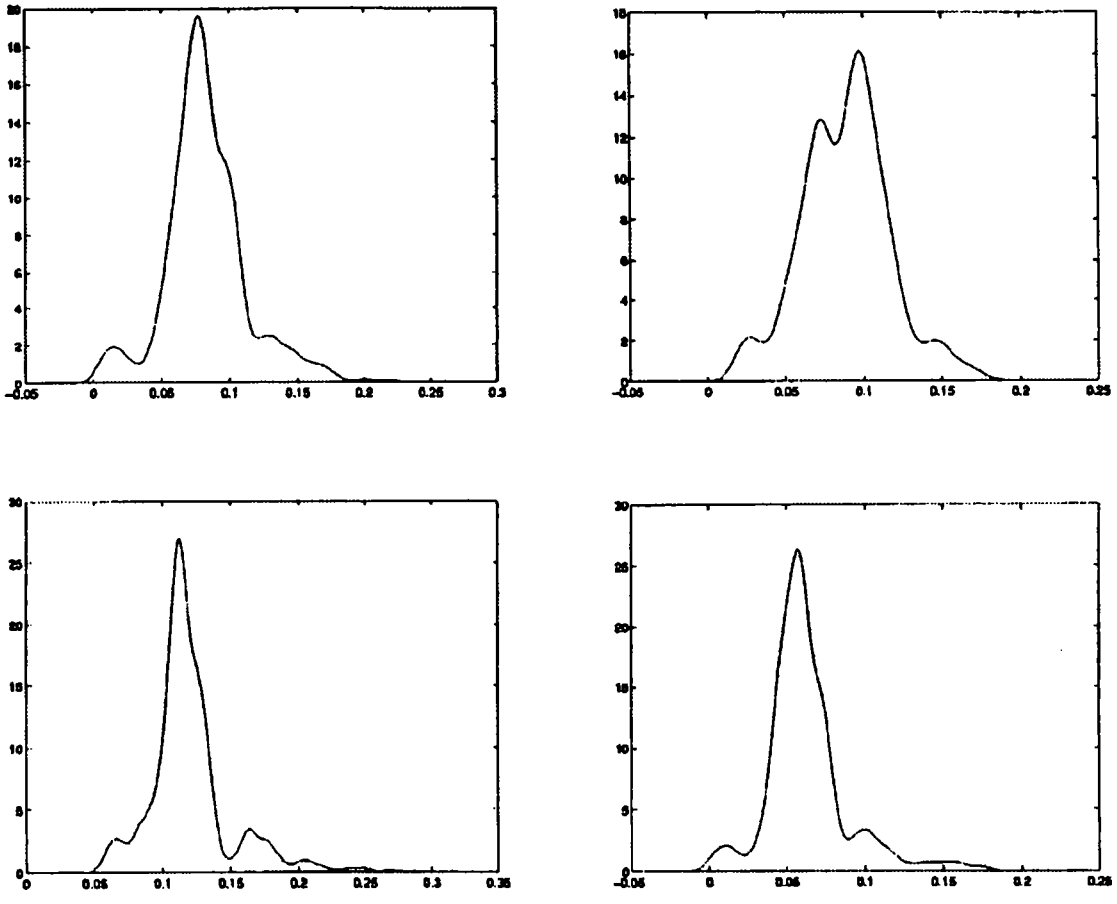
Recall from finance theory that given two (cumulative) distributions of asset returns A and B, distribution A is said to *first order stochastically dominate (FOSD)* distribution B (denoted by $A \succ B$) if the value of the cumulative distribution function (cdf) of A does not exceed that of B at any point on their support. Restricting the support of the cumulative distributions functions to $[0,1]$ (very convenient for the analysis since default probabilities have such support), write this definition as:

$$A \succ B \equiv F_A(z) \leq F_B(z), \forall z \in [0,1] \tag{5}$$

First order stochastic dominance means that all individuals with utility functions that are increasing in wealth prefer asset A to B or are indifferent between the two. To apply this concept to the cumulative distribution functions of default probabilities, we reverse the argument: A would be preferred to B if the cdf of B is exceeds that of A at every point of their support. Following this criterion, countries can be ranked according to their implied riskiness. Table 3 presents a country rating according to the simple mean of the estimated default probabilities (column 1), Moody's (column 2), and the first order stochastic dominance criterion, introduced above (column 3).

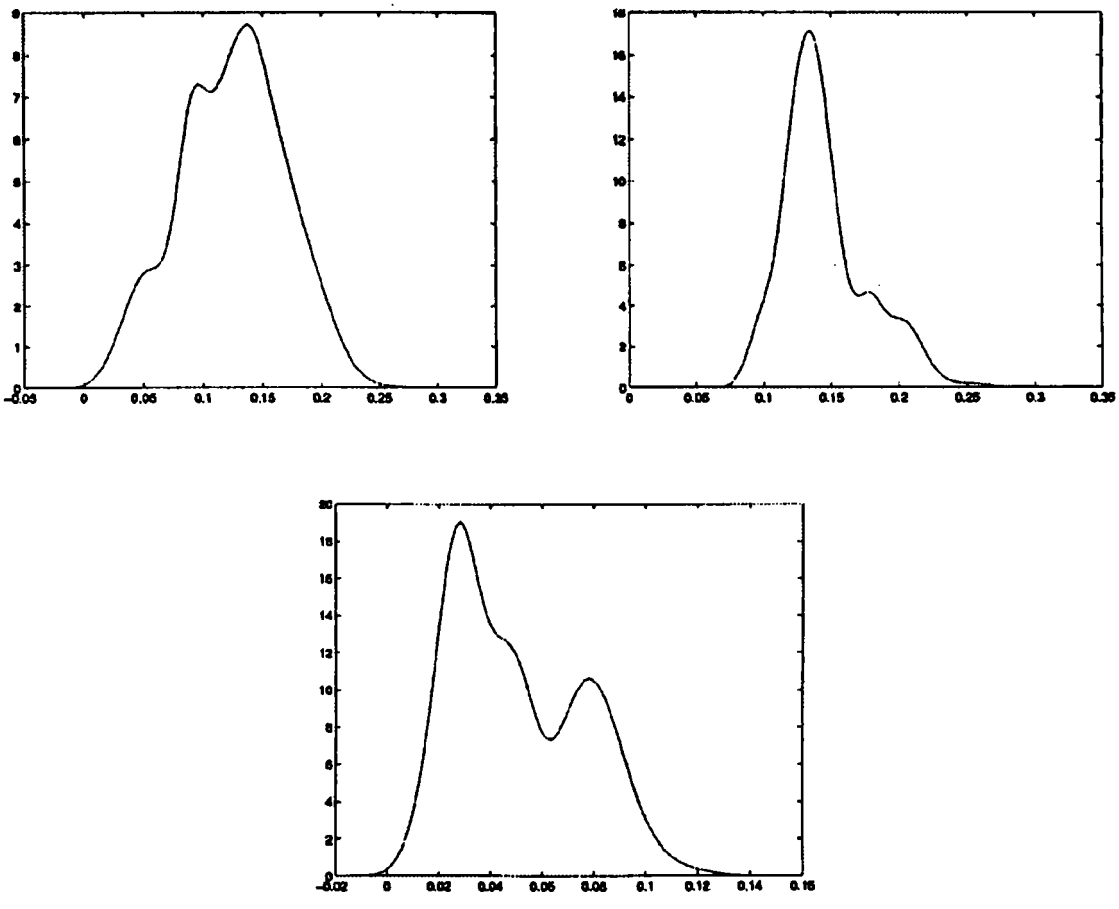
In figure 5 the cdf's of Mexico, Argentina, Brazil, and Ecuador clearly demonstrate why Mexico is the least risky and Ecuador the riskiest Brady bond issuer

Figure 3. Nonparametric Probability Density Function Estimate



Note: Nonparametric estimates of the density function of the probability of default for Argentina and Brazil (top row), and Ecuador and Mexico (bottom row). Results are obtained by using a normal kernel and an adaptive algorithm for determining the smoothing parameter.

Figure 4. Nonparametric Probability Density Function Estimate



Note: Nonparametric estimate of the density function of the probability of default for Venezuela and Bulgaria (top row), and Poland (bottom row). Results are obtained by using a normal kernel and an adaptive algorithm for determining the smoothing parameter.

in Latin America. While the results from that figure are unambiguous, first order stochastic dominance does not produce clear-cut results when comparing Mexico with Poland and Brazil with Venezuela because their cumulative distribution functions cross one another at points of their support. However, most of the mass of Poland's and Brazil's default probability is concentrated on the left, so that even though none of the cumulative distributions first order stochastically dominates the other, a reasonable approximation is certainly possible. Thus, the ratings presented in the table reflect some fine-tuning, which can be justified by invoking second-order stochastic dominance.[4]

Note that the mean probability of default and the first order stochastic dominance orderings are virtually identical. Thus, when comparing the market riskiness of discount Brady bonds, the first moments of the empirical pdf's seem to be sufficient statistics. Part of this result could be due to the assumption about the lack of serial correlation in the default probabilities. Moody's rankings are formally the same, except that Moody's does not rank all of the countries, while this paper assigns lower ratings for all non-rated countries.

The main implication of the results in this section is that the analysis that follows below explains not only the cross-sectional distribution of default probabilities, but also the cross-sectional distribution of sovereign country risk, as judged from the prices of Brady bonds.

VI. DISCOUNT BONDS AND PAR BONDS

It would be interesting to compare the default probabilities extracted from discount bonds, as presented in the previous section, and par Brady bonds. Recall that par bonds are issued at par for old debt but carry reduced, stepped up coupons for the first six or seven years. On bonds with identical characteristics, the computed default probabilities should be identical. Unfortunately, the par and discount bonds issued by developing countries do not have identical characteristics which explains the consistent differences among the computed probability series. For example, the coupon payments on Mexican par bonds are linked to the future price of oil and the oil revenues of the country via the so-called variable recovery rights (VRR).

The methodology for extracting the default probabilities from par bonds is similar to the one described for the discount bonds. The data are also available from the SMPBASE. Figure 6 plots the estimated default probabilities for discount and par Bradies for Argentina and Mexico. Even though the differences in levels of the

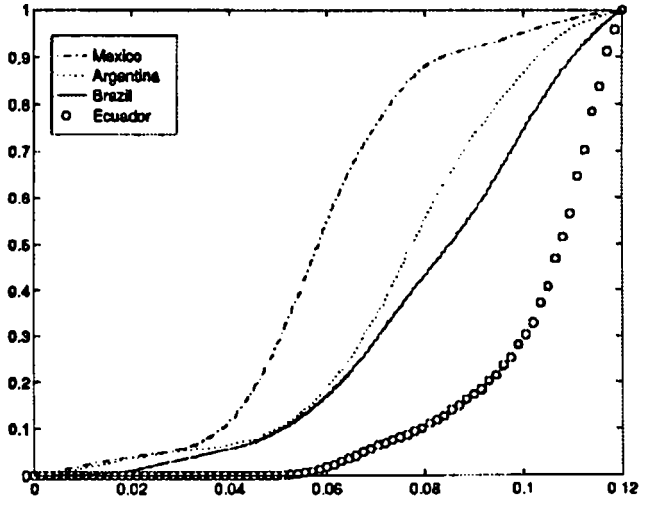
[4]A bit counterfactually, however, since the hypothesis of equal medians of the distributions for Poland and Mexico in one test, and Brazil and Venezuela, in another, is rejected.

Table 3. Estimated Sovereign Riskiness

Country	Mean of Def. Prob.	Moody's Rating	FOSD
Argentina	3	3	3
Brazil	4	5	4-5
Ecuador	5	6-7	6
Mexico	2	1-2	2-1
Venezuela	6	4	5-4
Bulgaria	7	6-7	7
Poland	1	1-2	1-2

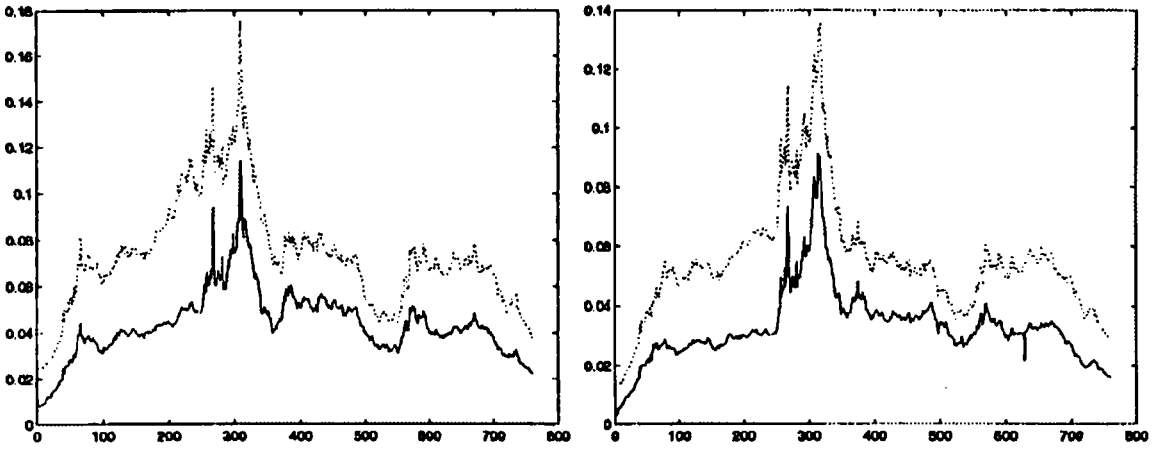
Note: The seven countries in the sample are ranked based on their sovereign riskiness according to three criteria ("1" is for the least risky, "7" is for the most risky). The first column uses the means of the computed probability distributions. Column 2 replicates Moody's ratings. Column 3 uses the First Order Stochastic Dominance (FOSD) concept, introduced earlier in this section.

Figure 5. Cumulative Distribution Function of Default Probabilities



Note: Cumulative distribution functions of the nonparametrically estimated density of the default probabilities for Argentina, Brazil, Ecuador, and Mexico. The figure clearly demonstrates why Mexico is viewed as the least risky issuer among these 4 countries.

Figure 6. Argentinian and Mexican Discount and Par Bonds.



Note: Inferred probability of default for discount (dotted line) and par (solid line) Brady bonds. Argentina is on the left panel, Mexico on the right.

individual series are statistically significant, they are highly and significantly correlated: the correlation coefficient is 91.74 percent for Argentina and 93.9 percent for Mexico.

VII. EXPLAINING THE DEFAULT PROBABILITIES

An initially striking feature of the estimated default probabilities is their high cross-correlation. Table 4 presents the correlation matrix of the estimated default probabilities paths of the seven countries. Although the lowest correlation coefficient is 72 percent (between Bulgaria and Venezuela), most of the coefficients are in excess of 90 percent.

Essentially the same results obtain when the individual probability series are regressed on a developing country index, which is either a Baker 15 index (an index of sovereign debt prices for 15 developing countries), an Eastern European index, or the face value weighted index of default probabilities (see Table 5). The absolute values of the t-statistics are statistically significant in all three cases which suggests a strong underlying "developing country" factor driving default probabilities.

Table 4. Correlation Matrix

Argentina	1.0000	0.9520	0.9605	0.9497	0.9139	0.8332	0.9247
Brazil		1.0000	0.9399	0.9550	0.9437	0.7870	0.9533
Ecuador			1.0000	0.9490	0.9194	0.8207	0.9125
Mexico				1.0000	0.8877	0.8087	0.9182
Venezuela					1.0000	0.7177	0.9495
Bulgaria						1.0000	0.8188
Poland							1.0000

Before proceeding, note that the t-statistic for Bulgaria is the lowest, in absolute value, for any of the three models. This suggests that the "developing country" factor is the least strong for Bulgaria, an observation which is confirmed by the relatively low correlation of the probability path for the Bulgarian Bradys with the other bonds, as presented in Table 4.

Since the default probabilities are computed using a bond pricing model, one may think that the influence of interest rates on default probabilities is accounted for and the remaining correlation is a sign of irrational herding or contagion. This, however, is not true. Table 6 presents OLS estimates of the model by using a constant, the Baker 15 index, the spot LIBOR for U.S. dollar deposits (results are virtually identical when a Treasury bill rate is used), and the ratio of long-term foreign debt to GDP as explanatory variables.

The spot LIBOR proxies for the level of the yield curve, one of the basic factors determining the term structure of interest rates.[5] The variable Debt/GDP proxies for the ability of the country to repay its foreign obligations. If debt is a burden, the expected sign on this variable is negative, while if debt levels have been increased under tighter investor scrutiny and allow for improved performance of the economy, the expected sign is negative.

The results are not surprising. The coefficients on the index do not change their signs or levels of significance for all countries in the sample except Bulgaria. For

[5]The slope of the term structure would be determined by a separate factor which we ignore in our model.

Table 5. Detailing the High Correlations: OLS Regressions Results

	Argentina	Brazil	Ecuador	Mexico	Venezuela	Bulgaria	Poland
				Using the Baker 15 Price Index			
Estimate	-0.132	-0.137	-0.150	-0.120	-0.234	-0.070	-0.120
t - stat.	-25.436	-32.321	-26.160	-27.973	-38.798	-8.597	-28.380
R^2	0.564	0.676	0.578	0.610	0.751	0.127	0.617
				Using an Eastern Europe Price Index			
Estimate	-0.078	-0.084	-0.092	-0.071	-0.149	-0.046	-0.074
t - stat.	-22.991	-31.218	-25.862	-24.493	-44.458	-9.130	-28.572
R^2	0.513	0.661	0.572	0.545	0.798	0.141	0.620
				Using a Default Probabilities Index			
Estimate	1.048	1.004	1.162	0.923	1.562	1.021	0.904
t-stat	104	124	88	124	61	35	78
R^2	0.955	0.968	0.939	0.968	0.879	0.712	0.923

Note: The dependent variable is the individual country probability of default. The explanatory variables include a constant and one of the three indices, described below. t-statistics are given for the index variable. The Baker 15 index is a face value weighted index of Brady bond offer prices. The Eastern Europe index is a face value weighted index of Bulgaria (discount bonds), Poland (par bonds), and Russia (clm bonds). The default probabilities index is a face value weighted index of the probabilities of default.

Data source: SMPBASE.

Bulgaria, the coefficient becomes positive with a t-statistic of 3.3168. On the other hand, the coefficients on the spot interest rate are strongly significant with t-statistics highest for Bulgaria and Poland.

The highly significant coefficients on the market index for all countries except Bulgaria can be interpreted as lack of a developing country factor in the determination of the probability levels for Bulgarian Brady bonds. On the other hand, U.S. spot interest rates have similar levels of significance for all countries in the sample. Note that it is not feasible to interpret the influence of spot rates on default probabilities solely, or even mainly, through the interest collateral as Poland has no interest collateral and yet, the t-statistic on its spot rate is the highest.

The coefficients on the variable Debt/GDP are positive and statistically significant for Argentina, Brazil, Bulgaria, and Ecuador and negative and statistically significant for Poland and Mexico, the least risky countries in the sample. The intuition is that these countries have been able to increase their debt levels because investors have adequate means of monitoring their performance (recall the lack of rolling interest collateral on the Polish Brady bonds).

In summary, spot U. S. interest rates, a developing market index, and the ability of the issuer to pay, as proxied by the ratio of long-term debt to GDP, explain most of the cross-sectional variation of the default probabilities perceived by market participants. The major caveat for these results is the assumption about the flat term-structure of the future default probabilities.

VIII. CONCLUSION

The paper computes the default probabilities implicit in the prices of Brady bonds for seven developing countries and examines the factors which determine the high cross-correlation of the probability paths. The term structure of U.S. interest rates and the ratio of long-term debt to GDP, together with a developing market index, explain more than 75 percent of the cross-sectional distribution of the default probabilities. The paper also demonstrates a new way to extract sovereign riskiness, implicit in traded bond prices. This allows the above results to be interpreted as explaining the cross-sectional distribution of sovereign riskiness as well.

Future research will focus on a more general form of the default probability, possibly estimating it nonparametrically. A broader array of instruments, including equity, could be used to examine the determinants of the cross-sectional distribution of risk across emerging markets.

Table 6. Explaining the Correlations

	Argentina	Brazil	Ecuador	Mexico	Venezuela	Bulgaria	Poland
Baker	-0.041	-0.048	-0.049	-0.043	-0.081	0.009	-0.034
t-stat	-22.174	-31.791	-21.588	-25.609	-37.160	3.317	-32.352
LIBOR	0.020	0.016	0.019	0.014	0.026	0.034	0.020
t-stat	27.777	28.121	22.660	21.806	31.907	34.243	49.388
Debt/GDP	0.003	0.008	0.011	-0.012	-0.002	0.024	-0.024
t-stat	1.710	6.808	20.052	-8.198	-0.661	21. 687	-14.9988
R^2	0.838	0.882	0.802	0.823	0.908	0.743	0.933

Note: The dependent variable is the individual country probability of default. The standard errors used to compute the *t*-statistics are heteroskedasticity corrected. The explanatory variables include a constant (estimates not reported), the Baker 15 index (an index of prices of developing countries' debt), the spot LIBOR (the level of the 6 months spot rate on dollar denominated deposits), and Debt/GDP, the ratio of the country's long-term debt to GDP.

Data Sources: SMPBASE and the World Development Finance Database.

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