



1990

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Recommended Citation

Chadesh '90, Jane, "Estimating the Risk of Third World Debt" (1990). *Honors Projects*. Paper 41.
http://digitalcommons.iwu.edu/econ_honproj/41

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Estimating the Risk of Third World Debt

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April 23, 1990

In August 1982, Mexico announced that it was unable to meet its debt obligations then falling due. Since this announcement more than 40 countries have been forced to reschedule on debt owed to commercial banks. Commercial banks have been criticized for blindly providing the lesser developed countries (LDCs) more credit and exposing themselves to more and more risk. For example, six months prior to Mexico's announcement that it could not meet its debt obligations, Mexico had been granted 6.4 billion dollars in new loans to make a total of 84 billion dollars in loans that needed to be rescheduled. If commercial banks had had more information on the credit risk of the LDCs, they could have foreseen such an event and taken some precautions, such as curtailing lending, to minimize their losses. Increased information on the riskiness of LDC debt could be extremely useful to commercial banks when making lending decisions or provisions. The purpose of this research is to estimate the risk associated with LDC debt, and to determine the variables which are significant in assessing this risk.

The discussion begins in Section II with an introduction to the "debt crisis" and an explanation of the various developments causing this situation. Following this causal analysis is a discussion of some of the proposed solutions that have been developed and the success some of these proposed solutions have had. Section II ends with a brief review of previous econometric work done on debt-servicing capacity and some discussion of the shortcomings of these models. Section III includes a discussion of the model this paper uses to assess country risk or the probability of default, and Section IV presents the results of the model. Finally, Section V summarizes the results and suggests some of the model's potential uses.

Section II

Over lending to underdeveloped countries began during the 1970's. Until the 1970's, banks' involvement with LDCs was limited to the provision of short-term trade finance facilities. After this period banks found LDC lending attractive for various reasons (which will be presented shortly), and started increasing their loans to developing countries at a rapid rate. By 1983, U.S. commercial banks owned over half of the 700 billion dollar debt owed by these developing countries. Luckily, banks have been able to carry their LDC loans at book value rather than market value. The average estimated secondary market price, as of July 1987, was between 45 and 55 dollars per 100 dollars of debt, and had commercial banks been required to carry this debt at market value, six of the largest banks would have defaulted (Exhibit 1) (Sachs 409).

The world banking system is only one of the parties being adversely affected by the crisis. LDCs also face grave difficulties because external debt obligations conflict with developmental needs. The large magnitude of debt these countries face, and the service payments on these debts, drains LDC resources which could otherwise have been used for internal development. LDCs are now in the position of borrowing additional capital just to meet service obligations.

Repayment problems have been attributed, in large part, to adverse developments in the international economy. OPEC's quadrupling of oil prices in 1973 was one such development. The oil importing developing countries found themselves unable to pay for these higher fuel prices from their own revenues. At the same time the current account balance of the oil exporting

countries jumped from seven billion dollars in 1973 to 68 billion dollars in 1974. These surpluses found their way into banks worldwide and hence the banking community was awash with liquidity at a time when there was a large scale demand for credit on the part of the LDCs. This combined with the fact that banks could not lend to their traditional borrowers in industrial countries due to the global recession, triggered the lending boom (Makin 27).

Another adverse development facing the LDCs during the 1970's was the surge of inflation in the industrial countries, particularly the United States. Inflation in industrial countries rose from a 1963-1972 average of 4.2% to 11.7% in 1974. An important consequence of this greater than expected surge of inflation was a very low, often negative, real rate of interest. In order to protect themselves from this, bankers learned to tie rates on LDC loans to market rates or, failing that, to build a healthy premium into their lending rates. From 1977 to 1981 the USA's high domestic interest rates forced interest on Euroloans up from 7.8% to 17.5%. The World Bank estimates that increases in the interest rates such as LIBOR (London interbank offer rate) have a profound impact on the debt service requirements of LDCs. The latest figure estimates that for a 1% increase in LIBOR the debt of developing countries increases by 1.9 billion (Makin 22). These higher interest rates also had a large impact on exchange rates. Lured by higher interest rates in the United States, investors throughout the world switched their funds from other currencies to the US dollar. As a result the dollar exchange rate surged. This placed another burden on developing countries, as most of their debt was expressed in dollars. Developing countries found their debt servicing repayments an even worse drain on their resources than the higher oil prices, as more and more new loans were necessary to pay off existing debts.

LDC export markets declined as well during this period, caused in part by the global recession, and added to the problems. In 1981, the combined trade deficit for oil-importing developing nations was \$99 billion. The average debt service ratio rose in two years from 17.4% in 1980 to 24.4% in 1982. Falling prices on raw materials, which are the chief exports of many developing countries, caused much of the problem. (Kettel 77). While they faced the rising cost of imports, developing countries saw a 25% drop in the price of raw materials in the period of 1980-1982 alone. Only countries whose exports were diversified and not solely raw materials were not hard hit by this slump. Increased protectionism in industrial countries also contributed to the decline in LDC's exports. Industrial countries, hit by a global recession, had to struggle with the problem of unemployment and therefore increasingly resorted to measures designed to defend their economies from world-market competition. This increased protectionism among industrial nations, along with falling raw material prices, created problems for LDCs in the adjustment of trade balances.

Not all of the LDC problems are caused by external developments; inadequate internal economic and political structures are also to blame. While the industrial countries are increasingly resistant to price slumps or drops in demand in the world market, countries with less flexible development are plunged again and again into crisis. As Korner sees it, the economic and social development of the industrial countries was possible only because the decline of feudalism allowed capitalist structures to form in industry. Political power gradually shifted from great landowners to an industrial working class, which brought about higher wages and social reforms. Developing countries have not had agrarian reforms or revolutions which would

have modernized their political structure. Korner feels this is because political power remains in the hands of "parasitic oligarchies" and unproductive state classes. There is an unequal distribution of income to the very small upper and middle classes who have very low savings ratios. The high incomes of these classes are very lightly taxed as they control much of the power and can prevent attempts at tax reform or other reforms designed to bring about a fairer distribution of income. Rigid traditional social and political structures prevent economic development in general and the productive use of foreign capital in particular. Developing countries also have few educational and research institutions. Thus, they remain dependent on foreign technologically sophisticated goods, which they must import and pay for partly with foreign loans. Their financial personnel are also often poorly trained causing debt management for these countries to be even more difficult.

Recently, there has also been discussion of capital flight and the adjustment burden this places on LDCs. Several studies have found that capital flight from LDCs in 1988 has totaled as much as 200 billion dollars (Lessard 27). Mexico was perhaps the hardest hit with capital flight totaling 41.8 billion dollars from 1978 to 1982. Venezuela had similar problems, with capital flight 29.9 billion dollars during this same period. Overall the Latin American countries experienced more capital flight than other developing nations due to the very unstable currencies in these countries. Brazil, one of the largest Latin American debtors, is a unique exception to the phenomena of capital flight. The continuity of a competitive exchange rate policy, avoiding real appreciation, and maintaining tight exchange controls in Brazil,

was the central element that prevented any significant capital flight (Lessard 44).

Estimates of these magnitudes suggest that reduction in capital flight could substantially ease the debt burden on developing countries. One of the causes of capital flight in the developing countries has been an overvaluation of the exchange rate which has led to a fear of devaluation. This fear of devaluation causes the private sector to shift its funds abroad to avoid losses due to exchange rate fluctuation. The consequences of capital flight are an exportation of domestic savings and foreign exchange earnings which leads to shortages of funds for investment and development projects. This in turn severely hinders potential growth. Attempts to further develop and industrialize are impossible without significant capital. Capital flight financed through external borrowing further increases the debt burden of LDCs.

All of these external developments and internal structural problems have created a situation in which many of the underdeveloped indebted nations are not able to meet the service payments on their outstanding debt. In this situation, a country may borrow more funds in order to meet its current payments. At times, however, this is impossible. It is then that debt needs to be rescheduled, forgiven, or repudiated.

In recent years, help to struggling LDCs has come in the form of debt rescheduling in order to help them meet their current payments. These reschedulings are given under the stipulation that the developing countries follow a stabilization policy as directed by the IMF (Kettel 155). The object of these stabilization programs is to help stimulate the growth needed in the LDCs in order to help them meet their obligations. However,

stabilization programs have recently encountered strong criticism from debtor nations. The IMF deflation policies almost invariably lead to recession (Korner 137). Argentina is an example of how severely IMF policies reduce domestic economic activity. At the end of a five year stabilization period the country's gross domestic product was 2% lower than its original level, while in Portugal economic activity was halved. The IMF stabilization policy brought Chile a fall in per capita income of 12.7% and had similar effects in Peru and Turkey. It is argued that these programs systematically favor the industrial countries or creditor nations when developing programs (Korner 131). While these policies are in theory a move in the right direction, the specifics of these programs need to be rethought to bring on more desirable effects.

Advocates of reformed stabilization programs argue that they should include more socio-political and institutional reforms. Korner argues that selected economic targets will only be met if production-inhibiting land-owning structures are reformed, if the tax system is restructured, and a more just distribution of income is achieved. Reforms are needed to stop mismanagement, corruption and personal privilege to make state enterprises and public administration more efficient (Korner 177). In the past, the World Bank's structural adjustment programs have shown that it is possible to include such reforms in condition packages. The task is therefore to create a political environment which enhances economic growth.

Other proposed solutions have included selling off the debt at a discount, for long-term bonds to the IMF, World Bank or creating some new international fund for such purposes. While this will help take the risks off banks, banks will still incur losses, for their loans to LDCs are not worth in

the secondary market the value banks are carrying on their books. This solution can also be viewed as short-term because it does not take into consideration the need for economic growth.

Debt-to-equity swaps seem to be better suited for the situation for they will encourage economic growth. A debt-to-equity swap involves the commercial banks and the debtor country forming joint partnerships in businesses within the debtor nation. This solution assumes the full cooperation of the debtor countries in liberalizing regulations towards direct foreign investment. New investment in the financial services sector in the LDCs is well suited for both banks and the LDCs. The country's consumers and businesses will gain by the increased competition in the financial service sector, while the bank gains new business opportunities in a field of its own expertise (Kettel 140). This new direct business relationship will help banks form a long-term strategic interest with the developing countries. Not only will banks' involvement with the local economy enhance their interest in the economic growth of the country, but the country will gain by having access to new and varied forms of financial services.

Yet another proposed solution to the debt problem involves trade surplus nations helping developing countries' trade-deficit problems. The Compensatory Financing Facility, which was introduced in 1963 to finance temporary reductions in export earnings, has been suggested as the agency to be used in such a solution. IMF member states with surpluses would pay a substantial part of their surpluses to fund the facility. The fund could then be used by the LDCs facing trade-deficit problems (Korner 177). This solution must accompany a plan which would help LDCs boost exports permanently.

The Brady plan has been the first attempt to use these trade surpluses to

help the LDCs with Japan agreeing to supply 4.5 billion dollars under the plan to bolster IMF and World Bank assistance. The Brady Plan is also gaining recognition for being the first plan to offer debt forgiveness. To reduce the \$350 billion mountain of Latin debt, Brady asked banks to forgive some loans in exchange for binding guarantees that the rest of the money will be repaid. Brady's plan urges banks to work out deals on a case-by-case basis, but provides bankers with sketched out guidelines. Brady's proposal applies to all of the LDCs but targets Latin America. Mexico will be the first country to negotiate a deal under the plan with, Venezuela, the Philippines and Costa Rica next. There has been some skepticism of the Brady plan by those who feel the LDCs are beginning to wait in line for assistance from the US commercial banks. These skeptics feel that debt assistance and forgiveness will be limited and policies which have more specific details of who gets what are needed. The Brady plan is still considered a step in the right direction for it includes debt-forgiveness, which is something that no other plan has included.

Previous to the Brady plan, in 1985, was the Baker plan, in which, then Secretary of State James Baker, called for the IMF and World Bank to join with the commercial banks to provide an additional 29 billion dollars in new loans to struggling LDCs. The countries receiving additional loans were to undertake comprehensive adjustment programs to reduce inflation and promote growth. Secretary Baker believed new lending would generate the growth needed to reduce the burden of debt-service payments and asked the commercial banks to adopt specific targets for new lending. The targets for new lending, however, were not met by commercial banks, and in some cases, bank claims on debtor nations were actually reduced. Then, in 1987, some of the major

commercial banks, led by Citicorp, set aside larger loan loss reserves against their exposure to the debtor countries. This was a signal from the banks that they did not intend to support the Baker Plan. Debt forgiveness was not mentioned in this plan which was criticized for subjecting commercial banks to more unwanted risk.

Perhaps additional loans to some LDCs do not add more unwanted risk to the banks' loan portfolios, but rather increase the long run probability of loan repayment. It is these countries that warrant increased bank involvement. Commercial banks are in need of more information concerning the LDCs' debt-servicing position in order to make these lending decisions.

Two previous econometric studies on debt-servicing capacity have provided a framework for the model presented here. The first study, by Frank and Cline, was an application of discriminant analysis for measurement of debt servicing capacity. The study attempted to identify the variables which are important in classifying a country as a default country (risky) or non default country (non-risky). Frank and Cline included the following variables: a debt service ratio (the ratio of debt-service to exports); the growth rate of exports; an export fluctuation index; a ratio of "non-compressible" imports (imports which cannot be eliminated) as a fraction of total imports; per capita income; the average maturity of loans; cash and foreign exchange reserves; and a ratio of imports to gross national product. Out of these variables Frank and Cline found only three variables significant at the 5% level: the debt-service ratio, average maturity of loans and the import reserve ratio. This study included data for 26 countries over a nine year period for a total of 234 observations but because of missing data the number

of observations was reduced to 145. The number of Type I errors was 3 and the number of Type II errors was 15. Type I errors occur when the model classifies a country as non-default when it is actually a default, while Type II errors occur when the model predicts that a non-default country will be part of the default population. Overall Frank and Cline had a 12.4% prediction error.

Although this model had a relatively small margin of error, there are criticisms of the theoretical framework of the model. Feder and Just, in their study of debt-servicing capacity, argue that discriminant analysis is not an appropriate method to measure debt-servicing capacity and suggest that a logit model is better suited. They argue that, while discriminant analysis assumes two completely different populations, the logit approach assumes a discrete event takes place after the combined effect of certain economic variables reaches some threshold. That is, it makes more sense to claim that in a specific period the country was pushed beyond a critical level leading to a rescheduling, than to claim that the country suddenly becomes a member of another class.

Feder and Just use nine economic indicators in their work but, to facilitate a brief discussion of them, seven are defined the same as in the Frank and Cline study. The two additional indicators used are capital inflows and growth of per capita domestic product. Non-compressible imports used in the Frank and Cline study was omitted on theoretical grounds. The usual argument is that consumption of some imports which are not vital necessities (compressible imports) can be curtailed temporarily to increase foreign exchange for debt-servicing purposes. Therefore a high percentage of compressible imports will lead to a lower probability of debt-servicing

difficulty. Feder and Just argue that the possibilities for reducing imports may depend on a government's internal political status rather than on the economic importance of import items. Thus the measure of compressible imports will not be adequate until an approach to including political status is developed. Feder and Just found five variables to be important in measuring debt-servicing capacity which include: the import reserve ratio; the debt service ratio; the amortization ratio; export growth; and per capita income. The Feder and Just model had a total of 238 data observations and had a lower margin of error than the previous Frank and Cline study with only one Type I error and seven Type II errors.

Although both of these models have a relatively low margin of error with most of the variables significant, the model presented in this paper will attempt to improve upon these previous models by including additional important variables which are left out of the two previous studies. Neither of the studies include a variable which would take into account the structural make-up of an economy. The model presented here will include the variable % of agricultural exports to total exports to account for the structure of a country's economy. By including this, the affect of a more industrialized economy on the riskiness of a country's outstanding debt can be estimated. This model will also include a variable which will account for Mexico's announcement of default in 1982 and the following "bandwagon" effect that resulted. After Mexico's announcement of default, forty additional countries announced the need for rescheduling. This suggests that perhaps some countries were more inclined to seek rescheduling after Mexico's success in rescheduling in 1982.

Section III: Model

In order to estimate the risk associated with a country's debt, several variables and their estimated effects on the risk will be examined in this study. The most commonly used indicator in assessing risk is the debt-service ratio. The debt-service ratio is the ratio of debt-service payments to exports. It is important in that any shortfall of foreign exchange earnings in the current account balance must be financed with either additional borrowing (capital import), or exchange reserves. Assuming that additional borrowing is not a favorable choice and exchange reserves are rather limited, the shortage in foreign exchange earnings must be met by a reduction in imports. Significant import reduction, in many countries, is difficult due to the fact that much of the imports in LDCs are used for development and investment projects. Therefore the higher the debt-service ratio the higher the probability of default.

A second variable related to the debt-service ratio is the growth of exports. Growing export markets will increase foreign exchange earnings and increase the probability that a country will be able to meet its current service obligations by using these increased foreign exchange earnings. For countries with large trade-deficits increasing exports will help close these trade gaps and reduce the amount of import reduction necessary to meet a shortfall in exchange earnings. Therefore the higher the growth in exports the lower the probability of default.

A country's official reserves are also important in estimating the probability of default because they measure a country's ability to pay without borrowing. Reserves include foreign exchange holdings and the net position of

the country with the IMF. The ratio of imports to reserves will be used here to allow for comparable measures among countries. The larger the ratio of imports to reserves the lower the debt-servicing capacity. This is because a shortfall in exchange earnings can be financed through reserves rather than additional borrowing, or import reduction when there are adequate reserves.

The London Interbank Offer Rate (LIBOR), as mentioned earlier, has been shown to have severe effects on debt-service payments. Whereas the debt service ratio measures the ratio of debt-service payments to exports and the import reduction needed to meet these service payments in the absence of adequate foreign exchange earnings, changes in the LIBOR are used in this model to account for the effects these changes have on the actual debt-service payments. These increases in recent years have been shown to be a tremendous drain on LDC resources. Large positive changes in the LIBOR will have an expected negative impact on debt-servicing capacity.

The percentage of agricultural exports is used to estimate the effects the structural make-up of an economy has on the riskiness of LDC debt. As mentioned earlier, declining export markets for agricultural products devastated the LDC's trade earnings during the world recession in the early 1980's. Prices of raw materials have also been declining, worsening their trade balances. Thus the higher the percentage of agricultural exports the more sensitive a country is to external world market developments. The ratio also will be used as a structural proxy for internal development. As countries develop, their industrial base develops as well, allowing for a more equal distribution of income and a shift in political power to an industrial class who brings with it higher wages and social reforms. The more industrialized a country becomes the more resistant it is to price slumps and

declining export markets. Therefore countries with higher percentages of agricultural goods to total exports will have a higher probability of default.

Year to year changes in the level of investment are used here to account for the degree of capital flight, and to account for the effect of investment on the development of the LDC's economy. Negative changes in investment from year to year will mean stagnant development, and indicate probable capital flight; hence a higher probability of default.

Per capita income will be included in this model because it seems likely that the higher the per capita income, the lower the probability of default. This is because the higher the level of per capita income the higher the level of savings and therefore the higher the level of investment. High levels of per capita income mean higher government revenues which may be used for development projects as well.

Finally this model will include a dummy variable taking on the value of zero until 1982 and from then on taking the value of one. This dummy variable is included to account for Mexico's announcement, in 1982, that it would no longer honor its service payments, and the bandwagon effects this announcement may have brought with it.

All of the preceding variables can be grouped to form the following equation:

$$z_t = b_1(\text{DSR}) + b_2(\text{EXP}) + b_3(\text{Res}) + b_4(\text{LIBOR}) + b_6(\% \text{AGR}) + b_7(\text{INV}) + b_8(\text{PERCAP}) + b_9(\text{DUMMY})$$

where DSR= Debt service ratio

EXP= growth in exports

Res= official reserves

LIBOR= London Interbank Offer Rate

%AGR= percentage of agricultural exports

INV= change in investment

PERCAP= per capita income

DUMMY= dummy variable

In this equation z_t is the variable indicating the presence of a default in year t . It has a value of one for a default and zero otherwise. The term, "default," as mentioned earlier, is used when debt is forgiven, rescheduled or repudiated. The effect each of the above variables has on the default probability of a country can be estimated using maximum likelihood techniques. The logit method can be used once the preceding equation is statistically estimated with the resulting dependent variable z being transformed into an indicator of the probability of default as shown below:

$$P = 1/(1+e^{-z})$$

where P is the composite indicator of the probability of default, and e is the base of the natural logarithm. This probability indicator may vary from zero (as z approaches negative infinity) to one (as z approaches positive infinity).

Both cross sectional and time series data are used. The countries included in the data sample are listed in exhibit 2 along with the years of default observations included. The time series is for the years 1972-1985. Data sources include the World Banks' World Tables, International Financial Statistics, the Wall Street Journal Index, and United States Business Statistics.

Section IV: Results

The table below contains the initial results obtained from the preceding logit model. Four out the eight variables have the predicted effects at .05 level of significance. These include: percentage of agricultural exports, reserves, investment, and the debt-service ratio.

LOGIT MODEL FOR DEP				
VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STATISTIC	
1 Constant	-4.826119	(1.1930)	-4.0452	
2 PERCAP	0.003572	(0.0007)	5.2328	
3 %AGR	0.050434	(0.0149)	3.3815	
4 ADJRES	-0.000514	(0.0002)	-2.8933	
5 LIBOR	-0.055577	(0.0624)	-0.8907	
6 INV	-0.006515	(0.0014)	-4.5555	
7 DSR	2.663414	(1.7051)	1.5621	
8 DUMMY	-0.139377	(0.4783)	-0.2914	
9 FDEXP	-0.000109	(0.0001)	-0.8271	

Per capita income, although significant, has the wrong predicted sign which suggests that the conventional belief that lower-income countries are less credit worthy may be incorrect. The other four statistically significant variables all carried the predicted sign.

Curiously, the LIBOR is not only statistically insignificant, but also carries a negative sign. This suggests that the higher the interest rate on loans the lower the probability of default. This not only violates financial theory, but refutes the claim that rising interest rates caused much of the debt-servicing difficulty in the late 1970's and early 1980's. The data in the sample reveal that, in fact, countries continued to experience debt-servicing difficulty even after the decline in interest rates began. Perhaps

the interest rate on LDC loans does not closely follow world interest rates, but rather, reflects the risk associated with LDC debt.

The dummy variable in the model which incorporates Mexico's default announcement in 1982 and the "band wagon effects" this announcement brought with it is also statistically insignificant. This could be due to the relatively small data sample used for this model. After Mexico's announcement in 1982, 40 additional countries sought additional loans and rescheduled debt payments. The data sample, however, includes only a small proportion of these countries, which could be the cause of this variable's insignificance.

Also showing statistically insignificant was the variable growth of exports. In later variations of the model, however, when lagged growth of exports is used, it becomes significant and carries the predicted sign.

The estimated coefficients in the results table have a different interpretation than they would in an ordinary least squares regression, where the coefficients tell the unit change in the dependent variable from a unit change in the given independent variable. In the logit model, the coefficients tell the change in the log of the odds of default given, a unit change in the independent variable. For example, the estimated coefficient for per capita income is .003207. This means that for a dollar increase in per capita income the log of the odds, change by .003207.

The table below gives the slight variant of the original model which obtained the best results. This model includes the variables per capita income, percentage of agricultural exports, reserves, change in per capita income, investment, the debt-service ratio, the dummy variable specified earlier, a one year lagged dependent variable, and a one year lagged change in

exports variable. All variables in this variation are significant at a .05 level except the debt-service ratio which is significant at an .075 level.

LOGIT MODEL FOR DEP				
VARIABLE NAME	ESTIMATED COEFFICIENT		STANDARD ERROR	T-STATISTIC
1 Constant	-5.467878	(	1.1334)	-4.8243
2 PERCAP	0.003207	(	0.0007)	4.7196
3 %AGR	0.052034	(	0.0154)	3.3862
4 ADJRES	-0.000501	(	0.0002)	-2.9040
5 FDPERCAP	-0.004205	(	0.0015)	-2.8170
6 INV	-0.004943	(	0.0014)	-3.4419
7 DSR	2.686617	(	1.8370)	1.4625
8 DUMMY	-1.000070	(	0.5923)	-1.6885
9 LAGDEP	0.936655	(	0.4592)	2.0397
10 LAGFDEXP	-0.005915	(	0.0028)	-2.1091

The dummy variable is significant but has the wrong predicted sign. Again, this could be due to the small data sample which only contained a small number of the total defaults during this period.

Per capita income is again significant with the wrong predicted sign, however, the change in per capita income is significant with the expected sign. This, again, suggests that it is not only the lower income countries that are experiencing debt-servicing difficulty, but the higher income countries that are experiencing a decline in income as well.

The lagged dependent variable included in this variant is significant with the predicted sign. It has a positive sign, which indicates that if a country defaults in a given year, the probability of default for the following year is also higher.

Although significant variables are important in judging the models performance, the best indicator of the model's performance is its success in predicting the occurrence and absence of rescheduling. Unfortunately, the

overall predictive power of a logit model is more difficult to determine than in the case of a normal ordinary least squares regression analysis, in which the "adjusted R squared" represents the total variation in the dependent variable explained by the model. In measuring the predictive power of a logit model, it is first necessary to transform the estimated "z", the log odds of default, into a probability. It is then necessary to choose a threshold probability, above which the model has predicted default, and below which it has not. The first step merely entails transforming the model's estimates of "z" for each data observation into probabilities. Once these probabilities are obtained, a threshold value must then be determined. One possible approach is simply to choose .5 as the critical threshold. If the model's estimated probability exceeds .5 it has predicted default, while if it is lower than .5 it has predicted non-default. This approach, however, would lead to an extremely unbalanced distribution of errors with only a small percentage of non-default cases wrongly predicted (Type I error), but practically all of the default cases wrongly predicted as non-default (Type II error.)

The approach taken here resembles the established tradition of choosing a critical probability threshold which results in a relatively equal percentage rate of error for the two types of errors. That is, the threshold is chosen so that not all of the error is concentrated in one direction or other. While this is a common method of measuring a logit model's predictive power, its fault lies in that the model's estimates are used in determining its own predictive power. The coefficients estimated are not the true coefficients and may contain errors which will affect the model's predicted probabilities. This in turn may result in the threshold probability being biased. Due to the characteristics of the data sample used for this model, however, this method

seems appropriate. The large imbalance of default observations (36) as compared to non-default observations (433) warrants this approach.

The critical threshold that best minimizes the distribution of error in this particular model is 0.17. Any predicted probability higher than .17 is a predicted default while anything lower is a non-default prediction. Using this threshold for prediction the regression in Exhibit 4 correctly explained approximately 88% of non-default cases, and 82% of default cases. Overall all the model predicted 87% of all observations correctly which is comparable to the error rates of the previously discussed models.

A closer analysis of the model's wrongly predicted cases reveals that a good deal of the models' errors were concentrated in three countries. The model's errors for Bolivia, Peru, and Zambia, account for 40% of the model's total errors. In the case of Peru the model does show a trend that would indicated debt-servicing difficulty, however, the models' estimated probabilities did not reach the critical threshold value of .2 in the actual event of default. The model had similar problems with Bolivia. It did, as with the case of Peru, show a definite trend towards debt-servicing difficulty, however, the models predicated probabilities did not reach the critical threshold until one year following the actual event of default. Although the model wrongly predicted the occurrence of a default in a number of cases for these countries, it was correct in showing the trend toward debt-servicing difficulty.

With the case of Zambia the model did not perform as well. It predicted default for the years 1975-1985, but in actuality, Zambia had no instances of default or debt-servicing difficulty in the years included in the data sample. The model was completely inaccurate in predicating cases of default. Perhaps

there is a lack of data concerning Zambia's reschedulings, or perhaps Zambia has support from another country in meeting its debt obligations. Notice in Exhibit 1 that Zambia's debt is only worth 18 cents on the dollar which indicates that it is perceived as a credit risk, even though it has never needed debt rescheduling. Further research should look at Zambia's political and economic position in order to better explain the model's completely inaccurate predictions for this country. If the faulty predictions for these preceding countries are excluded, the error rate for the model becomes 8%.

Section V: Conclusion

In sum, the results obtained in this study, support most of the hypotheses presented. The key influences on the probability of LDC default are, changes in per capita income, percentage of agricultural exports, reserve levels, investment levels, the debt-service ratio, previous events of default, and the previous years change in exports. Obviously, these are not the only influences affecting the LDCs' ability to meet debt obligations, however, these influences found significant could provide guidelines for policy makers attempting to enact economic programs that will enhance the probabilities of LDC loan repayment. Political structures and other country specific variables are not included in this model which limits the models use in such an area, but nonetheless, the model does suggest general guidelines. It is naive to think that all LDCs can be classified as experiencing the same difficulties, and further research should try and incorporate more country specific variables in estimating a countries probability of loan repayment.

The accuracy level of the model does confirm the belief that objective

risk assessment for LDC loans is possible and can provide bankers with relatively accurate estimates of the probability that a given country will be able to meet its debt obligations in a given year. The nature of the model prohibits long-term probability estimations, except in cases where accurate levels of the significant independent variables can be determined for the future. In recent years, short-term loans to countries unable to meet the service obligations on long-term debt have been very common, and it is in this case a risk assessment model such as this one would be beneficial. The model can also be useful in helping commercial banks predict and prepare for potential disruptions in the expected performance of their LDC loan portfolios. Necessary loan loss reserves and similar precautionary measures, along with secondary market values of LDC debt, could be more accurately determined using the information this model provides.

This research was in no way an attempt to discourage further bank involvement in the LDC crisis, but was merely an attempt to provide banks with more information concerning their LDC loans. Halting lending to the LDCs is not a solution to the problem, but more adequate information can help banks in making lending decisions and provisions.

Exhibit 1.

Millions of dollars except where noted

Country	Debt to financial institutions	Secondary Market	
		Bid price dollars	Total value
Argentina	20395.3	47	9585.8
Bolivia	126.3	10	12.6
Brazil	49624.7	55	27293.6
Chile	12084.8	67	8096.8
Colombia	4144.2	81	3356.8
Costa Rica	1530.4	33	505
Dominican Republic	328.4	42	137.9
Ecuador	4972.5	45	2237.6
Gabon	532	82	436.2
Guatemala	101.1	72	72.8
Honduras	164.8	38	62.6
Ivory Coast	2486.6	60	1492
Jamaica	406.5	37	150.4
Liberia	41.4	5	2.1
Malawi	53.7	74	39.7
Mexico	58757.3	53	31141.4
Morocco	2568	65.5	1682
Nicaragua	1144.9	5	57.2
Nigeria	6515.2	28	1824.3
Panama	1877.6	64	1201.7
Peru	3224.6	11	354.7
Philippines	4206.6	67	2818.4
Romania	2261.4	87	1967.4
Senegal	233.5	61	142.4
Sudan	553.6	2	11.1
Uruguay	1300.5	68	884.3
Venezuela	9968.2	67	6678.7
Yugoslavia	4510.3	70	3157.2
Zaire	402.9	24.5	98.7
Zambia	226.5	18	40.8
Total	194743.8	---	105542.3

Exhibit 2.

**Countries Included in Logit Analysis
Along with Years of Default Observations**

- | | |
|----------------------------|----------------------------------|
| 1. Algeria | 16. Morocco 1983 |
| 2. Argentina 1976,82,83,84 | 17. Nigeria 1983 |
| 3. Bolivia 1981,83 | 18. Pakistan |
| 4. Brazil 1982,83 | 19. Peru 1976,78,79,83,84 |
| 5. Chile 1972,74,75,83,84 | 20. Philippines 1983 |
| 6. Colombia | 21. Portugal |
| 7. Ecuador 1982,84 | 22. Sudan 1979,81,82 |
| 8. Egypt | 23. Syria |
| 9. Greece | 24. Thailand |
| 10. Indonesia | 25. Tunisia |
| 11. India | 26. Turkey 1978,79,80,82 |
| 12. Israel | 27. Venezuela 1982,83,84 |
| 13. Korea | 28. Yugoslavia 1983,84 |
| 14. Malaysia | 29. Zaire 1976,77,79,80,81,83,84 |
| 15. Mexico 1982,84,85 | 30. Zambia |

Exhibit 3.

Variable Name	Estimated Coefficient	Anti-Log*
Per Cap	0.003207	1.007
%Agr	0.052034	1.127
Res	- 0.000501	0.999
FDPerCap	- 0.004205	1.009
INV	- 0.004943	0.988
Dummy	- 1.000070	0.099
LagDep	0.936655	8.642
LagExp	- 0.005915	0.986

* The anti-log of the estimated coefficients can be interpreted as the change in the odds of default for a unit change of the corresponding variable.

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