A Formulation and Test of a Simple Model of World Bank Behavior

By

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Contents: I. Introduction. – II. The Conceptual Approach. – III. The World Bank's Optimization Problem. – IV. Empirical Test of the Model's Hypotheses. – V. Summary and Concluding Remarks.

I. Introduction

There exists a large literature describing the behavior of international institutions (see e.g. von Maerhaege [1980] for a general survey, and Gold [1979] for the World Bank). This literature is, however, with few exceptions[1], purely descriptive, i.e. it lacks an analysis based on clearly stated behavioral assumptions leading to falsifiable and hence empirically testable hypotheses. A positive theory of the behavior of international organizations is thus lacking.

This paper endeavors to provide a simple theoretical model of the behavior of such an international organization – The World Bank – using the traditional approach of maximizing a utility function subject to constraints (Sections II; III). The theoretically derived hypotheses are empirically applied to the World Bank's granting of loans to developing countries during recent years (Section IV). A final part summarizes the main findings (Section V).

II. The Conceptual Approach

The behavior of an international organization can be theoretically modelled in at least two different ways[2]:

(i) The organization is treated as an aggregate unit possessing well-defined preferences.

Remark: The paper was initiated during the first and last authors' stay at the Institute for International Studies in Stockholm, September – December, 1982. Helpful comments were provided by Thor Gylfason and a referee.

[1] Dreyer and Schotter [1980] have empirically analyzed the voting power within the International Monetary Fund on the basis of a game theoretic (Bhanzaff) index; Fratianni and Pattison [1982] have developed a rather general theory which is, however, difficult to test.

[2] The two approaches are well visible in the economic theory of (national) bureaucracy where Tullock [1965] and Downs [1967] use the individualistic and Niskanen [1971] uses the aggregate approach.

(ii) The interests of the individual members of the organization are considered. The behavior of the organization as a whole is taken to be the (unintended) outcome to the individuals' action.

The second approach is more ambitious and complicated as it may be necessary to explicitly model the bargaining and (changing) coalition formation of the various groups of members. One cannot say in general which of the two approaches is preferable, of course, since that depends on the specific objective of the analysis. If the objective is to study the internal decision-making in the organization, it is necessary to use the individualistic approach (or at least so economists think). The unified-actor approach, on the other hand, might provide a convenient short-cut if the focus is on the outside actions of an organization: Indeed, our aim in this paper is to shed some light on the World Bank's distribution of credits and we rely on a unified-actor approach.

A similar issue concerns the interactions between the organization and outside actors such as its external sources of funds. Again, one faces the choice of either modelling the process whereby the typically diverging interests of the different parties are aggregated to final actions, or treating these final actions as emanating from some aggregate preference function. Also here we take the latter route.

To sum up, our approach thus treats the behavior of the "typical World Bank employee" as the final outcome of any struggles and deliberations between members of the organization as well as between the organization and outside interests. However, we explicitly assume that the final outcomes do fulfill the well-known axioms of consistent decision-making. Then, the choices of how to distribute the World Bank's credits can be described by the solution of a standard optimization problem.

III. The World Bank's Optimization Problem

We assume that the World Bank's granting of credits to developing countries can be represented by help of a utility function $B(\cdot)$ with the following arguments. First, the choice variables, i.e. the credits per capita granted to the potential recipient countries; we assume that utility is increasing, at a decreasing rate, in each country's credit level. Second, the per capita income (or wealth) of the recipient countries; the poorer a country, the higher the marginal utility of granting credits to it. This captures, to some extent, the goal of the World Bank institution to ease the development of LDCs. The function B can hence be viewed as an indirect utility function in which the process by which credits enhance development is subsumed. Third, the expected default on the distributed credits. Here, we assume that utility is decreasing in total expected defaults: It is commonly argued that a prime objective of any organization is survival or, less drastically, the avoidance of

reductions in the scope and scale of its operations, and it seems reasonable to assume that this applies to the World Bank institution as well. Default on loans is likely to reduce the amount of credit available for future lending. This argument can easily be given a formal motivation by assuming that the World Bank engages in intertemporal considerations and contemplates its credits over several periods. Then the more defaults on loans suffered in the current period, the less credits may be given in future periods, which reduces welfare[1].

The World Bank's choice of how to distribute credits in a given period is then viewed as the solution to a standard optimization problem. A vector of credits per capita $(c_1, \ldots, c_n)$, is chosen in order to maximize, against a constraint on the total available resources, a utility level b, given by

$$b = B\,(c_1, \ldots, c_n, w_1, \ldots, w_n, E\,(D))$$

where w_i denotes the per capita income (wealth) of country i, $i = 1, \ldots, n$, and E (D) is the expected default on the total credits given in the period we consider.

However, with a general form of B we do not get very specific results. To get such results and hence testable hypotheses, some simplifying assumptions are made. First, the World Bank is taken to hold subjectively certain probabilities (point expectations) for each country defaulting, $\rho_1, \ldots, \rho_n$, which implies that $E\,(D) = \sum_i \rho_i m_i c_i$, where m_i is the population in the ith country. Second, the objective function is assumed to be additively separable in each country's credit and income, and total expected defaults, respectively. Third, apart from the considerations of income and risk, preferences are assumed to be unbiased over countries in the sense that each country's weight in the objective function is strictly proportional to its population. Given these assumptions the resulting allocation of credits may be viewed as the solution to the optimization problem

$$\underset{c_1, \ldots, c_n}{\text{maximize}} \quad u = \sum_i m_i U\,(c_i, w_i) - V\left(\sum_i \rho_i m_i c_i\right) \tag{1}$$

$$\text{subject to } \sum_i m_i c_i \leq \bar{y}$$

[1] Assume, for example, that the bank looks over a horizon of two periods and consider the following problem

$$\underset{c^1, c^2}{\text{Max}}\; U\,(c^1, w^1) + U\,(c^2, w^2)$$

$$\Sigma\, c_i^1 \leq \bar{y}^1 \text{ and } \Sigma\, c_i^2 \leq \bar{y}^2 + \bar{y}^1 - D\,(c^1)$$

where c^t and w^t are n-vectors of credits and income levels in period $t = 1, 2$, where $\bar{y}^t$ is the bank's total budget in period t, and where D is total defaults. The envelope function to this problem is the indirect utility function: $v = V\,(\bar{y}^1, w^1) + V\,(\bar{y}^2 + \bar{y}^1 - D\,(c^1), w^2)$, where $\delta V/\delta y > 0$. In this setting, clearly, $\delta v/\delta D < 0$.

where the assumptions in our discussion above imply $U_c > 0, U_{cc} < 0, U_{cw} < 0$, and $V' > 0$. In addition, we postulate, $V'' = 0$; i.e. a constant marginal disutility of defaults which means that we may interpret V as a positive constant (rather than as a functional operator).

For convenience, the maximization problem is assumed to have an interior solution[1]. This solution is a vector $(c_1^*, \ldots, c_n^*)$ which satisfies the first order condition[2]

$$\delta u\,(c_i^*, w_i) / \delta c_i = \delta u\,(c_j^*, w_j) / \delta c_j \quad \text{or,}$$

$$U_c\,(c_i^*, w_i) - U_c\,(c_j^*, w_j) = -\,V\,(\rho_i - \rho_j) \tag{2}$$

for all i and j.

The qualitative properties of the solution can be compactly summarized in the following *proposition:*

If $w_i \leqslant w_j$ *and* $\rho_i \leqslant \rho_j$ *with at least one strict inequality, then* $c_i^* > c_j^*$, (P1)

and symmetrically,

if $w_i \geqslant w_j$ *and* $\rho_i \geqslant \rho_j$ *with at least one strict inequality, then* $c_i^* < c_j^*$.

To verify the first part of the proposition, note that the RHS of (2) is non-positive if $\rho_i \leqslant \rho_j$. Suppose then $c_i^* = c_j^*$. Since $U_{cw} < 0$, the LHS of (2) is non-negative if $w_i \leqslant w_j$, however, which violates the first-order condition, unless both equalities hold so that both sides of the equation are zero. Consequently, $c_i^* > c_j^*$ since $U_{cc} < 0$. The second part of the proposition follows from exactly the same reasoning, with a switch of country indices.

These results are intuitively very plausible. In a pairwise comparison of country i and j, country i will unambiguously get more (less) loans if it is both poorer (richer) and has a lower (higher) risk of default. But if it is poorer (richer) and has a higher (lower) risk of default than country j, the outcome is uncertain.

The comparative statics of a given equilibrium may also be investigated. To do this we express the first-order conditions as $\delta u_i / \delta c_i - \lambda m_i = 0$ for all i, where λ is a Lagrange multiplier, and differentiate the resulting n conditions and the budget constraint in (1) totally. The resulting system can be expressed on matrix form, *viz.*

$$\begin{bmatrix} (U_{cc}) & (-m) \\ (-1)^T & 0 \end{bmatrix} \begin{bmatrix} dc^* \\ d\lambda \end{bmatrix} = - \begin{bmatrix} (U_{cw}) & (0) \\ (0)^T & 1 \end{bmatrix} \begin{bmatrix} dw \\ d\bar{y} \end{bmatrix} + V \begin{bmatrix} d\rho \\ 0 \end{bmatrix} \tag{3}$$

[1] This may be ensured formally by putting appropriate restrictions on the utility function. However, it would be a straightforward extension, in terms of Kuhn-Tucker analysis, to handle corner solutions where some countries did not get any credits.

[2] Since the preference function is concave and the constraint linear we know that the second-order condition is fulfilled.

where (U_{cc}) is an (n×n) diagonal matrix where U_{cc} (c_i^*, w_i) are the diagonal terms: (U_{cw}) is a diagonal matrix with entries U_{cw} (c_i^*, w_i); c*, w, ρ, and m are column vectors $(c_1^*, \ldots, c_n^*)$, etc; and (−1) and (0) are n-dimensional column vectors with −1 and 0 in all positions.

It is straightforward, if somewhat tedious, to solve (3) and derive the following results:

$$\frac{\delta c_i^*}{\delta w_i} < 0, \quad \frac{\delta c_i^*}{\delta w_j} > 0, \quad \frac{\delta c_i^*}{\delta \rho_i} < 0, \quad \frac{\delta c_i^*}{\delta \rho_j} > 0, \text{ and } \quad \frac{\delta c_i^*}{\delta \bar{y}} > 0$$

which apply to all countries.

Hence, if a country gets (relatively) poorer it will get an increased share of the budget, while the shares of all other countries will decline. Similarly, if the probability of a country defaulting decreases, it will get more and all other countries less credits. Finally, an increase in the budget will increase the credits for all countries.

IV. Empirical Test of the Model's Hypotheses

From our proposition in Section III, we directly get two empirically testable hypotheses:

(i) If a country is poor (rich) – compared to the other recipient countries – in a year t, ceteris paribus it will get greater (smaller) loans per capita in the year t+1 from the Bank than the remaining recipients.

(ii) If the probability of a country defaulting is low (high) – compared to the other recipients – in a year t, ceteris paribus it will get greater (smaller) loans per capita from the Bank in the year t+1 than the other recipients.

From these two hypotheses we may also predict that, if countries are classified into four groups according to whether their income is high or low, and whether they have a high or low risk of default, then:

(iii) In a given year the group of countries which are both poor and have a low risk of default will unambiguously get more Bank loans than the group of countries which are both rich and have a high risk of default. But, comparing the group of rich countries with low default risk to the group of poor countries with high default risk, the outcome is ambiguous, a priori.

The first two hypotheses will be empirically tested using regression analysis and the last by help of covariance analysis. Our dependent variable, LC, is the amount of World Bank loans per capita (measured in U.S.$) received by less developed countries in the fiscal years 1981 and 1982. Our sample consists of 55 developing countries, which got loans during the two

years under study. A limiting factor on our sample was the availability of data on risk-ratings (see below), which essentially meant that we had to exclude the smallest countries that had obtained credits. The independent variable for income, GNPC, is GNP per capita (in U.S.$), in the *calendar* year preceding the fiscal year studied. As for the risk of default, we use IICR, the Institutional Investors Credit Ratings, similarly in the preceding calendar year. These ratings can take values on a scale of 0 to 100 with 0 representing the least creditworthy countries (those with greatest chance of default on their debt) and with 100 representing the most creditworthy[1].

In testing hypotheses *(i)* and *(ii)* we estimate the following regression equation for the two years 1981 and 1982:

$$LC_i^t = a_0 + a_1\, GNPC_i^{t-1} + a_2\, IICR_i^{t-1} + e_i$$

where e_i is a white noise error term, and where the subscript i indexes each separate country in our sample.

The empirical results of the cross section estimations – employing the OLS regression technique – for the two years 1981 and 1982 are shown in Table 1. In the two equations the two independent variables have a statistically significant influence with the expected sign. Our estimations explain statistically between 37 and 40 percent of the variance of the Bank loans[2].

A difference of U.S.$ 10 in GNP per capita between two countries in 1981, ceteris paribus, leads to a difference in loans of U.S.$ 3.80 per capita, while a difference of 10 points in risk rating gives a difference in loans of U.S.$ 4.25 per capita. Clearly, these results do not say anything directly about the relative influences of the two independent variables, since the units of measurement are quite different. However, one way of coming somewhat to grips with this question is to standardize the ordinary regression coefficients by calculating the beta-coefficients. These coefficients, displayed in Table 1, indicate that differences in risk contribute more to differences in loans than do differences in income (in a standardized sense).

To investigate hypothesis *(iii)* the recipient countries are grouped in the

[1] The Institutional Investors Credit Ratings are compiled by using input from the world leading bankers. About 75 banks participate in the compilation. The series is provided by the *Institutional Investors Magazine*. This series was chosen because it was the only one available for the years 1979, 1980 and 1981 as well as for the most of the IBRD loans recipients. The sources of the other variables are: (a) World Bank loans (IBRD loans in U.S.$ per capita): *World Bank Annual Report 1981 and 1982*, Statistical Appendix, Table 3, Washington, D.C., 1981, 1982; (b) Income (GNP per capita in U.S.$) for the years 1980 and 1981: *World Development Report 1972–1982*, Washington, D.C.

[2] To explain statistically between 37 and 40 percent of the Bank loans for the years 1981 and 1982 is quite satisfactory for a cross section analysis, where we have by definition no time trend in the data which pushes the $\bar{R}^2$ up. A coefficient of determination (adjusted for degrees of freedom) in this range indicates that at least some major influentional factors have been captured in these two regression equations.

Table 1 – *Cross Section Analysis of the World Bank Loans to 55 Developing Countries: OLS-Estimates of the IBRD Loans per Capita for the Years 1980, 1981, and 1982*

Year	Intercept	Income (GNP per capita)	Risk of default (IICR)	$\bar{R}^2$	s.e.	F	d.f.
1981	2.032	−0.384**	0.425*	0.37	14.47	3.99	52
	(1.56)	(−2.99)	(2.61)				
		−0.301	0.415				
1982	1.984	−0.417**	0.497**	0.40	17.41	4.71	52
	(1.65)	(−3.12)	(2.99)				
		−0.323	0.455				

Note: The figures in parentheses below the estimated coefficients are the t-values; underneath the t-values are the beta-coefficients. – One asterisk indicates statistical significance at the 95 percent level of confidence; two asterisks at the 99 percent level of confidence (both one-tailed tests); $\bar{R}^2$ is the coefficient of determination corrected for degrees of freedom; s.e. is the standard error; and F indicates the F-value for testing the significance of the independent variables on the dependent variable.

four categories I–IV for a particular time period (Table 2). A low (high) risk country is one where the IICR is greater (less) than 50.00 and a low (high) income country is one where GNP per capita is less (greater) than U.S.$ 1000[1].

We then use covariance analysis, employing as our dependent variable the Bank loans to the same 55 countries in the two years 1981 and 1982, but corrected for the influence of the covariates (GNPC and IICR). The results are also presented in Table 2.

They clearly do not reject hypothesis *(iii)* in that group I countries get the greatest loans and group IV countries get the smallest loans in all three years, and the F-values indicate that the difference between the adjusted cell means are statistically significant at the 99 percent confidence level. Furthermore, considering the countries in groups II (high risk, low income) and III (low risk, high income), the ones in group III get more loans per capita than the countries in group II – a result which is in line with the regression results where the coefficients of the risk variables had a greater impact on the loans than the income variable.

[1] The exact values for the grouping into the four categories are chosen in such a way that each of the four cells has at least 10 observations. The grouping of poor and rich countries follows roughly the categories used by the World Bank (e.g. in the *World Development Report,* years 1980, 1981 and 1982), and the one used to group into low and high risk countries goes back to a grouping of the *Institutional Investors Magazine.*

Table 2 – *Analysis of Covariance of the per Capita IBRD Loans for 55 Developing Countries: Adjusted Cell Means of the per Capita Bank Loans*[a]

Year	Income category	Risk category		F-statistic
		low risk	high risk	
1981	low income	I: 19.47	II: 8.47	9.47
	high income	III: 14.36	IV: 4.98	
1982	low income	I: 26.27	II: 10.04	9.62
	high income	III: 18.62	IV: 5.69	

[a] An adjusted cell mean is the mean of the dependent variable (Bank loans) adjusted for the covariates (per capita GNP and IICR).

V. Summary and Concluding Remarks

In this paper we provided a simple theoretical framework for the analysis of the behavior of the World Bank using a unified-actor, utility maximizing approach. The utility function had the amounts of credits to the recipient countries, the income of these countries and the total expected default on credits given to potential recipients as its arguments. The constraint was the Bank's total budget. From the solution to this maximization problem we derived several hypotheses regarding the loans to developing countries and tested three of them empirically[1]. None of the three hypotheses could be rejected.

From the simple model and the empirical results we conclude that income and risk of default are important factors determining the amount of loans by the World Bank to developing countries. Using only these two factors as independent variables one can explain between 37 and 40 percent of the variance of World Bank loans distributed during 1981–1982. Also, the risk of default seems to be more important than the income situation when World Bank officials decide on the amount of loans to be distributed to recipient countries.

[1] Behrman and Sah [1984] analyze the distribution of international aid with a similar approach. Their analysis parallels ours in that they start from explicit modelling of the donors' maximization problem, and from that derive and test hypotheses regarding the international flow of funds for development purposes. Just as here a richer country gets less funds, *ceteris paribus,* on *equity* grounds. In their case, that deals with aid, there is a potential trade-off between equity and *efficiency,* in that poorer countries might be less efficient in generating income from aid. Here, in the case of *credit,* the potential trade-off is instead between equity and *risk-avoidance.* However, there is a potential link between the two studies in that the same factor that leads to a higher default also could cause increased inability to generate income from aid.

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Zusammenfassung: Formulierung und Test eines einfachen Modells für das Verhalten der Weltbank. – Um das Verhalten der Weltbank zu analysieren, wird ein einfacher theoretischer Ansatz entwickelt, indem angenommen wird, daß die Weltbank wie eine einzige Person ihren Nutzen maximiert. Die Argumente der Nutzenfunktion sind die Summe der Kredite an die Empfängerländer, die Einkommen dieser Länder und der gesamte erwartete Zahlungsausfall beim Schuldendienst. Die Beschränkung der Funktion liegt im Gesamtbudget der Bank. Auf dieser Grundlage werden mehrere Hypothesen bezüglich der Kreditpolitik der Weltbank abgeleitet und getestet. Es zeigt sich, daß das Einkommen und Ausfallrisiko zu 37–40 vH die Varianz der Weltbankdarlehen, die 1981 und 1982 gewährt worden sind, erklären können.

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Résumé: Une formulation et teste d'un simple modèle du comportement de la Banque Mondiale. – Les auteurs présentent un simple cadre théorique pour analyser le comportement de la Banque Mondiale en utilisant une approche d'acteur-unifié qui maximise son utilité. Les arguments de la fonction d'utilité sont les montants des crédits accordés aux pays destinataires, le revenue de ces pays et la suspension de paiements totale attendue. La contrainte de la fonction est le budget total de la Banque. Les auteurs dérivent et testent plusieurs hypothèses regardant les crédits accordés aux pays développants. Ils démontrent que le revenue et la risque des créances douteuses peuvent expliquer 37–40 pourcent de la variance des crédits de la Banque Mondiale accordés en 1981–1982.

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Resumen: Formulación y test de un modelo simple del comportamiento del Banco Mundial. – En este trabajo se presenta un marco teórico simple para analizar el comportamiento del Banco Mundial, utilizando un modelo individual de maximización de utilidad. La función de utilidad contiene como argumentos el volumen de crédito otorgado a los países receptores, el ingreso de estos países, y el total esperado de créditos vencidos. El presupuesto total del banco constituye la única restricción. Varias hipótesis sobre el otorgamiento de préstamos a países en desarrollo son derivadas y analizadas empíricamente. Se concluye que el ingreso y el riesgo de que un crédito venza pueden explicar del 37 al 40 por ciento de la varianza de los créditos otorgados en los años 1981 y 1982.