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VALUATION AND MANAGEMENT OF EXPORT CREDIT GUARANTEES

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Keywords: loan guarantees, export credit, contingent liability, risk-efficiency, GSM

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Introduction

Recent global economic stresses and depressed farm prices have renewed interest in the General Sales Manager (GSM) export credit guarantee programs as possible mechanisms to stimulate exports of U.S. commodities. The increased demand for guarantees renews questions concerning the efficiency and effectiveness of credit guarantee programs. On the surface, guarantees appear to benefit exporting countries -- in this case the U.S. -- through increased exports. However, the existing programs have come under criticism because losses have been high and unpredictable, and because many program features are simply not well understood. As a result, existing GSM programs have been simultaneously criticized for being too large and costly while at the same time being criticized for failing to exhaust their available guarantee limits, with the implication that they must somehow be failing to generate the maximum benefits for producers. In addition to questions about the ideal program size, there is no clear understanding of the risk-efficiency of the existing portfolio of guarantees, nor is there clear empirical or theoretical guidance for the allocation of guarantees to countries given their differing risk profiles.

The explicit purposes of the GSM programs are: "(a) To increase exports of U.S. agricultural exports; (b) To compete against foreign agricultural exports; [and] (c) To assist countries, particularly developing countries, in meeting their food and fiber needs . . . " (GPO, 1998, 1493.2). From a practical standpoint, GSM programs are used to facilitate exports of commodities in cases where private financing is unavailable. The largest program in dollar amounts is the GSM-102 program, which can be used to guarantee loans up to 3 years in length. The intermediate program, GSM-103, can be used to guarantee loans up to 10 years in length. Both types of guarantees typically cover 98% of the principal and a portion of the interest due. Although the Commodity Credit Corporation (CCC) is authorized to allocate over $5 billion per year in aggregate under the two programs, they allocated and covered only $3.5 billion in FY 1998, up from only $2.7 billion during 1997 (CCC, 1998b). CCC refers to this amount as "credit guarantees outstanding" and the "total contingent liability". For clarity it is referred to herein as "exposure", or "coverage" which reflects the outstanding guarantees on which the U.S. government has contingent liability in the event of default.

The CCC has recognized a portion of exposure on their budget as an estimated liability since the enactment of the Credit Reform Act of 1990, which requires explicit scoring of guarantees, and a corresponding accounting entry on the current budget for any associated contingent liability. At the end of FY 1997, the budgeted guarantee liability was $2.2 billion (CCC, 1998a) -- an amount intended to reflect the actuarial value of the portfolio of outstanding guarantees. However, this estimate has little empirical or theoretical justification, and its likelihood for sufficiency is not known. Further, the tradeoffs between program size and liability have not been quantified, and the allocation among countries has not been examined in terms of the risk-efficiency. And, although there have been repeated calls for changes in the program design and in the coverage extended, little is known about the implications of various proposed alternatives to program costs. Finally, subsidy levels implicit in the current design are not well understood or documented – an issue receiving considerable attention in the World Trade Organization (WTO) negotiations.

To contribute to the understanding of the above issues, a theoretical loan guarantee model is developed and applied to provide direct empirical evidence about the actuarial costs of the existing GSM programs. In addition to evaluating the existing program, the model provides a direct mechanism to assess the marginal costs of changing guarantee activity to any other contemplated coverage level. Tradeoffs between the coverage volume (exposure) and the implicit budget liability are described in the context of an objective function that can accommodate both political and economic aspects. In any case, risk-efficiency is a compatible goal, and thus the optimal relative allocations across countries at any given program size can also be solved. The risk-efficiency at the portfolio level is examined, and guidance provided for improving the risk-efficiency of allocations across countries. Alternative policy objectives are considered and the associated optimal portfolio implications for each case are provided. Finally, popular recommendations for program design changes are evaluated in terms of their implied portfolio-level impacts.

Prior Work

Because the GSM programs are U.S. government functions, much of the work examining the budget and cost implications has likewise been conducted by government agencies. GAO (1992) conducted a cost/benefit study of the GSM programs and found the cost of the program to be "high" at that point in time, citing "high risk" recipients as the cause. A drawback to that study is that the static evaluation made it difficult to assess program performance at that point in time relative to other periods, or assess accumulated benefits through time. Also, the technique used provides little information about the value of the portfolio when the guarantees were originated, or more importantly *when the next guarantee is issued*. GAO (1997) acknowledges that trade negotiations such as the 2000 WTO talks, will result in additional scrutiny of GSM programs and therefore calls for improved valuation methods and evidence about implicit subsidy levels.

Mody and Patro (1996) survey the literature on the accounting practices used for guarantee valuation. When feasible, they cite contingent claims valuation as more acceptable than other methods. They also identify a general trend toward accounting for the contingent liability at the time guarantees are originated. In examining alternative approaches for evaluating actual programs in the U.S., they indicate that the GAO (1994) method is a "rule-of-thumb approach" that was developed for cases when the market price of debt is unknown or cannot be observed. Therefore, it is not easily generalized or applied to cases beyond the specific set of contracts examined. GAO (1994) proposed a somewhat ad-hoc budget scoring method, and computed the subsidy cost rate for the GSM-102 program at 25.1% of exposure, which contrasts sharply with the value of 7.4% proposed at the same time by the executive branch. However, neither went beyond simple credit scoring methods, and the resulting approaches both implied a constant estimated risk cost across different exposure levels.

While theoretically appealing, applications using contingent claims models (e.g. Black-Scholes style models) have faced a common problem of identifying the underlying asset or state variable. Schich (1997) proposes the use of a country's debt-servicing capacity as the underlying asset in a model of export credit insurance. He suggests two proxies for capacity, a debt-service ratio, and a ratio of reserves to imports, and regresses observed insurance premiums on the proxies. Conceivably, the proxies could be inserted directly into his equation to obtain theoretical values for the insurance rates and these could be compared to the observed premiums, potentially validating the proxies. Dahl, Wilson, and Gustafson (1999) model GSM guarantees where the value of a letter of credit is the underlying asset. While they find the guarantee value to be about 15% of the value of the guaranteed exports, the guarantee value is sensitive to the base value of the letter of credit and its volatility. Their method would not be useful if generalized to a portfolio setting, because the letter of credit does not reflect a country's capacity to repay, but only its likelihood.

One other commonly promoted approach to valuation uses the difference between the market rate of interest and the rate with a guarantee, commonly referred to as an implicit subsidy approach. Skully (1992) quantifies the implicit guarantee subsidy, and the subsidy of other U.S. export promotion programs, using these approaches. Similarly, Hyberg et al. (1995) quantify the size of the implicit subsidy provided by GSM guarantees for cases with observable guaranteed and non-guaranteed tradeable debt. They find that the subsidy averages about 4.5% of every dollar guaranteed for the countries examined. Guarantors often justify use of guarantees and subsidies with arguments that "additionality", or incremental sales that would not have taken place without the program, is worth more to producers than the cost of the guarantees. However, repeated attempts to identify and quantify "worldwide additionality" for GSM programs remain unsuccessful, leading GAO (1997) to question the appropriateness of the programs.

Yang and Wilson (1996a) model the allocation decisions of the CCC and other international guarantors of wheat. The quantity extended was found to be negatively related to risk and positively related to the level of imports for a given recipient. Yang and Wilson (1996b) found a positive relation between the size of GSM allocations and market share. While not specifically addressed, these results suggest that because larger allocations result in increased liability, the benefit of increased market share could potentially be more than offset by higher default costs.

Numerous changes have been proposed for the GSM programs even though the impacts of these changes are not clearly understood. Proposed modifications include the use of "better risk assessment methods" in general, and the limiting of exposure to high-risk countries (GAO, 1994). To offset costs they suggest that Congress eliminate the ban of fees over 1% of exposure and advocate that CCC institute risk-based fees (GAO, 1995b). To improve the overall performance they suggest eliminating the conflicting objectives of having exposure of at least $5.5 billion per year and that recipients be creditworthy enough to repay such exposure. A broader definition of eligible recipients would perhaps allow greater flexibility in assembling a portfolio (GAO, 1995a). Internally, the Foreign Agricultural Service is looking for ways to increase program activity levels while remaining attendant to risk (Habenstreit, 1998).

GSM Activity Levels and Existing Guarantee Portfolio

The most visible GSM program activity registers in new guarantee allocations. Beginning with an aggregate authorization level, the CCC offers guarantees to various countries for a wide array of eligible commodities. The CCC may not allocate its entire authorization if it fails to identify enough eligible recipients, or if it simply holds back part of the authorization for other unspecified reasons. Fiscal-year totals of new activity are provided in table 1 for the period 1985-98. As can be seen, these vary substantially through time reflecting changes in demand for U.S. commodities and changes in the risk profiles of recipient countries. New activity peaked in FY 1992 with just over $5 billion in guarantees. New activity dropped to below $3 billion as recently as FY 1995, resulting in significant unused allocations.

[Insert Table 1 here]

Exporters are charged a fee for guarantee coverage, which presumably is passed on to importers in the commodity price. Aggregate fee revenue represents the only explicit benefit of the programs to the CCC. Fee rates are set based on the terms of the guaranteed loans, the risk faced, and other factors. Guarantee fee revenue is simply the fee rate times the amount guaranteed (more detail on the fee rate process is provided in GPO, 1998, 1493.70). Aggregate annual fee revenues, shown in table 1, have generally been between $10 million and $20 million. Fee rates range from $0.31 per $100 covered, for GSM-102 guarantees with 12-month terms and annual payments, up to

$5.00 per $100 covered, for GSM-103 guarantees with 10-year terms and annual payments (www.fas.usda.gov).

Claims paid by CCC represent the most obvious and direct apparent measure of historic cost for the GSM programs. Before obtaining a GSM guarantee, an importer must obtain a letter of credit from an eligible domestic bank. If the importer's bank subsequently fails to pay the exporter, the CCC pays the claim and attempts to collect the balance from the importer's bank. Annual claims paid are shown in table 1. The majority of claims in terms of numbers of cases represent only small fractions of the outstanding exposures to each recipient. However, large claims occasionally occur as well, as in the case of Iraq, which has not made any payments since the Gulf War.

Once a claim is paid, CCC seeks to recover the amount from the importer, its bank, or its government. As a result, claims can be resolved by being repaid, rescheduled, or forgiven and written off. Until an agreement with the importing country is reached, "paid claims" are carried on the balance sheet of the CCC. These paid claims outstanding increased with the large claims paid during the early 1990s. These amounts, shown in table 1, reached more than $2 billion by the end of FY 1997.

Countries are given new allocations while still having outstanding balances from previous allocations. Provided in table 2, aggregate exposure at the end of the fiscal year reflects the amount under guarantee from both current and previous years that could still result in claims. The trend in exposure follows the pattern of new guarantees extended. End-of-year exposure peaked in FY 1992 following the record level of new guarantees that year.

[Insert Table 2 here]

In addition to carrying unresolved claims paid, CCC has rescheduled a sizable volume of guarantees through time, making them a direct creditor as well as a guarantor. These amounts are sometimes referred to as defaults (shown in table 2), but they are considered current, or are being partially serviced as opposed to being part of "claims paid". The level of defaults has increased over time approaching $7 billion at the end of FY 1997. The remaining columns in table 2 show the liability and allowances made by the CCC for claims paid outstanding and rescheduled defaults.

CCC acknowledges the expected cost of exposure in various capacities. In reference to new exposure "CCC recognized an estimated liability of $43 million for anticipated claims on shipments made" (CCC, 1998b, p. 17). In accordance with the Federal Credit Reform Act of 1990, guarantees extended under the GSM programs are required to be carried on the federal budget on an actuarially fair basis, although there is no agreement as to what that represents. Further, the portion of a program's outlays that is not expected to be recovered is required to be recognized as a subsidy under the notion that, "Subsidy costs approximate the present value of the estimated net cash outflows at the time the credit guarantees are disbursed by the lender." (ibid., p. 56). In aggregate the subsidy costs would be the sum of contingent-claims valuations of the guarantees, because fee revenue is subtracted afterward. For FY 1996, the subsidy limit was $374 million (ibid., p. 21) and the estimated subsidy cost was $310 million (ibid., p. 95). Given the visibility of the U.S. round of the WTO negotiations, the need for better estimates of these subsidy values is apparent.

Theoretical Valuation Model

Loan guarantees have a payoff structure identical to a put option (Merton, 1977). In a risk-neutral valuation setting, the value of a guarantee can be specified as:

(1) $$V(k) = kF(k) - \int_0^k rf(r)dr\,,$$

where r is a dollar valued return with a known distribution and k is the guaranteed return value analogous to the "strike" price in traditional option models. This characterization of guarantee values is adapted for application to the GSM guarantees. The return in this case is the repayment capacity available to service the GSM guarantees.

Valuation of credit guarantees as contingent claims requires that the repayment capacity distribution be identified and mathematically characterized for each country. Numerous alternative approaches have been developed for doing so. GAO (1994) constructs estimates of uniform distributions by observing single historic default frequencies. Historically, FAS used an internally-developed method to assess country risk, but has recently switched to a commercial vendor (Moody's) to provide country risk rating services that are used to assess the repayment likelihoods of recipient countries. However, their approach does not result in an explicit characterization of the repayment capacity distribution, and thus is not sufficient for the purposes of this model. Another method in use involves traditional credit scoring methods, most commonly employed in consumer and small commercial lending situations to assess relevant portions of an individual repayment capacity distribution. These methods usually impose a fairly simple functional form (e.g. logit) and estimate the influence of variables that differ across borrowers using some measure of default or performance from historic experience. Finally, as international finance markets have become relatively well developed, a number of commercial vendors have begun offering a wide array of country risk-rating data products that hold great promise for use in characterizing repayment capacity distributions.

Because a number of commercial vendors compete to provide literally hundreds of different country-specific risk indicators, there is the potential for great detail (and great overlap) in the information sets that characterize country-specific risks. Thus, information contained in country risk ratings from multiple sources was combined to forecast elements that characterize the repayment capacity distributions of GSM recipients. One important aspect of a repayment capacity distribution is the probability that the future level fails to exceed exposure. Hence, a model is needed to explain the probability that a recipient country will default. Using ratings from *Institutional Investor* and historic GSM defaults obtained from the CCC, a logistic model of the probability of default was estimated. The final specification is:

$$(2) \qquad P_j = 1/1 + e^{-(\alpha + \beta R_j)}$$

where P_j is the probability of default, α equals -1.274, β equals -0.047, and R_j is the *Institutional Investor* rating level for country j at the time the guarantee is extended. Data were collected on all countries included in the GSM programs over the sample period from 1985 to 1995.

Similarly, the severity of GSM defaults was modeled as a function of several *International Country Risk Guide* (ICRG) rating components. Observed default magnitudes were standardized to account for disparity of exposure levels and non-normality. The standardized severity was then modeled as a linear function of four ICRG components: Economic expectations vs. reality (EER), Quality of the bureaucracy (QOB), Racial and Nationality Tensions (RNT), and Foreign trade collections experience (FCR) over the same time period as the probability of default model. Then ICRG component levels were used to forecast the standardized severity for new guarantee recipients, which was subsequently unstandardized to obtain forecasts of the conditional mean of the repayment capacity distributions in the event a default occurs, C^d_j.

Given forecasts of the probability of default and conditional mean in cases of default, a beta distribution consistent with those characteristics can be uniquely identified for each guarantee recipient. The probability forecast can be used in the left side of a relation that determines the cumulative probability of the repayment capacity distribution evaluated at the exposure level for recipient j:

$$(3) \qquad P_j = \int_0^{E_j} f(c_j)\,dc_j$$

where E_j is the exposure or guarantee level for recipient j and $f(c_j)$ is its unknown repayment capacity distribution. Likewise, the forecast of the conditional mean is related to the unknown repayment capacity distribution because:

$$(4) \qquad C_j^d = \int_0^{E_j} c_j \frac{f(c_j)}{P_j} dc_j \, .$$

Thus, equations 3 and 4 permit the identification of the beta distribution associated with the repayment capacity distribution. For recipient j, the solution is:

$$(5) \qquad f_j(c|a,b,u) = \frac{1}{uB(a,b)}\left(\frac{c}{u}\right)^{a-1}\left(1-\frac{c}{u}\right)^{b-1}, \quad 0 \le c \le u,$$

where a, b, and u are greater than zero and $B(a,b)$ is the beta function. The value $c = x/u$ is the point on the distribution that partitions the probability of default from nondefault, or can be viewed as the relative strike price in an option pricing context where x equals E_j. The estimated beta parameters are shown in table 3. Other methods for determining the repayment capacity distributions including those in currently in use by FAS or in commercially available credit scoring packages could likewise be used if preferred.

For the beta distribution the guarantee value is equal to:

$$(6) \qquad V_j(x|a,b,u) = xI_x(a,b) - u\frac{B(a+1,b)}{B(a,b)}I_x(a+1,b),$$

where $I_x(a,b)$ is the cumulative beta distribution function. The FY 1996 exposure levels and corresponding guarantee values are shown in table 4. The total exposure level reflects the end of FY 1995 exposure level and the new guarantees extended in FY 1996. The guarantee values are computed at the exposure levels for each of the major guarantee recipients at the end of FY 1996.

Also shown in table 4 are the fractions of the total portfolio exposure by country, ES_j, and the fractions of the total guarantee liability or risk shares, RS_j, for each country. The exposure share is largest for Mexico at over 50% and smallest for Russia at less than 1%. However, the risk shares convey very different information. Even though Algeria only has a relative volume of 11% (exposure share), its relative portion of the contingent cost is the largest at 68% (risk share). The guarantee values as a percentage of exposure can also be compared to the guarantee fees charged by CCC. These risk-adjusted fee equivalents, shown in table 4, display sizable variation across countries. The risk-adjusted fee equivalent is the actuarially fair rate for that specific country's case. Note that most of the risk-adjusted fees are less than the actual fixed rate of $0.663 that would be charged for $100 coverage of 3-year term GSM-102 guarantees.

Framework to Evaluate Optimal Exposure

First, consider a guarantor with a single potential recipient country. Assume that there exists a positive constant "bonus rate", or economic benefit per dollar guaranteed with value d. The bonus rate takes into account the additionality and slippage of the guarantee program and the impact on the prices of commodities sold through non-program channels. The total bonus (analogous to a consumer and producer surplus measure) is simply the bonus rate, d, times the exposure, E. Figure 1 depicts the relationships among this bonus value and the guarantee value, fee revenue, marginal guarantee value and probability of default under a guarantee. The guarantee exposure is shown on the horizontal axis and corresponding probability of default is on the vertical axis along with the associated dollar values of the guarantee, bonus, and fees. The total bonus is shown as the upper straight line with a slope equal to the bonus rate per dollar of exposure, in this example shown with a slope equal to 0.6. The lower of the curved lines represents the value of a guarantee as a function of its exposure, $V(E)$, calculated using equation (6). Notice that guarantees increase in value as the coverage (or analogously the strike price) increases.

[Insert figure 1 here]

The guarantor chooses the fee rate and exposure level to set for the recipient. For convenience, assume that the fee rate is set to a constant, *m*, at some fraction of the exposure level, and is less than the bonus rate. The total fee revenue is simply $m*E$. The fee revenue is depicted by the lower straight line in figure 1 with a slope of 0.2 in this example. For a given fee rate and bonus rate, the choice of optimal guarantee coverage reduces to a choice of exposure level.

For a given fee rate, the optimal exposure depends upon the objective of the guarantor. If the objective of the guarantor were to maximize net fee revenue only, the guarantor would set the exposure at point *A* in figure 1 where the marginal fee revenue equals the marginal cost associated with the guarantee value. The marginal cost of the guarantee is reflected in the slope of the guarantee value function. At point *A* the slope of the guarantee value equals 0.2, and thus, this exposure level results in the maximum expected profit from fees. This point also maximizes the benefits to the program if there were no bonus.

If the objective were instead to maximize the net bonus from the program, the guarantor would not be concerned about the fee revenue and would instead choose exposure at point *C* in figure 1. Here the marginal cost associated with the guarantee value equals the marginal bonus of 0.6. At point *C*, the guarantor would operate at an expected cost that exceeds fee revenues, but would maximize the welfare distributed back to the producers less direct actuarial costs of the guarantees. This case would require a subsidy to be injected at the program level using a mechanism similar to that currently employed in the GSM programs.

If the objective were to maximize the bonus subject to operating at the break-even point with regard to fee revenue and expected cost, the guarantor would operate at *B*. At point *B*, the fee revenue equals the expected cost or guarantee value. Unlike the other potential optimal points, the crossing point does not depend on the slope of the guarantee value at that point. Point *B* is also the perfectly competitive solution for a private guarantor. With a lower bonus level, point *C* could be to the left of point *B*, and point B would not be the most cost-effective solution.

For given fee and bonus rates, there is a unique solution for the single country case. Changing either the fee or bonus rate does not change the nature of the optimal solutions, but only affects their locations. Thus, by changing the fee rate (bonus rate) a set of points can be found at which the slope of the guarantee value equals the fee rate (bonus rate) across exposure levels. Another set of points exists where the guarantee value equals fee revenue across exposure levels. These facts are useful in the construction of risk-efficient portfolios across multiple countries.

Regardless of the guarantor's objective, the slope of the guarantee value, or marginal guarantee value, is needed to determine the optimal exposure level. The slope of interest is the partial derivative of the guarantee value with respect to the exposure level. To illustrate, first consider the general guarantee valuation formula from equation (1). Its partial derivative with respect to the strike price k reduces to F(k), or the cumulative distribution function evaluated at k. Similarly, if the repayment capacity follows a beta distribution, then:

(7) $$\frac{\partial V_j(x|a,b,u)}{\partial x} = I_x(a,b).$$

In the general case, a guarantor has multiple potential guarantee recipients comprising a portfolio. A net revenue-optimizing guarantor would seek to cover as many dollars of exports for a given level of liability as possible. The risk-efficient objective function for a guarantor is therefore:

(8) $$\max_{E_j}\left\{\sum_{j=1}^{J} d_j E_j + \sum_{j=1}^{J} m_j E_j - \sum_{j=1}^{J} V_j\left(E_j\right)\right\},$$

where d_j is the bonus rate for country j, E_j is the exposure to country j, m_j is the fee rate for country j, and $V_j(E_j)$ is the guarantee value for country j.

Assuming the existence of single fee and bonus rates *m* and *d*, respectively for each guarantee recipient, the first-order conditions for the guarantor are:

$$(9) \qquad \frac{dV_j(x)}{dx} = F_j(E_j) = d + m \quad \forall j.$$

Importantly, this set of first-order conditions applies regardless of whether the objective is to maximize fee profits, bonus profits, or joint profits. Under the optimal risk-efficient solution, E_j is chosen by country such that $F_j(E_j)$ is equal across all recipients. Its level depends on the objective being pursued, but the equal marginal condition is still obtained at the optimal solution.

The solution set is a portfolio of guarantees held by the guarantor. A typical portfolio is measured in terms of its expected return and risk. The guarantor's portfolio has a return equal to the aggregate fee revenue plus the aggregate bonus revenue, and is a function of the exposure levels. The portfolio's risk is its expected cost or aggregate guarantee values. To describe the guarantee portfolio, total exposure, *TE*, is defined as the sum of exposure across recipients, or:

$$(10) \qquad TE = \sum_{j=1}^{J} E_j ,$$

and guarantee liability, *GL*, is defined as the sum of the guarantee values across recipients, or:

$$(11) \qquad GL = \sum_{j=1}^{J} V_j\left(E_j\right).$$

Political preference functions dictate the acceptable tradeoff between total exposure and guarantee liability. These preference functions are assumed to increase in the directions of higher total exposure and of lower guarantee liability. For a given objective, the portfolio frontier is obtained by mapping points where optimal total exposure is measured against its corresponding guarantee liability. For example, if the objective is to maximize bonus profits, then there is a set of optimal outcomes corresponding to different bonus rates. The frontier thus constructed gives the most cost-effective combination of total exposure and guarantee liability associated with different bonus rates. The point of tangency between the frontier and the political preference functions then gives the optimal portfolio.

Identification of the Optimal Frontier

Next, the cumulative probability is set equal to a given revenue rate, and the exposure level for a country identified that that is the solution to the inverse of the cumulative distribution function at that rate. Once the optimal exposure level is known, the guarantee value for that exposure level is computed. The process is then repeated for desired levels of the cumulative probability of the repayment capacity across countries, and the risk-efficient frontier of guarantee allocations is constructed.

To demonstrate the solution, consider a revenue rate equal to 1% of the exposure. Assume the objective is to maximize total net revenue from both the fee, with a 0.5% rate, and the bonus, with a 0.5% rate – the fee rate corresponding to a charge of $0.50 for $100 of exposure. To maximize total net revenue the guarantor would find the exposure levels such that the cumulative probability of default equals 1%. The resulting optimal exposure levels for the different countries are shown in table 5, along with the corresponding guarantee values for the different countries. Each country has the same probability of the guarantee being "exercised" or defaulting, but the costs of the guarantees and exposure levels differ across countries.

[Insert Table 5 here]

Under this example on the risk-efficient frontier, Algeria has an optimal exposure level of $679 million. Fee revenue would equal $3.4 million with an expected bonus of $3.4 million. The guarantee has an expected cost equal to its value of $486,039. Hence, the guarantee would be expected to return just under $3 million in net fee revenue with the expected bonus of $3.4 million. At any time, however, Algeria could default on the entire $679 million resulting in a substantial loss relative to the joint net fee revenue and bonus revenue. Consider also the fee equivalent amount shown in the last column of table 5. This value reflects the dollar cost per $100 of exposure, and is interpretable as the guarantee value as a percent of the optimal exposure (on a $100 basis). While under the assumed fee rate Algeria would pay $0.50 for every $100 of exposure, the coverage only has an expected cost of $0.07 for every $100 of exposure.

The exposure and risk shares, ES_j and RS_j, vary substantially across countries, but are risk-efficient by construction (no greater coverage at lower expected cost is possible, or no lower cost for that given coverage is possible). For the most part, the variation reflects the proximity to locations on the repayment capacity distributions where the probability of default is extremely small - or where the guarantee coverage has minimal cost over a large range. Mexico has the largest exposure share at over 50 percent. However, Algeria has the largest share of the risk in terms of the value of its guarantee relative to guarantee liability at just under 45 percent. In contrast, GAO (1995) implies that Russia's large share of the GSM risk is by itself undesirable. However, portfolios on the frontier share the feature that all guarantee recipients represent an equivalent cost at the margin. That is, for an additional dollar of total exposure the expected guarantee liability is the same, regardless of the recipient.

[Insert table 5 here]

Once an efficient portfolio is obtained, the revenue rate can be changed and other efficient portfolios identified. Because the revenue rates equal the slope of the cumulative distribution function of the repayment capacity for each country, the slope of the frontier also corresponds to the fee and/or bonus rate. Hence, the frontier also shows the effects on the optimal portfolio for different fee and/or bonus rates. If the fee rate is low, for instance as a result of a political mandate, then the optimal portfolio would also be low in terms of total exposure and guarantee liability. If higher fee rates could be charged, then a higher total exposure level could be obtained while remaining risk-efficient. Conversely, if a total exposure were desired or mandated, the frontier also shows the fee rate (or bonus rate) necessary to be optimal under that mandated volume of coverage. Guarantee liability, *GL,* is small for low revenue rates, reflecting the low likelihood of any guarantee payments for the corresponding exposure. As the revenue rate or slope increases, total exposure or *TE* increases at a constant rate, while *GL* increases at an increasing rate. At the highest revenue rates the marginal cost of extending additional guarantees approaches one.

The frontier, shown in figure 2, has the shape expected of a combination of option values. As all of the guarantee values are convex, their weighted average, inverted, is necessarily concave. Evident in the graph is the relation whereby *GL* approaches zero as *TE* decreases. The slope approaches one as *TE* increases (although the differing scales on the axes in figure 2 mask that relation somewhat). All possible portfolios are located on or below this frontier with either a higher *GL* or lower *TE* than the portfolios on the frontier.

[Insert figure 2 here]

Evaluating Risk-Efficiency of the GSM Portfolio

The actual GSM portfolio is next evaluated by comparing its total exposure and estimated liability to the efficient frontier. The actual portfolio characteristics were summarized in table 4, using FY 1996 data. Total exposure in the sample was approximately $7.5 billion. Guarantee liability was $9.5 million for the sample. Actual fee revenue during FY 1996 was $21 million or about 0.6% of guarantees extended during that year (CCC, 1998b). That level of fee revenue is consistent with an average fee rate of $0.60 per $100 of exposure. That value also appears reasonable given the predominance of GSM-102 guarantees with terms between two and three years. The actual FY 1996 portfolio is shown in figure 3, along with the portfolios on the efficient frontier.

[Insert figure 3 here]

The actual FY 1996 portfolio is located inside the frontier with both a lower total exposure and higher guarantee liability than if it had been efficient. The implications are that a higher total exposure could have been obtained for the same level of guarantee liability, or that a lower guarantee liability could have been obtained for the same level of total exposure.

Using CCC data, the total exposure is less than $8.2 billion, and the guarantee liability was approximately $310 million for FY 1996 (CCC, 1998b). For comparison purposes these can be related to the efficient frontier shown in figure 3.

Risk efficiency can unambiguously be improved by moving to any point on the segment of the frontier between the point on the frontier directly above the actual portfolio and the point on the frontier directly to the left of the actual portfolio. For example, an efficient portfolio can be found with total exposure just above the actual FY 1996 level. Such a portfolio (not shown) can be found by changing the CDFvalues across countries until the exposure is directly above the actual FY 1996 level. Another portfolio on the frontier, shown in table 6, has a guarantee liability least as large as the FY 1996 portfolio, but with a higher total exposure level. The efficient portfolio has total exposure of $7.538 billion, about $24 million greater than in the FY 1996 portfolio. The shares and fee equivalent measures are similar to the base case and the other efficient portfolio. This exercise demonstrates that the significance of following optimal allocation rules in terms of the guarantee liability and total exposure could be substantial.

[Insert Table 6 here]

Expansion Path Solution

A break-even strategy may be chosen by a public guarantor who seeks to gain as much bonus revenue as possible without an expected loss in excess of fee revenue. A competitive solution would also have the characteristics of the break-even solution, although the motivation would be the absence of fee revenue in excess of the cost of extending the guarantee. By finding the set of optimal solutions for different fee rates, an expansion path is obtained that can be used to evaluate existing portfolios relative to the expansion path. Implicit in the expansion path solution is a bonus rate high enough to dominate the net revenue maximizing solutions. In other words, if the guarantor were following the net revenue maximizing objective, the solutions would involve an expected cost greater than fee revenue.

To obtain portfolios on the expansion path, the fee rate was set to a fixed proportion of exposure, m. Once the fee rate is set, the exposure level of individual countries was adjusted until the break-even level was identified, $mE_j = V_j(E_j)$ for each country. To find the break-even levels of E_j, the absolute difference between the revenue and guarantee value was summed across countries, then minimized by changing E_j across countries. The result is a portfolio on the expansion path with total exposure, guarantee liability, and break-even exposure levels for each country. The process was then repeated for different fee rates.

Consider the break-even portfolio corresponding to a fee rate of $0.50 for $100 of exposure. This fee rate is close to the average fee rate of $0.60 charged in FY 1996, with the resulting break-even portfolio as documented in table 7. Fee revenue in this case is 0.5% of total exposure or approximately $38 million (also equal to the guarantee liability).

[Insert Table 7 here]

Other interesting features of the break-even portfolio are evident in table 7. For example, the risk shares are the same as the exposure shares in this case -- a feature that was identified as desirable by GAO (1995), but it is doubtful that economic efficiency was their motivation for suggesting so. This resulting relation holds because the fee rates were set the same across countries and thus the marginal benefits from additional exposure are equated across countries. The other feature is the equality of the fee charged and the fee equivalent amounts.

The expansion path for different fee rates is shown in figure 4. Even over this small band of fee rates, the liability quickly reaches $120 million. The total exposure for portfolios on the expansion path is slightly higher than for those on the efficient frontier for similar revenue rates. Following a break-even strategy would thus require greater reliance on external subsidies or long-term sources of credit to fund the relatively larger potential swings in program solvency.

[Insert figure 4 here]

Program Design Changes

One available method for changing guarantee liability is to change the subordination method or level. GSM guarantees typically cover 98 percent of credit amounts under guarantee, but can cover up to 100 percent of the credit. In theory, the partial subordination encourages additional screening and monitoring of importers by exporters and lenders, and helps to avoid moral hazard problems. By changing the percentage covered, guarantors can shift risk and responsibility to exporters and lenders. The cost of doing so would be reflected in any increase in financing cost ultimately passed to importers or reductions in program activities.

Consider the FY 1996 portfolio evaluated using the guarantee valuation method. Implicit in the portfolio is 100 percent coverage on total exposure. Next, consider a portfolio with 99 percent coverage on total exposure. Assume the exposure for different countries, E_j, remains unchanged. A reduction to 99 percent coverage implies the guarantee value or expected cost by country borne by the guarantor is $0.99 * V_j(E_j)$. The adjusted portfolio is shown in table 8. The individual guarantee values and fee equivalent amounts are reduced relative to the base case. The exposure shares are unchanged, while the risk shares are negligibly changed.

An alternative subordination method would be to provide full coverage on only a fraction of exposure. At the country level this method implies a greater shift in guarantee cost between the guarantor and exporter or lender. The guarantee now covers a lower exposure level, analogous to a put option with a lower strike price. For example, let the full coverage be on 99 percent of the exposure. Then, guarantee values are evaluated where $V_j(0.99 * E_j)$. The lower exposure levels and the different guarantee values are shown in table 8.

[Insert Table 8 here]

The guarantee values are now substantially lower than in either the base case or the other subordination case. Because the slopes of the guarantee values are quite low for the initial exposure levels, the guarantee values are quite sensitive to changes in the exposure level. There is a modest change in the risk shares reflecting the different distributions of the guarantee recipients. The fee equivalent amounts change slightly as well. With lower percentages of exposure the guarantee values approach zero for a number of countries. Hence, guarantee liability is greatly reduced as the subordination level is lowered under this method. Further reductions in the subordination levels for both subordination methods result in lower guarantee liability for the resultant portfolios. These portfolio-level changes are shown in figure 5. The full-coverage method shows a greater sensitivity to the subordination level than the fractional coverage method. At the 95 percent subordination level, the guarantee liability is still above $9 billion for the fractional coverage method. However, the guarantee liability is down to $4.5 billion for the full coverage method. Hence, changing from a fractional coverage on the full value to a full coverage on a fractional value of the guarantee is a particularly attractive design change to those interested in minimizing budget exposure. Changes in the down-payment level are analogous the changes in full coverage on a percentage of exposure.

This result occurs because a larger down-payment reduces the amount the guarantee recipient has to pay when the credit is due. A larger down-payment, however, may change the final repayment capacity of the guarantee recipient.

[Insert figure 5 here]

Conclusions

This paper provides a theoretical model of guarantor activity that allows the guarantor to quantify the tradeoff between the exposure and liability of guarantees in a portfolio. The model shows that a guarantor seeking to maximize either net fee or bonus revenue would do so by extending guarantees such that the marginal value of guarantees is equated across recipients. A risk-efficient frontier for guarantee portfolios results where the cost-effective exposure level depends on the available fee or bonus, and the marginal cost of guarantees is equated across countries. A guarantor may also choose to maximize the fee revenue in excess of default costs, or maximize the total bonus net of default costs, or pursue the equivalent of the private guarantor's objective. In any case, the methods provide a means of identifying the optimal portfolio for the particular objective pursued.

The actual GSM guarantee portfolio was compared to the optimal frontier that could have been obtained. The actual portfolio was found to be inefficient in terms of both the total exposure and guarantee liability. Hence, it would have been possible to either extend more guarantees for the same liability or reduce the liability at the same total exposure level. Thus, the model provides a framework for use by guarantors to adjust exposure levels among guarantee recipients to achieve efficient portfolios.

Both internal and external changes to program parameters would impact the chosen guarantee portfolio. Different fee and/or bonus rates imply that different portfolios on the efficient frontier are optimal. Obtaining different levels of total exposure may require a different fee rate or an acceptance of losses on fees if other benefits are considered. Changing the subordination method or level would change the optimal guarantee portfolio. The amount depends on the nature of the beginning portfolio.

Future research may address the composition of the guarantee portfolio in the traditional manner. Private guarantors, or the agents of a public guarantor, may act as though they are risk-averse and would thus discount risk. Hence, any correlation between guarantee recipients in the guarantee portfolio could be assessed to account for the tradeoff between risk and return. Such an investigation may also be beneficial from a budgeting standpoint, because loss provisions could be adjusted to account for any group of countries that would be more or less likely to default in unison.

Regardless of the guarantor's objective or constraints there exists rational methods to manage guarantees and portfolios in a risk-efficient manner. Hence, the analysis is part of a larger scope of problems associated with managing credit guarantee programs. In addition, the framework itself can be expanded to further accommodate program-level behavior and policy-level ramifications. Such analysis is warranted because of the sensitivity of the guarantee portfolios that necessitates and guides a guarantor's risk management decisions.

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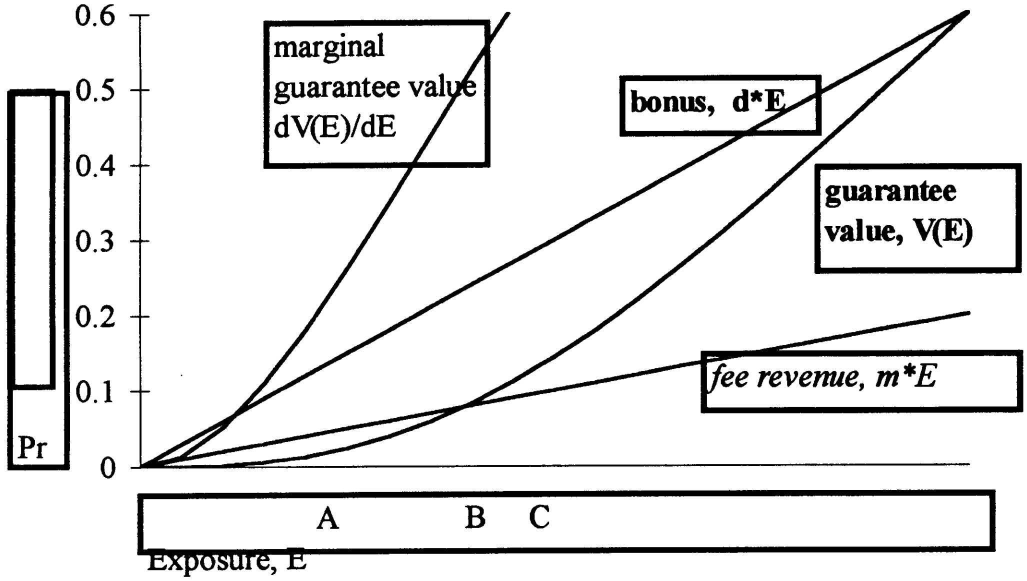

Figure 1. Guarantee program components and optimal exposure level, guarantee value, probability of default, fee revenue and bonus levels for different objectives.

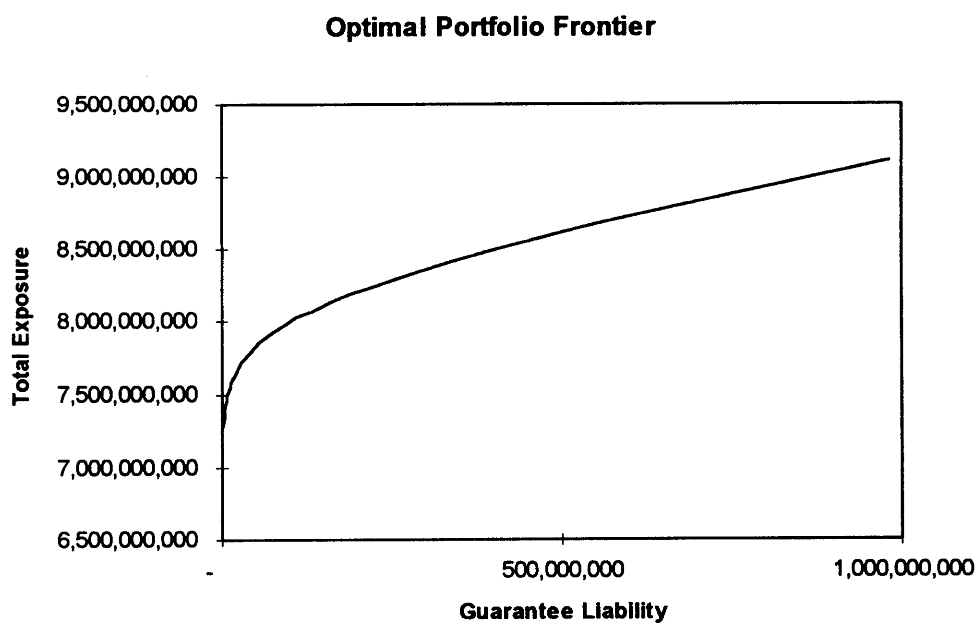

Figure 2. Efficient guarantee portfolio frontier

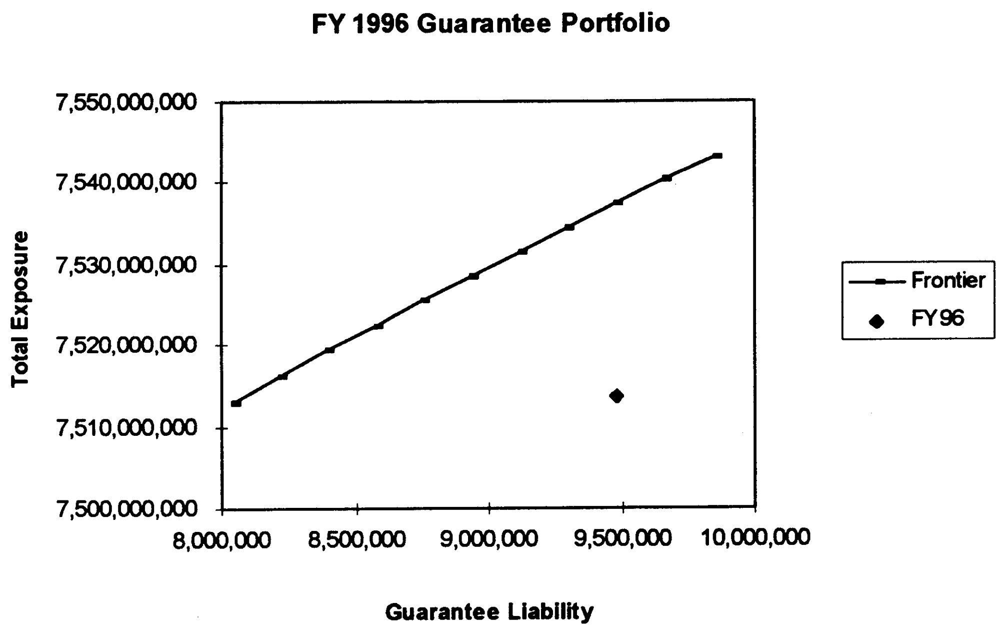

Figure 3. FY 1996 portfolio in relation to the efficient portfolio frontier

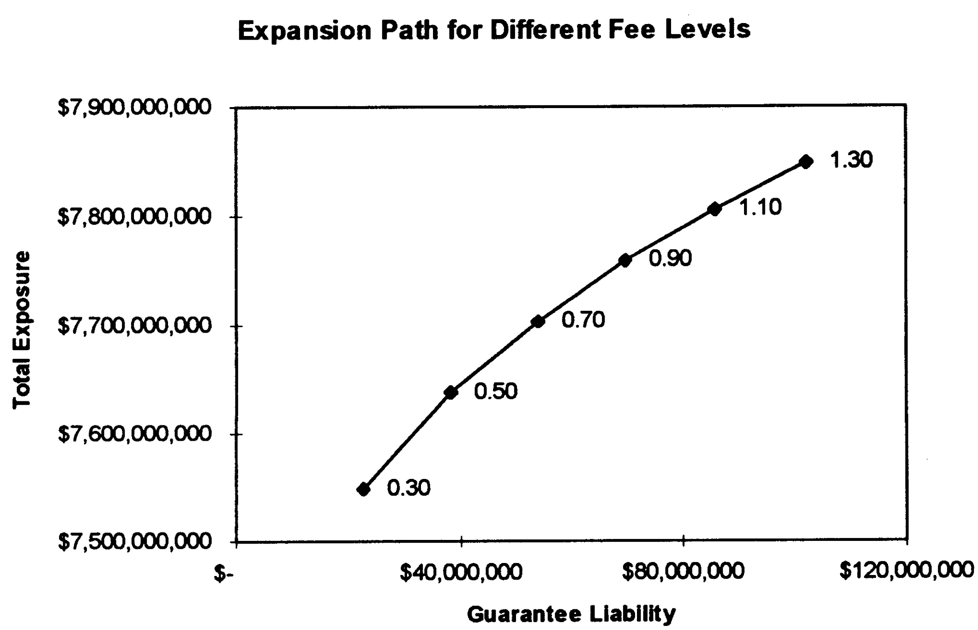

Figure 4. Expansion path for different fee rates and break-even objective

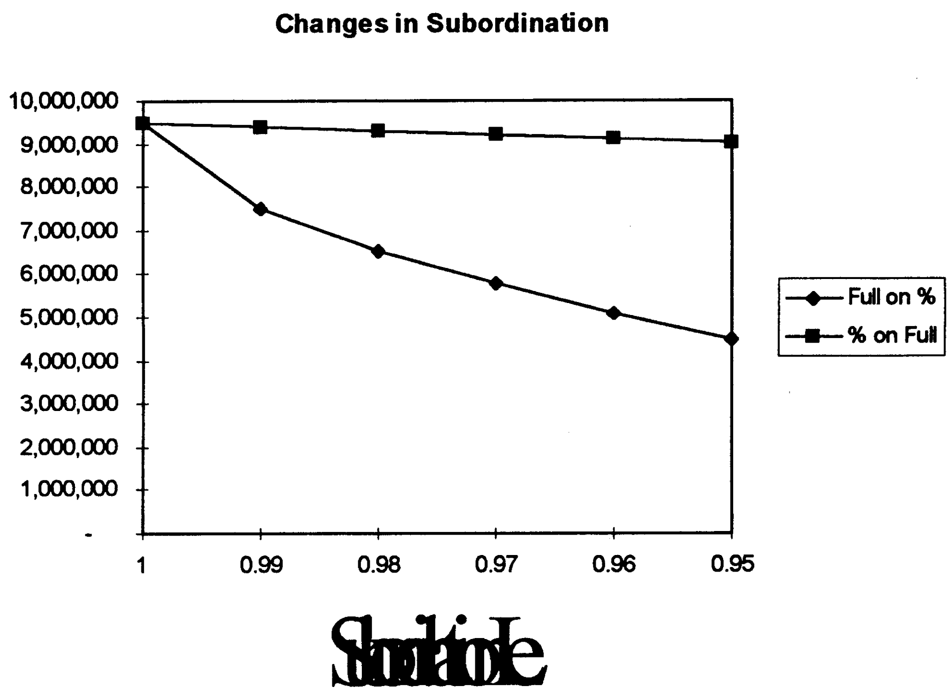

Figure 5. Changes in guarantee liability from different subordination scenarios

Table 1. Annual Guarantee Activity and Claims Data

Fiscal Year	Guarantees Extended ($ million)	Guarantee Fees ($ million)	Claims Paid During FY ($ million)	Claims Paid Outstanding ($ million)
1985	2,674	16	184	1,037
1986	2,503	15	328	162
1987	2,674	16	184	269
1988	4,557	na	287	225
1989	3,218	na	4	234
1990	4,127	na	17	194
1991	4,360	29	780	971
1992	5,083	39	705	1,465
1993	3,839	34	1,365	2,714
1994	3,219	17	1,168	1,693
1995	2,906	14	737	1,677
1996	3,424	21	223	2,071
1997	3,196	15	31	2,072
1998	3,405	na	24	na

Sources: Data through fiscal year 1996 are from Annual Report of the Commodity Credit Corporation (various issues). Other data are from a document marked "DRAFT" for Fiscal Year 1997, and related documents received November 10, 1998 from CCC (1998a).

Table 2. Annual Exposure and Rescheduled Defaults with Contingent Values

Fiscal Year	End of FY Exposure ($ million)	End of FY Liability ($ million)	End of FY Defaults ($ million)	End of FY Allowance ($ million)
1985	5,709	na	1,670	na
1986	4,395	na	2,113	na
1987	4,484	na	2,626	na
1988	6,022	1,961	2,907	1,288
1989	8,366	2,608	2,627	1,165
1990	8,240	2,527	2,622	1,263
1991	8,350	1,875	2,298	1,026
1992	9,634	4,302	4,349	2,846
1993	8,634	3,050	5,587	3,396
1994	6,567	1,089	5,812	3,794
1995	4,772	430	6,782	3,207
1996	5,339	1,719	6,891	1,651
1997	4,675	2,183	6,851	1,911
1998	4,286	na	na	na

Sources: Data through fiscal year 1996 are from Annual Report of the Commodity Credit Corporation (various issues). Other data are from a document marked "DRAFT" for Fiscal Year 1997 received November 10, 1998 and CCC (1998a).

Table 3. Beta Distribution Parameters for FY 1996 GSM Recipient Countries

FY 1996 GSM Recipient	Upper Bound, *u* ($ million)	Beta Parameters *a*	*b*
Algeria	5,000	26	92
Brazil	500	8,156	22,967
Egypt	500	6,811	9,017
Indonesia	1,000	13	20
Jordan	120	21,172	26,308
S. Korea	1,200	3,512	7,947
Mexico	12,000	6,330	13,094
Morocco	1,500	14,268	37,387
Pakistan	2,000	4,479	7,279
Romania	500	381	1,010
Russia	500	19	132
Sri Lanka	500	19	52
Tunisia	1,000	261	782
Turkey	1,000	504	2,039

Table 4. Exposure and Guarantee Values for FY 1996 GSM Recipient Countries

GSM Recipient	Exposure	Guarantee Value[a]	Exposure Share	Risk Share	Fee Equivalent[b]
Algeria	$850,931,486	$6,441,075	11.3%	67.9%	$0.757
Brazil	$129,004,690	$26,705	1.7%	0.3%	$0.021
Egypt	$211,998,945	$44,625	2.8%	0.5%	$0.021
Indonesia	$237,521,815	$582,639	3.2%	6.1%	$0.245
Jordan	$53,106,993	$8,572	0.7%	0.1%	$0.016
S. Korea	$355,714,139	$16,008	4.7%	0.2%	$0.005
Mexico	$3,839,226,405	$605,474	51.1%	6.4%	$0.016
Morocco	$409,248,707	$50,983	5.4%	0.5%	$0.012
Pakistan	$748,127,835	$238,954	10.0%	2.5%	$0.032
Romania	$127,915,154	$162,816	1.7%	1.7%	$0.127
Russia	$47,047,600	$511,319	0.6%	5.4%	$1.087
Sri Lanka	$92,856,140	$500,504	1.2%	5.3%	$0.539
Tunisia	$226,410,946	$170,857	3.0%	1.8%	$0.075
Turkey	$184,425,536	$119,638	2.5%	1.3%	$0.065
Total	$7,513,536,390	$9,480,168	100.0%	100.0%	

Note: [a] The guarantee is valued for the actual exposure level. [b] Reflects the actuarial value of the guarantee value per $100 of exposure at the actual size.

Table 5. Portfolio on Efficient Frontier with One-Percent Revenue Rate

Guarantee Recipient	Optimal Exposure	Guarantee Value	Exposure Share	Risk Share	Fee Equivalent
Algeria	$697,350,502	$486,039	9.6%	44.7%	$0.070
Brazil	$128,144,890	$4,177	1.8%	0.4%	$0.003
Egypt	$210,591,942	$6,640	2.9%	0.6%	$0.003
Indonesia	$214,388,847	$214,731	3.0%	19.7%	$0.100
Jordan	$52,872,941	$926	0.7%	0.1%	$0.002
S. Korea	$355,844,164	$17,265	4.9%	1.6%	$0.005
Mexico	$3,817,224,026	$135,433	52.6%	12.5%	$0.004
Morocco	$407,472,253	$9,922	5.6%	0.9%	$0.002
Pakistan	$741,112,232	$30,099	10.2%	2.8%	$0.004
Romania	$123,247,504	$19,222	1.7%	1.8%	$0.016
Russia	$36,034,584	$30,792	0.5%	2.8%	$0.085
Sri Lanka	$77,348,709	$64,401	1.1%	5.9%	$0.083
Tunisia	$220,007,896	$42,422	3.0%	3.9%	$0.019
Turkey	$180,127,263	$25,329	2.5%	2.3%	$0.014
Total	$7,261,767,755	$1,087,398	100.0%	100.0%	

Table 6. Efficient Portfolio with Higher Total Exposure than FY 1996

Guarantee Recipient	Efficient Exposure	Guarantee Value	Exposure Share	Risk Share	Fee Equivalent
Algeria	$822,350,979	$4,303,453	10.9%	45.3%	$0.523
Brazil	$129,130,431	$33,888	1.7%	0.4%	$0.026
Egypt	$212,155,655	$53,767	2.8%	0.6%	$0.025
Indonesia	$271,197,796	$1,954,989	3.6%	20.6%	$0.721
Jordan	$53,090,842	$7,492	0.7%	0.1%	$0.014
S. Korea	$359,921,443	$140,195	4.8%	1.5%	$0.039
Mexico	$3,849,167,347	$1,098,317	51.1%	11.6%	$0.029
Morocco	$409,810,983	$80,416	5.4%	0.8%	$0.020
Pakistan	$748,208,731	$244,013	9.9%	2.6%	$0.033
Romania	$127,837,539	$157,854	1.7%	1.7%	$0.123
Russia	$44,219,077	$282,015	0.6%	3.0%	$0.638
Sri Lanka	$94,190,657	$579,899	1.2%	6.1%	$0.616
Tunisia	$230,186,701	$350,088	3.1%	3.7%	$0.152
Turkey	$186,179,042	$208,132	2.5%	2.2%	$0.112
Total	$7,537,647,222	$9,494,518	100.0%	100.0%	
FY96	$7,513,536,390	$9,480,168			

Table 7. Break-Even Guarantee Portfolio with Fee Rate of $0.50

Guarantee Recipient	Break-Even Exposure	Guarantee Value	Exposure Share	Risk Share	Fee Equivalent
Algeria	$818,978,370	$4,094,892	10.7%	10.7%	$0.500
Brazil	$131,324,294	$656,621	1.7%	1.7%	$0.500
Egypt	$215,692,810	$1,078,464	2.8%	2.8%	$0.500
Indonesia	$258,908,773	$1,294,544	3.4%	3.4%	$0.500
Jordan	$53,749,387	$268,747	0.7%	0.7%	$0.500
S. Korea	$367,340,828	$1,836,704	4.8%	4.8%	$0.500
Mexico	$3,917,327,710	$19,586,639	51.3%	51.3%	$0.500
Morocco	$415,821,106	$2,079,106	5.4%	5.4%	$0.500
Pakistan	$762,354,832	$3,811,774	10.0%	10.0%	$0.500
Romania	$131,900,161	$659,501	1.7%	1.7%	$0.500
Russia	$43,042,082	$215,210	0.6%	0.6%	$0.500
Sri Lanka	$92,118,962	$460,595	1.2%	1.2%	$0.500
Tunisia	$237,739,860	$1,188,699	3.1%	3.1%	$0.500
Turkey	$191,967,310	$959,837	2.5%	2.5%	$0.500
Total	$7,638,266,486	$38,191,332	100.0%	100.0%	

Table 8. FY 1996 Portfolio with Full Coverage on 99% of Total Exposure

Guarantee Recipient	99% of FY 1996 Exposure	Guarantee Value	Exposure Share	Risk Share	Fee Equivalent
Algeria	$842,422,171	$5,730,883	11.3%	76.3%	$0.680
Brazil	$127,714,644	$1,415	1.7%	0.0%	$0.001
Egypt	$209,878,956	$2,144	2.8%	0.0%	$0.001
Indonesia	$235,146,596	$529,507	3.2%	7.0%	$0.225
Jordan	$52,575,923	$22	0.7%	0.0%	$0.000
S. Korea	$352,156,998	$1,622	4.7%	0.0%	$0.000
Mexico	$3,800,834,141	$37,555	51.1%	0.5%	$0.001
Morocco	$405,156,220	$732	5.4%	0.0%	$0.000
Pakistan	$740,646,556	$25,755	10.0%	0.3%	$0.003
Romania	$126,636,002	$95,910	1.7%	1.3%	$0.076
Russia	$46,577,124	$465,480	0.6%	6.2%	$0.999
Sri Lanka	$91,927,579	$450,671	1.2%	6.0%	$0.490
Tunisia	$224,146,837	$107,158	3.0%	1.4%	$0.048
Turkey	$182,581,281	$63,634	2.5%	0.8%	$0.035
Total	$7,438,401,026	$7,512,488	100.0%	100.0%	