Swords into Plowshares: Financing a World Economic Equalization Program

Abstract

Using a simulation model, this research examines the potential impact of a very large-scale foreign development assistance program (a "global Marshall Plan"), financed largely from reallocation of military expenditure, on the future development of the world economy. The model's key premise is that inequality among nations in per capita income is all or mostly due to differentials in generalized capital stocks. Generalized capital encompasses all reproducible primary factors of production other than raw labor power, and it includes, in addition to the value of plant and machinery, the value of education and training inputs into the labor force, and the value of social infrastructure capital such as roads and schools. The program, dubbed the World Economic Equalization Program (WEEP), would entail large-scale transfers of new generalized capital investment from rich nations to poor nations. The benchmark simulation of the model without such a program in operation indicates indefinite continuation of the recent trend toward increasing world economic inequality. The benchmark simulation of the model with the program in operation indicates a dramatic reduction in world economic inequality, at the cost of a very minor retardation in the economic growth of the rich nations. Sensitivity analysis demonstrates that with certain key exceptions, the optimistic results are reasonably robust against parametric variation. In cases of unfavorable parameter values, such that the equalizing effect of the program is minor, the cost is mostly borne by the poor nations, in the sense that unfavorable parameter values do not reduce the economic growth of the rich nations by a substantial amount. These results might support the initiation of a real-world WEEP on a tentative and provisional basis, with the intention of abandoning it if, after a fair trial period of perhaps 10-15 years, the achieved results are disappointing.

Journal of Economic Literature Classifications:
F21 International Investment, Long-Term Capital Movements
F35 Foreign Aid
F37 International Finance Forecasting and Simulation
O11 Macroeconomic Analyses of Economic Development
O21 Planning Models, Planning Policy

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Now that the intense ideological conflict of the Cold War is a rapidly fading memory, the drastic inequality in economic living standards among the nations of the contemporary world has become the single most important impediment to international harmony and world peace. Among visionaries, the notion of a massive, coordinated, worldwide effort to ameliorate the economic gap—along the lines of the post-World War II Marshall Plan but far more ambitious both financially and geographically—has a long history (Stringfellow Barr, 1953; Seymour Melman, 1961; and George J. Church, 1978). Some excerpts from Church's editorial essay "The Case for a Global Marshall Plan" in the June 12, 1978, issue of *Time Magazine* are as follows:

> The advanced countries have an urgent self-interest in improving a situation [world economic inequality] that in a few years may well overshadow any other international issue. The self-interest is partly political: poverty in the LDCs provides fertile soil for demagogues… These strains have bred North-South tensions that easily match in bitterness the East-West ideological clashes. At conference after conference, LDCs have demanded a "new international economic order" involving vaguely defined transfers of wealth from North to South. Northern statesmen, with much justice, have regarded this rhetoric as a kind of impractical Robin Hoodism. But with no discernible justice, the industrial countries have kept a tight lid on their assistance to LDCs. The Northern attitude is myopically stingy… Says West German Economics Minister Count Otto Lambsdorff: "I do not believe that a kind of Marshall Plan for the Third World—which today would have to be shouldered jointly by the U.S., Europe and Japan—is a feasible solution." Yet a new version of the Marshall Plan that rebuilt Europe after World War II may well be the most workable solution. Only such a plan could overcome the widespread feeling among voters that much aid to LDCs is wasted because it consists of piecemeal efforts by the givers to finance uncoordinated projects… Any Marshall Plan for the developing nations would admittedly be imperfect. But consider the alternatives: for the LDCs, continued poverty; for the industrial nations, endless political threats and damage to their own economies. Rich and poor countries do not have to like each other to realize they have a common interest they cannot escape.

The passing of a quarter century has not diminished the potential importance of this idea.

Conventional opinion among professional economists, especially those resident in the more prosperous nations, holds that a massive world economic development program would almost certainly result in massive waste. Although some minor progress might be made by some of the LDCs, a heavy price would be paid by the taxpayers of the wealthy nations, the principal beneficiaries of the effort would surely be an army of corrupt bureaucrats and dishonest businessmen, and the overall net impact of a tremendous resource flow on the world poverty problem would be minimal. This article issues a direct challenge to this conventional judgment. It

presents solid economic evidence that a global Marshall Plan, dubbed herein the "World Economic Equalization Program" (WEEP), could well be a spectacular success that within a 50-year planning period would reduce the world poverty problem to a small fraction of its present dimensions. It argues that the conventional pessimistic judgment on this matter is merely a superficial rationalization of short-sighted selfishness. What is especially unfortunate about this particular rationalization is not so much that it manifests a fundamental human vice—but rather that it is based, very likely, on two seriously mistaken premises: (1) that such a program would impose heavy costs on the rich nations; (2) that such a program would have little beneficial impact on the poor nations. Evidence derived from computer simulations will be presented here that disputes both of these premises. This evidence suggests: (1) that a World Economic Equalization Program would not seriously impinge on the continued economic progress of the wealthy nations, (2) at the same time such a program would dramatically accelerate the economic progress of the poor nations.

Obviously no evidence based on computer simulations of economic models is ever conclusive: too often there are large gaps between model specifications and reality. Moreover, it is shown via sensitivity analysis that the positive results obtained from benchmark computer simulations of the WEEP model are heavily dependent on the numerical value of at least one critical parameter of the model. If this parameter departs substantially from its benchmark value, the results achieved from the WEEP simulations become drastically degraded, to the point where the conventional pessimistic prognostications are largely supported. Nevertheless, what these simulations do clearly demonstrate is that a World Economic Equalization Program *might* be successful in achieving its purposes. The only way to determine more or less conclusively whether or not a real-world WEEP would in fact be successful would be to apply the same experimental method that has been so instrumental to the advance of knowledge in the physical sciences. The program could be initiated and pursued for a reasonable period of time sufficient to derive strong empirical inferences concerning its long-run success probability. If the indications from a 10-15 year experiment are unpromising, then the program could be drastically curtailed or even abandoned altogether. Some useful information concerning economic growth and development would have been achieved, but more importantly, thereafter the populations of the rich nations would not have their consciences troubled by the possibility that the world economic inequality situation might be substantially ameliorated by a sufficient amount of generosity on their part—because it will have been established by experiment, to most reasonable minds, that

no such possibility actually exists.

Past visionaries who have proposed a global Marshall Plan, such as Barr, Melman and Church, all assume that sufficiently large transfers from the rich nations to the poor nations would dramatically increase living standards in the poor nations while not seriously decreasing living standards in the rich nations. If the "transfers" envisioned involved current output in the form of final consumption commodities, this underlying premise would almost certainly be false. This is intuitively obvious simply from the fact that the combined population of the poorer nations greatly exceeds the combined population of the richer nations. But a few economists have taken the trouble to work out the numerical implications of what might be termed "crude redistribution" (Jan Tinbergen, 1990; John B. Horowitz and Cecil E. Bohanon, 1996; James A. Yunker, 2000). Their calculations confirm that a global welfare state that simply transferred current output from rich nations to poor nations would entail very high reductions in the mean disposable income of the rich nation populations to support relatively modest increases in the mean disposable income of the poor nation populations. However, none of the visionary proponents of a global Marshall Plan have ever advocated short-term equalization of living standards via transfers of current output of consumption goods. Instead it is envisioned that the bulk of the transfers would be in the form of investment goods: capital plant and machinery, as well as social overhead capital (roads, harbors, etc.) and human capital (education and training). The emphasis is invariably on giving the poorer nations the capital resources they require to raise their production of all goods, capital goods as well as consumption goods.

This is also the emphasis in contemporary real-world foreign development assistance programs. These programs contain in microcosm all the elements that would be involved in a global Marshall Plan such as the World Economic Equalization Program under consideration here. The principal substantive difference is simply scale. The critical question is this: Would—as the visionaries presume—a sufficiently massive scaling-up of existing foreign development assistance programs suffice to achieve substantial worldwide economic equalization, within a reasonable period of historical time, and at a reasonable cost in terms of reduced growth among the rich nations? No doubt because of the ubiquitous assumption that a massive scaling-up of existing foreign aid programs is politically unlikely if not impossible, economists (other than myself) have not examined this question. There is, however, a substantial literature on the economic impact of existing foreign development assistance to try to ascertain what impact, if any, the current programs are having. Results range from perverse effects, through no effects,

through very favorable effects. A recent contribution by Craig Burnside and David Dollar (2000) suggests that foreign aid can have a very substantial positive effect on economic growth—but only if the recipient nation is practicing "good policy" according to the Washington consensus: openness to foreign investment, trade liberalization, fiscal discipline, etc. Given that this research was sponsored by the World Bank, an institution heavily influenced by the Washington consensus, the results are almost "too good." Be that as it may, Burnside and Dollar do not extrapolate from their findings to estimate what foreign aid contributions from the rich nations would be required to achieve the objectives of a full-fledged global Marshall Plan.

The research reported here builds upon my earlier work on the subject (Yunker, 2000). Although the same basic model and data are utilized, there are several enhancements. Five years of additional data have become available: in the earlier contribution the validation period is from 1970 to 1995, whereas here the validation period is from 1970 to 2000. The policy simulation period has been changed: from 1970-2020 in the earlier contribution to 2000-2050 in the present contribution. Needless to emphasize, there have been major changes in the relative economic positions of the nations between 1970 and 2000, so that a policy simulation from 2000 to 2050 provides better illumination on a potential WEEP commenced in the relatively near future.

The most important revision pertains to the principle for determining the respective contributions of the rich nations into the transfer fund for global economic development. In the earlier model, a "residual" is defined for each nation as total national output less military expenditure and consumption expenditure. One part of this residual is earmarked for the global transfer fund while the remainder goes into domestic investment. The richer the nation, the higher the proportion of the residual earmarked for the transfer fund. For the benchmark values of the contribution function, this principle resulted, for the wealthiest nations, in some rather large numbers as the percentage of national output to be allocated to the global transfer fund: in some cases as high as 8 percent of national income. Of course, anyone in a wealthy nation who proposes that any more national government expenditure at all be allocated to foreign aid—let alone enormous incremental amounts—will inevitably be confronted by the skeptical question: "But where is the money coming from?" The presumption of the skeptic is that additional foreign aid allocations must be financed either by reallocations from other categories of national government expenditure (such as domestic welfare programs), or from higher taxes that will cause lower consumption expenditures among the population. Both of these options are deemed highly unattractive. According to the earlier WEEP model, these allocations would be drawn

neither from current private consumption expenditure nor current government expenditure—rather they would be financed by a lower rate of domestic investment. The cost of the transfers would not be in terms of lower current private and government expenditure, but rather in terms of lower economic growth. (The benchmark simulations, however, indicated that the foregone growth would be very minor.) Nevertheless, this proposition may be too subtle to constitute a rhetorically effective response to the standard "where is the money coming from" challenge.

In the current WEEP model, contributions by the rich nations into the global development fund come largely from reductions in military expenditure. Of course this contribution scheme amounts to a straightforward implementation of the biblical injunction, long cited by visionaries, to "beat swords into plowshares." There would be no need for higher taxes or major reallocations from other categories of national government expenditure. Although the proposed reduction in military expenditure would be substantial, the absolute level of military expenditure would remain quite high, and presumably would be sufficient to meet the needs of national security as defined by most nations of the world. Employing this revised approach to determining transfer fund contributions, the percentages of national output devoted to the transfer fund by the rich nations are much reduced, in every case to significantly less than 1 percent of national income. These levels of transfer fund contributions might be sufficiently low to be politically feasible. The benefits to the developing nations, according to the benchmark policy simulation, are not substantially less than those estimated using the earlier contribution principle. In short, the benchmark results suggest that an effective WEEP might be financed mostly from drawdowns in military expenditure. Of course, a more egalitarian and prosperous world would be a safer and more secure world, presumably in less need of military presence.

The remainder of the article is organized as follows. Section I explains the theoretical structure of the WEEP model. Section II deals with numerical implementation of the model using World Bank data, and setting model parameters so as to produce a reasonable fit of the model output to the empirical data over the validation interval 1970-2000. Section III presents the benchmark policy simulations for the planning interval 2000-2050. These results suggest that the impact of such a program on the world economic inequality situation could be very favorable. Section IV discusses the sensitivity of the results to parametric variation. For most parameters the favorable results are fairly robust against parametric variation. However, for at least one critical parameter, unfavorable values could have a very seriously adverse effect on the success of the program. Section V briefly summarizes and evaluates the research.

I. Theoretical Framework

The WEEP model set forth and numerically implemented herein attempts to achieve a reasonable compromise between the diverse objectives of realistic economic content, tight focus on the main question of interest, analytical simplicity, and computational convenience. Variables are subscripted with an *i* for "country *i*" and a *t* for "time period *t*." There are 140 nations in the dataset, comprising all nations that had populations over one million people in 1970. The dataset consists of World Bank data on the populations and per capita incomes of these nations from 1970 through 2000. Data from the 31-year period 1970 through 2000 are used to validate the model: that is, to show that the benchmark numerical parameter values produce a reasonably close fit between the observed data and results from the WEEP model validation simulation. The WEEP model policy simulations, as opposed to the validation simulation, cover the 51-year period from 2000 through 2050.

Probably the single most critical assumption incorporated in the model is that the same Cobb-Douglas production function holds in all nations. The production function, shown in equation (1) below, gives output *Y* as a function of inputs generalized capital *K* and population *P* (used as a numerical proxy for productive labor). It is an abstraction from reality, of course, to utilize population for productive labor, because the ratio of productive labor to total population is not the same over all nations. However, usage of labor force participation rates to infer productive labor from total population would be problematical, even if such rates were reliably available for all nations.

Statistical data are utilized for *Y* and *P* in the numerical implementation of the model, but *K*, *generalized* capital, represents a hypothetical construct for which existing statistical proxies such as "plant and equipment," even if they were reliably available for all nations, would not be appropriate. "Generalized capital" is the value of *all* reproducible inputs *other than* physical labor power. In addition to the usual "plant and equipment," it would definitely include the value of educational and training inputs into the labor force (human capital components) as well as the value of publicly provided productive resources such as roads, bridges, dams, and schools (social capital components).

Generalized capital plays a central role in the WEEP model. It is presumed that the extreme differentials in per capita income between nations in the contemporary world may be all or mostly attributed to extreme differentials in current endowments of generalized capital. Needless to say, this presumption is highly controversial. It is believed by many economists that the bulk of

the per capita income differentials in the world today are attributable to imbedded cultural and institutional factors. If this proposition were correct, then for the model under consideration here to be realistic, the total factor productivity coefficient A in equation (1) below would be very different over nations, instead of being either equal or approximately the same for all nations. Of course, if the observed per capita income differentials in the world today are the result of A differentials rather than K differentials, then a program such as the WEEP, that would alter the future allocation of world investment in K as between nations, would have a very small impact on the distribution of production over nations. This possibility is modeled by means of a parameter designated ξ, which represents the proportion of the initial per capita income differentials that may be attributed to differentials in total factor productivity coefficients, as opposed to differentials in generalized capital stocks. It is shown by sensitivity analysis that if the ξ parameter departs sufficiently from its benchmark value, the WEEP will be ineffective.

Once total output in each nation has been produced according to the Cobb-Douglas production function, it is allocated among four uses: military output M; consumption C; transfer fund contribution T; and domestic investment I. In a WEEP-less world, no nation makes a contribution into the WEEP transfer fund. In a WEEP world, the richer nations would make net contributions into this fund, from which the poorer nations would draw net shares. These shares would be applied to investment in generalized capital K. The rules embodied in the WEEP model for determining contributions and shares are of an ad hoc nature. They are meant to be appealing to common sense, but have no explicit justification in terms of economic efficiency or social welfare theory.

A. *The National Output Production Function*

The production function of country i at time t is specified to be a Cobb-Douglas form in generalized capital K and population P:

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} P_{i,t}^{\beta} \qquad (1)$$

where Y = output, K = generalized capital, P = population, A = total factor productivity, and where the power parameters α and β are such that $0 < \alpha, \beta < 1$ and $\alpha + \beta = \nu$. The parameter α is the output elasticity of generalized capital, and the parameter β is the output elasticity of population/labor. These are required to be positive numbers less than one by conventional economic assumptions. The parameter ν, whose value depends on α and β, is the degree of

homogeneity of the production function. If $\nu < 1$, we have diminishing returns to scale; if $\nu = 1$, we have constant returns to scale; and if $\nu > 1$, we have increasing returns to scale.

The parameters α and β in equation (1) may be expressed in terms of α^* and ν. Let $\alpha^* = \alpha/\nu$ and $\beta^* = \beta/\nu$. Then $\alpha^* + \beta^* = 1$ and $\beta^* = 1 - \alpha^*$. Therefore, given numerical values for α^* and ν, we calculate first $\alpha = \alpha^*\nu$, then $\beta^* = 1 - \alpha^*$, and finally $\beta = \beta^*\nu$. We will refer to α^* as "adjusted generalized capital elasticity of output" because it is obtained by dividing generalized capital elasticity of output (α) by the degree of homogeneity ($\nu = \alpha + \beta$).

The parameter A in equation (1) above represents total factor productivity. The concept of the World Economic Equalization Program is to allocate new K resources, generated mostly in the wealthier nations, across all nations in such a way that the poorer and more populous nations get proportionately larger shares of these new resources. The effectiveness of the WEEP in equalizing living standards across the world would depend on the extent to which the currently observed differentials in living standards are a function of unequal stocks of generalized capital K rather than of differentials in the total factor productivity coefficients A. The parameter ξ indicates the extent to which per capita income differentials are a function of differences in total factor productivity coefficients rather than of differences in generalized capital endowments.

The present discussion pertains exclusively to the initial period $t = 0$, therefore the time period subscript is omitted. Let $y_1 = Y_1/P_1$ be per capita income in the richest nation. Then total output in the richest nation is $Y_1 = y_1P_1$. Now let k_1 be a model parameter representing the ratio of generalized capital in the richest nation K_1 to total output Y_1 in the richest nation: $k_1 = K_1/Y_1$. By this definition, $K_1 = k_1Y_1$. The Cobb-Douglas production function for the richest nation is:

$$Y_1 = A_1K_1^{\alpha}P_1^{\beta} \tag{2}$$

and therefore A_1 is solved for as follows:

$$A_1 = \frac{Y_1}{K_1^{\alpha}P_1^{\beta}} \tag{3}$$

Now consider some nation i poorer than nation 1. Its Cobb-Douglas production function for output Y_i in the initial period is:

$$Y_i = A_iK_i^{\alpha}P_i^{\beta} \tag{4}$$

In terms of per capita income y_i, this is:

$$y_i = \frac{Y_i}{P_i} = \frac{A_i K_i^{\alpha} P_i^{\beta}}{P_i} = A_i K_i^{\alpha} P_i^{\beta-1} \tag{5}$$

There are two extreme cases with respect to the observed difference between per capita income in nation 1 and per capita income in nation *i*: (1) the entire observed differential between y_1 and y_i is owing to differences in total factor productivity coefficients A ($k_i = k_1$ and $A_i < A_1$); (2) the entire observed differential between y_1 and y_i is owing to differences in generalized capital stocks K ($A_i = A_1$ and $K_i < K_1$).

In the first case, the k_i ratio in nation *i* is the same as the k_1 ratio in the richest nation, so that generalized capital in nation *i* is:

$$K_i^o = k_1 Y_i \tag{6}$$

Substitute equation (6) above into equation (5) for y_i and solve for A_i. This gives us the A_i that is consistent with the first hypothesis that all *y* differentials are the result of total factor productivity differentials:

$$A_i^o = \frac{y_i}{(K_i^o)^{\alpha} P_i^{\beta-1}} = \frac{y_i}{(k_1 Y_i)^{\alpha} P_i^{\beta-1}} \tag{7}$$

In the second case, the A_i parameter in nation *i* is the same as the A_1 parameter in the richest nation:

$$A_i' = A_1 \tag{8}$$

Now let the actual A_i be a weighted average of the two extreme case *A*'s:

$$A_i = \xi A_i^o + (1-\xi) A_i' \tag{9}$$

where ξ is a parameter in the range from 0 to 1 inclusive. The actual K_i is then calculated from the weighted average A_i:

$$K_i = \left(\frac{y_i}{A_i P_i^{\beta-1}} \right)^{1/\alpha} = \left(\frac{y_i}{(\xi A_i^o + (1-\xi) A') P_i^{\beta-1}} \right)^{1/\alpha} \tag{10}$$

If $\xi = 0$, then all the A_i are equal to A_1 and all differentials in per capita income are owing to differentials in generalized capital K_i. If $\xi = 1$, then every nation has the same amount of K_i in proportion to output Y_i as does nation 1 ($k_i = k_1$), and all differentials in per capita income are owing to differentials in the total factor productivity coefficients A_i. If ξ is between 0 and 1, then the differentials in per capita income are partially owing to differentials in generalized capital

stocks and partially owing to differentials in total factor productivity coefficients.

B. *Production Allocation and Gross Transfer Fund Contribution*

Once output *Y* in a certain nation has been produced, it is allocated over four uses: (1) military expenditure *M*; (2) consumption *C*; (3) gross transfer fund contribution *T*; and (4) domestic investment *I*. (As explained below, for all nations except the richest nation in terms of per capita income, its gross transfer fund contribution is greater than its net transfer fund contribution.) It is assumed that of these four categories, military expenditure has the highest priority, i.e., the military expenditure "obligation" is determined first as a proportion of national income according to the relationship:

$$M_{i,t} = m_i Y_{i,t} \tag{11}$$

Each nation's military proportion (m_i) is estimated as the average of its observed annual military proportion from 1995-2000. The existence of a World Economic Equalization Program financed by a once-for-all reduction in military expenditure is modeled by reducing m_i by the proportion μ and reallocating the reduced military expenditure into a transfer fund contribution. If there is no WEEP in effect, then the parameter $\mu = 0$ and the military proportion is assumed to remain a constant over the interval (validation interval or planning interval).

With respect to consumption, we start by postulating a linear "potential per capita consumption function" that relates the potential per capita consumption c' of the nation's population to the nation's per capita disposable income y^d after the military expenditure obligation has been met:

$$c'_{i,t} = a + by^d_{i,t} = a + b\frac{Y_{i,t} - M_{i,t}}{P_{i,t}} \tag{12}$$

where *a* and *b* are respectively the intercept and slope parameters of the linear function ($0 < b < 1$). Since by definition potential per capita consumption $c' = C'/P$ (where C' = total amount of potential consumption), the linear function for the total amount of potential consumption may be written as:

$$C'_{i,t} = \left(a + b\frac{Y_{i,t} - M_{i,t}}{P_{i,t}}\right)P_{i,t} = aP_{i,t} + b(1 - m_i)Y_{i,t} \tag{13}$$

where the second RHS term shows the result of substituting the military expenditure equation

(11) into (12). In the case of poorer nations with low per capita income, it is likely that C' computed from equation (13) exceeds the value of *Y* - *M*. In these cases, it is presumed that military expenditure takes precedence over consumption. Thus actual consumption *C* is the minimum of potential consumption and disposable income:

$$C_{i,t} = \min(C'_{i,t}, Y_{i,t} - M_{i,t}) \tag{14}$$

The "residual" $R_{i,t}$ of nation *i* at time *t* is defined as:

$$R_{i,t} = Y_{i,t} - M_{i,t} - C_{i,t} \tag{15}$$

Nations are divided into two categories depending on whether this residual is positive or zero. If it is zero, then the nation's domestic investment in generalized capital and gross transfer fund contribution are also zero. If it is positive, the proportion μ of the nation's military expenditure in the initial period becomes its gross transfer fund contribution *T* in that period. This amount is taken as the proportion λ of national income:

$$\lambda_i = \frac{T_{i,0}}{Y_{i,0}} = \frac{\mu M_{i,0}}{Y_{i,0}} \tag{16}$$

In succeeding periods ($t > 0$), nation *i*'s gross transfer fund contribution is computed as this same proportion applied to its current national income:

$$T_{i,t} = \lambda_i Y_{i,t} \tag{17}$$

Domestic investment is the residual after *M*, *C* and *T* have all been deducted from national income:

$$I_{i,t} = Y_{i,t} - M_{i,t} - C_{i,t} - T_{i,t} \tag{18}$$

A practical problem with this method of determining gross transfer fund contributions is that a few nations, most notably Japan, have very high per capita income combined with relatively low military expenditure proportions. Therefore, if this method were applied uniformly, it would result in Japan contributing a smaller proportion of its national income to the transfer fund than the United States, which, despite several years of disarming in the 1990s, still has a relatively high military expenditure proportion of national income. No doubt this would seem anomalous to both the people of the United States and the people of Japan. Although its per capita income is now exceeded by that of several other nations, the United States still has by far the largest economy in the world in terms of GDP. Therefore, it is proposed that the United States play a

pivotal role in determining the transfer fund contributions of other nations.

For nations with per capita income higher than that of the United States and gross transfer fund contribution proportions on the basis of equation (16) less than that of the United States, their gross transfer fund contribution proportions would be set equal to that of the United States. For nations that have gross transfer fund contribution proportions less than that of the United States on the basis of equation (16), but per capita income lower than that of the United States, their gross transfer fund contribution proportions would be set equal to a fraction of that of the United States, with the fraction defined as the ratio of that nation's per capita income to per capita income of the United States. Formally this is stated as follows (note: the United States is number 132 on the alphabetical list of nations included in the World Bank dataset):

$$\lambda_i = \lambda_{132} = \frac{T_{132,t}}{Y_{132,t}} \quad \text{if} \quad y_{i,t} > y_{132,t} \tag{19}$$

$$\lambda_i = \frac{y_{i,t}}{y_{132,t}} \lambda_{132} \quad \text{if} \quad y_{i,t} < y_{132,t} \tag{20}$$

Once λ has been determined, the nation's gross transfer fund contribution is determined by equation (17). The total transfer fund is the sum of the gross transfer fund contributions of all nations.

C. *Inequality Measures and Transfer Fund Shares*

Let $y_t^{\max}$ stand for the maximum per capita income over all nations in the dataset at a particular point in time:

$$y_t^{\max} = \max(y_{i,t},\ i = 1,...,n) \tag{21}$$

The ratio r of per capita income to maximum per capita income for a particular nation at a particular time is defined as:

$$r_{i,t} = y_{i,t} / y_t^{\max} \tag{22}$$

Let *WMRatio* designate the weighted mean ratio over all nations using relative populations as the weights:

$$WMRatio = \sum_{i=1}^{n} \frac{P_{i,t}}{P_t} r_{i,t} = \sum_{i=1}^{n} \frac{P_{i,t}}{P_t} \frac{y_{i,t}}{y_{i,t}^{\max}} \tag{23}$$

where P_t is the total population at a point in time. This measure, defined for each period of time,

is positively related to the level of equality among nations and negatively related to the level of inequality.

In addition to *WMRatio*, two other inequality measures will be used to assess performance over the validation and policy planning intervals: *MinRatio* and *RangePCY*. The *MinRatio* is the lowest ratio *r*, over all nations at a particular time period, of per capita income of the nation to maximum per capita income. The *RangePCY* is the difference, at a particular time period, between maximum per capita income and minimum per capita income. Formally, these are stated as follows:

$$MinRatio = \min(r_{i,t},\ i = 1,...,n) \tag{24}$$

$$RangePCY = y_t^{\max} - y_t^{\min} \tag{25}$$

MinRatio is negatively related to inequality and positively related to equality, while *RangePCY* is positively related to inequality and negatively related to equality.

Turning now to the determination of the share of each nation in the total transfer fund *TT*, we desire a formula that would give proportionately more to nation *i* on the basis of both its poverty level and its population size, since both poverty level and population are indicators of the nation's "need" for new generalized capital resources. Define the "difference" *d* as the difference between the maximum per capita income over all nations and the per capita income of nation *i*:

$$d_{i,t} = y_t^{\max} - y_{i,t} \tag{26}$$

The larger the difference *d*, the larger the poverty of nation *i*. The "population-weighted difference" is the product of the difference factor *d* and the nation's population *P*. It is proposed that the proportional share *s* of a given nation in the total transfer function be the ratio of the nation's population-weighted difference to the total population-weighted difference over all nations:

$$s_{i,t} = \frac{d_{i,t}P_{i,t}}{\sum d_{i,t}P_{i,t}} \tag{27}$$

where the sum in the denominator is over all nations. The absolute amount *S* of nation *i*'s share *s* in the total global transfer fund *TT* would then be:

$$S_{i,t} = s_{i,t}TT_t \tag{28}$$

It is envisioned that every nation in the world—except for the richest nation—would receive

a certain share of the transfer fund. (For the richest nation, equations (26), (27) and (28) would evaluate to zero.) This includes the richer nations that are liable to positive gross transfer fund contributions. For all nations in the world (or at least those participating in the World Economic Equalization Program), their *net* transfer fund contributions are defined as follows:

$$T^{n}_{i,t} = T_{i,t} - S_{i,t} \tag{29}$$

For the rich nations, these net contributions would be positive while for the poor nations they would be negative. All nations, whether rich or poor, would be expected to utilize their shares *S* for purposes of deepening their stocks of generalized capital.

D. *Intertemporal Transition*

If the WEEP is put into operation, it is assumed that all nations, rich and poor, reduce their military expenditure in the initial period by the same proportion μ. Following this once-for-all reduction, military expenditure in each nation, as a proportion of national income, remains the same throughout the planning period. The reallocation of military expenditure for the richer nations is to the global development transfer fund, while the reallocation of military expenditure for the poorer nations is to domestic consumption and investment. The absence of a WEEP is modeled by setting $\mu = 0$ and leaving the military expenditure proportion for all nations constant over all periods at their initial-period levels.

The transition of the national economies from period *t* to period *t* + 1 is shown in the following set of equations:

$$\tau_{t+1} = (1+\phi)\tau_t \tag{30}$$

$$A_{i,t+1} = (1+\tau_{t+1})A_{i,t} \tag{31}$$

$$g_{i,t+1} = (1+\gamma)g_{i,t} \tag{32}$$

$$P_{i,t+1} = (1+g_{i,t+1})P_{i,t} \tag{33}$$

$$K_{i,t+1} = (1-\delta)K_{i,t} + I_{i,t} + S_{i,t} = (1-\delta)K_{i,t} + (Y_{i,t} - M_{i,t} - C_{i,t} - T_{i,t}) + S_{i,t} \tag{34}$$

Equations (30) and (31) show the evolution of each nation's total factor productivity coefficient *A*. The variable τ represents the rate of change of disembodied technical progress, which is determined by its initial value τ_0 and its rate of change ϕ. The parameter ϕ could be a negative number, which would indicate a slowdown in the rate of disembodied technological

progress.

Equations (32) and (33) show the evolution of each nation's population P. The variable $g_{i,t}$ represents the rate of change of population for nation i in period t, which is determined by its initial value $g_{i,0}$ and its rate of change γ. The initial rate of population growth for each nation is specified as the observed average annual rate of geometric population growth between 1970 and 2000. From the geometric population growth equation:

$$P_{i,T} = P_{i,0}(1+g_i)^T \tag{35}$$

where $P_{i,T}$ is the terminal year population, $P_{i,0}$ is the initial year population, T is the number of years between 1970 and 2000, and g_i is the rate of geometric growth, we may solve for g_i:

$$g_i = (P_{i,T} / P_{i,0})^{1/T} - 1 \tag{36}$$

The computed value g_i for each nation serves as its initial rate of population growth $g_{i,0}$, for both the validation interval and the planning interval. These initial population growth rates could be called "benchmark" values, but a better term might be "fixed" values since there is no investigation of the sensitivity of WEEP model results to variations in these rates. These particular parameters, based as they are on observed population growth over the recent past, have a solid empirical foundation. In this respect, they are unique among the WEEP model parameters. The parameter γ in equation (32) could be a negative number, representing a slowdown in the rate of growth of population.

All nations' generalized capital growth is shown in equation (34). One additional parameter occurs in this equation: δ is the standard physical depreciation factor.

II. Numerical Implementation

A. *World Bank Dataset*

The dataset used for model validation and for setting initial values of the policy simulations was derived from the World Bank CD-ROM *World Development Indicators 2002*. It contains annual values from 1970 through 2000 (31 years inclusive) for population P (series "Population, total," SP.POP.TOTL) and per capita income y (series "GDP per capita, constant 1995 US$," NY.GDP.PCAP.KD) for the 140 nations that were listed in the data source as having populations of one million or more in 1970. It also contains annual values 1995-2000 on military expenditure percentage (series "Military expenditure (% of GNI)," MS.MIL.XPND.GN.ZS) for these nations.

These latter figures are converted to proportions m_i by dividing by 100.

Source data on total population is complete for the 140 nations, but source coverage for the other variables is incomplete. For approximately 50 out of the 140 nations, there is missing data on per capita income for one or more years between 1970 and 2000, and for a small number of nations (eight) there is no data at all for this period. To fill in the missing data for the nations that had per capita income data for some years, the following method was used. First, the first year in which data on per capita income is available in the source for a specific nation was determined. Second, the ratio between per capita income in that nation and per capita income in the United States for that year was determined. Third, this ratio was applied to the known per capita income figure in the United States to estimate the per capita income figure for the specific nation in each year for which data is not available in the source. For nations that had no per capita income data at all for any of the years 1970 through 1995, they were given per capita income figures of similar nations. For the military proportion variable, the average was taken over as many data points as were available in the 1995-2000 interval. For nations with no military expenditure data at all in this interval, they were given the military proportion values of similar nations.

B. *Benchmark Parameter Values*

Few economists would dispute that the theoretical content of contemporary economics is far more voluminous than its empirical content. Although a tremendous amount of raw data is collected, recorded and published, virtually all of this data is produced by the complex real world rather than by the controlled experiments from which are derived the great majority of precise and reliable empirical results in the physical sciences. Normally the numerical parameters of theoretical relationships must be econometrically estimated from non-experimental data. Owing to a variety of problems, ranging from unrepresentative and inaccurate data to equation misspecification and under-identification, these estimates tend to be unreliable. Even with respect to the most fundamental economic concepts (the consumption function, the production function, and so on), very little consensus exists even as to the appropriate mathematical forms of these functions, let alone the numerical values of those parameters that occur in any specific mathematical form.

The problem is compounded in the case of the equations of the WEEP model. These equations represent hypothetical cross-national relationships, and very few econometric studies undertake estimation of cross-national relationships. Moreover, the purpose of the WEEP model is to examine the potential impact of an unprecedented policy innovation: a World Economic

Equalization Program. A plausible speculation is that a policy innovation so monumental in scope as this would have major ramifications throughout the entire world economy. Therefore the relationships and parameters that hold today in the absence of such a program—even if they could be econometrically estimated—might be substantially different from those that would hold in the future if such a program were inaugurated.

The upshot of this is that it would be futile to aspire to a high level of numerical precision and accuracy in specifying the parameters of the WEEP model. Benchmark parameter values are utilized in this study that satisfy the following criteria: (1) they are consistent with fundamental economic theory; (2) they lie within the boundaries of plausibility established by impressionistic appreciation of related empirical literature; (3) they produce a reasonably satisfactory fit between the empirical data and the model results over the validation period extending from 1970 through 2000. Of course, the uncertainty that exists with respect to model parameter values means that an important part of the research is sensitivity analysis: the determination of how policy simulations are affected by changes in numerical parameter values.

The benchmark numerical specifications of the various parameter values are shown in Table 1. These numerical values are consistent with fundamental economic theory as well as with the imprecise empirical indications forthcoming from relevant statistical literature. As shown in the following section, they also produce a benchmark validation simulation that demonstrates the WEEP model with these parameter values is capable of producing a reasonable approximation to real world data from the 1970-2000 period.

C. *Validation Simulation*

Prior to the application of a simulation model to examine the potential consequences of a policy innovation, it is customary to validate it by determining that it tracks reasonably well the observed variable values during a period in which there was no policy innovation. In the case of the present research, the validation period covers the 31 years of the World Bank dataset from 1970 to 2000. The validation simulation uses as initial values the population and per capita income figures for the 140 nations in 1970. Population growth over the period is "smoothed" using the geometric population growth equation (35). Throughout the 1970-2000 period the military expenditure proportion for each nation remains constant at its estimated average level for the 1995-2000 interval, i.e., no part of military expenditure is diverted to the transfer fund ($\mu = 0$). The benchmark numerical parameter values shown in Table 1 above were determined by trial-

and-error to produce a satisfactory fit to the observed data over the validation interval.

Two standard statistical measures of goodness of fit are Root Mean Squared Error (*RMSE*) and R-Squared (*RSQ*). In our application, the empirical variable is observed per capita income (*y*) over the 140 nations and 31 years of the World Bank dataset, and the model variable is computed per capita income $(\hat{y})$ from the WEEP model over the same nations and years. The Root Mean Squared Error over the 31 years for each nation *i* is given by:

$$RMSE_i = \sqrt{\frac{1}{31}\sum_{t=0}^{30}(y_{i,t} - \hat{y}_{i,t})^2} \tag{37}$$

The R-Squared over the 31 years for each nation *i* is given by:

$$RSQ_i = \frac{\sum_{t=0}^{30}(\hat{y}_{i,t} - \overline{y}_i)^2}{\sum_{t=0}^{30}(y_{i,t} - \overline{y}_i)^2} \tag{38}$$

where $\overline{y}_i$ is the mean per capita income for nation *i* over the 31 years.

Obviously with 140 nations in the dataset, it would be impractical to look directly at these statistics. Therefore, two summary statistics over the 140 nations were computed from the nation-level statistics: respectively Weighted Mean Root Mean Squared Error (*WMRMSE*) and Weighted Mean R-Squared (*WMRSQ*). In computing the weighted means, the weights are each nation's 2000 population as a proportion of total 2000 population over the 140 nations. Formulae for the two summary statistics are as follows:

$$WMRMSE = \sum_{i=1}^{140}\frac{P_{i,30}}{P_{30}}\sqrt{\frac{1}{31}\sum_{t=0}^{30}(y_{i,t} - \hat{y}_{i,t})^2} \tag{39}$$

$$WMRSQ = \sum_{i=1}^{140}\frac{P_{i,30}}{P_{30}}\frac{\sum_{t=0}^{30}(\hat{y}_{i,t} - \overline{y}_i)^2}{\sum_{t=0}^{30}(y_{i,t} - \overline{y}_i)^2} \tag{40}$$

where P_{30} is total population in period 30.

An additional summary statistic was computed for each validation run: the R-Squared over the 140 nations for the final year empirical and model per capita income. This is a cross-sectional rather than a time series statistic; it looks at the model data fit to the actual data in the last period of the validation interval. Designated *RSQ*30 for the 30th period cross-sectional R-Squared, its

formula is as follows:

$$RSQ30 = \frac{\sum_{i=1}^{140} (\hat{y}_{i,30} - \overline{y}_{30})^2}{\sum_{i=1}^{140} (y_{i,30} - \overline{y}_{30})^2} \tag{41}$$

where $\overline{y}_{30}$ is the mean per capita income in period 30 (2000) over the 140 nations.

The numerical parameter values shown above in Table 1 produce the following values for the three summary statistics:

WMRMSE = 752.613

WMRSQ = .7642

*RSQ*30 = .9070

These values are consistent with customary numerical standards regarding reasonable fit.

To further support the proposition that the WEEP model adequately tracks observed reality under no-WEEP conditions, consider Figure1 and Table 2. The upper panel of Figure 1 shows plots of actual versus model growth in per capita income for four representative high-income nations: United States, Belgium, United Kingdom and Spain, while the lower panel of this figure shows plots of actual versus model growth in per capita income for four representative low-income nations: Algeria, Philippines, India and Zimbabwe. Actual growth is shown by solid lines, while model growth is shown by dashed lines. Clearly the model does not explain short-term variations and fluctuations in per capita income growth, but it does a reasonable job of tracking long-term movements in per capita income.

Table 2 provides numerical information over the validation interval on the three aggregate inequality measures introduced earlier: *WMRatio*, *MinRatio* and *RangePCY*. Columns headed "model" show these measures computed from WEEP model output, while columns headed "actual" show these measures computed from empirical data. Once again, there is a reasonably close fit between the model figures and the actual figures.

III. Benchmark Policy Simulations

We now apply the model to examine the question of interest, namely: What might be the effect of a very large-scale economic development assistance program (a "global Marshall Plan") that would shift massive amounts of generalized capital resources from the rich nations to the poor nations? The benchmark WEEP model policy simulation results suggest that the potential

effect could be dramatic. Such a program might well produce a remarkable acceleration in the economic growth of the poor nations, while imposing on the rich nations only mild retardation of their economic growth rates. The world poverty problem might well be greatly alleviated within a 50-year period. This does not mean that the problem of economic inequality would be completely eliminated. But the gap between the richest and poorest nations would be greatly reduced, and sufficient progress would have been made in the poorest nations that they would no longer be "poor" in today's absolute terms. Lest enthusiasm be unrestrained, it must be conceded that optimistic simulation results are *not* achieved over *all* reasonable ranges of parameter values. Sensitivity analysis using adverse parameter values confirms what is intuitively evident: that the World Economic Equalization Program *might* be a dismal failure. The question, however, is whether failure is so overwhelmingly likely as to preclude even a tentative and provisional WEEP. The sensitivity analysis in fact brings to light certain evidence that might be construed as favorable to undertaking a real-world WEEP on an experimental basis.

A. *With-Without WEEP Comparison*

The policy simulations use for initial values the observed population and per capita income figures in 2000 for the 140 nations included in the dataset. The simulations are continued for 50 years past the initial year, up to 2050. The benchmark simulations consist of two components: the without-WEEP simulation and the with-WEEP simulation. The without-WEEP simulation specifies that the military expenditure proportion of each nation remains the same over the entire 2000-2050 period, i.e., $\mu = 0$. In this case, no funds are allocated by the rich nations into the transfer fund. The with-WEEP simulation specifies that there is a once-for-all reduction, by all nations, of the military expenditure proportion by the amount $\mu = 0.25$. That is, military expenditure in all nations is reduced by 25 percent. In the rich nations in which the residual R defined by equation (15) above is positive, this reduction in military expenditure is reallocated to the gross transfer fund contribution T. This amount is taken, for each nation in the initial year, as a proportion of its national income λ, and this same proportion is applied to national income in each succeeding year of the planning interval to compute the nation's gross transfer fund contribution.

The potentially dramatic effect of a World Economic Equalization Program on the future economic development of human civilization is illustrated by Figure 2. The upper panel of this figure shows per capita income growth without a WEEP for the same eight representative nations included in Figure 1: the four high-income nations comprise the United States, Belgium, United

Kingdom and Spain while the four low-income nations comprise Algeria, Philippines, India and Zimbabwe. According to this plot, we can expect the existing trend toward greater economic inequality established in the latter part of the twentieth century to continue onward into the twenty-first century. The gap between the rich nations and the poor nations will continue to widen. The lower panel of Figure 2 shows per capita income growth for the eight representative nations with a World Economic Equalization Program in operation. The economic gap narrows radically owing to the accelerated growth of the poor nations—but at the same time the economic growth of the rich nations is not appreciably reduced.

The results displayed in Figure 2 are remarkable to say the least. The losses in terms of a slightly lower growth rate for the same number of rich nations are minuscule relative to the huge gains of the poor nations. This, of course, raises the question of believability. Are not these results simply too good to be true? Before answering this skeptical question in the affirmative, it should be recognized and acknowledged that these results are in fact consistent with one of the oldest and most universally accepted economic principles of all: the law of diminishing returns to a factor of production. The factor of production in this case is generalized capital, comprising not only the value of physical plant and machinery, but also the value of human capital resources and social capital resources. The rich nations are utilizing large amounts of generalized capital, therefore the marginal product of generalized capital in these nations is low. The poor nations are utilizing small amounts of generalized capital, therefore the marginal product of generalized capital in these nations is high. Consequently, if a certain increment of generalized capital that would have been installed in a rich nation, is instead installed in a poor nation, the reduction in potential output of the rich nation will be small, while the increase in actual output of the poor nation will be large. This proposition in itself is hardly a matter for debate. But according to the benchmark WEEP model simulations with and without a World Economic Equalization Program in operation, the numerical implications of this proposition, in the context of the world poverty and inequality problem, are far more dramatic than have ever been imagined by most contemporary economists.

Table 3 presents a quantitative assessment of the potential effect of a World Economic Equalization Program on the economic inequality situation. The table compares the three inequality measures (*WMRatio*, *MinRatio* and *RangePCY*) as between the benchmark with-WEEP simulation and the benchmark without-WEEP simulation. As can be seen, without the WEEP the inequality situation slowly but steadily intensifies. With the WEEP, the inequality situation

improves dramatically.

The world economic inequality situation is a serious problem with no obvious solution. It is a natural human tendency to avoid contemplating serious problems without solutions, whereupon they become—in our perception and consciousness—less serious. Thus some economists might be tempted to dismiss the scenario depicted in the upper panel of Figure 2 showing projected growth in per capita income without a WEEP—a scenario of steadily increasing economic inequality—as unduly pessimistic. It is worth emphasizing that the scenario depicted in the upper panel (a) of Figure 2, for the first five decades of the twenty-first century, is simply a continuation of the observed situation over the last three decades of the twentieth century. This might be difficult to accept, because in the lower panel (b) of Figure 1, showing actual and model per income growth for four representative low-income nations from 1971 to 2000, these nations are showing a respectable amount of growth. But note the difference in the units of measure along the vertical axes of the lower and upper panels of Figure 1. The units of measure on the upper axis are roughly 20 times those on the lower axis. Figure 3 shows actual per capita income growth from 1971 to 2000 for all eight nations in the same panel. It can be seen that the upper panel of Figure 2 is not all that different from Figure 3.

B. *Burden of the WEEP*

From the standpoint of professional economic logic, the most sensible and meaningful cost imposed on the rich nations by their contributions into the transfer fund of a World Economic Equalization Program would be in terms of foregone growth: the difference between their per capita incomes at the end of the 51-year period 2000-2050 if no WEEP takes place and no contributions are made into the transfer fund, and their per capita incomes at the end of this period if a WEEP does take place and they do make contributions into the transfer fund. The estimated differences between the benchmark without-WEEP simulation and with-WEEP simulation, in percentage terms, are shown in Table 4 for the 20 richest nations in per capita income (PCY) in the year 2000. The five columns of the table show respectively the name of the nation, its actual PCY in 2000, its projected PCY in 2050 without a WEEP, its projected PCY in 2050 with a WEEP, and the percentage difference between the two. For all nations the percentage differences are well under 1 percent. The foregone growth of the rich nations, according to the benchmark simulations, could reasonably be described as inconsequential.

Outside of the realm of professional economic logic, and within the realm of everyday

political discourse and controversy, in which such questions as "where is the money coming from" assume critical importance, the costs of the WEEP are more likely to be assessed in terms of the percentages of national income contributed into the transfer fund, and the reductions in other categories of national expenditure consequent upon these contributions. Table 5 indicates the burden of the WEEP on the rich nations in these terms. As stated earlier, the initial basis of each nation's gross transfer fund contribution is a once-for-all reduction of its military expenditure proportion by the amount μ. In the benchmark case $\mu = .25$. Table 5 once again pertains to the 20 richest nations. The first three numeric columns show respectively the nation's actual military expenditure in 2000 as a percentage of its total output *Y* (these figures are estimated as the average from 1995 through 2000), its projected military expenditure in 2000 as a percentage of *Y* had a WEEP been commenced in 2000, and the difference between the two. (The with-WEEP simulation is a "what-if" exercise that starts from the counter-factual presumption that a WEEP had been commenced in the year 2000.) The projected military expenditure percentage for each nation is 75 percent of the actual percentage ($1 - \mu$ in percentage terms). The projected military expenditure percentage for 2000 continues to hold throughout the remainder of the 2000-2050 period; no further reductions in military expenditure percentage are contemplated.

Numeric columns 3-5 of Table 5 show projected net transfer fund contributions as a percentage of total output *Y*, with a WEEP in operation, for the 20 richest nations respectively in 2000, 2025 (the midpoint of the planning period), and 2050 (the endpoint of the planning period). The rules for computing these percentages are embodied in equations (16)-(20) and (26)-(29) above. Let us look at one example, Japan, representing nations with PCY greater than that of the United States and a second example, France, representing nations with PCY less than that of the United States. The gross transfer fund contribution of the United States in the initial period, in percentage terms, is .25 of its military expenditure percentage: 3.340 x .25 = 0.835. Japan, which has a lower military expenditure proportion than the U.S. but a higher PCY, would have its gross transfer fund contribution set equal to 0.835. France, which has a lower military expenditure proportion than the U.S. and also a lower PCY, would have its gross transfer fund contribution adjusted by the ratio of its PCY to U.S. PCY: 0.835 x (29811/31996) = 0.77798. Recall that a nation's net transfer fund contribution is its gross contribution less its share in the total transfer fund, and that each nation with a PCY less than that of the richest nation in the world (Switzerland) gets a share of the fund determined by its relative population and the difference between its PCY and that of the richest nation. As a percentage of its *Y*, Japan's share of the fund

in the initial period is 0.0036, while France's share is 0.04799. For Japan, 0.0036 is deducted from its gross transfer fund contribution percentage, while for France 0.04799 is deducted. Thus for Japan its net transfer fund contribution percentage of *Y* is 0.835 – 0.0036 = 0.8314, while for France it is 0.77798 – 0.04799 = 0.72999 (rounded off in Table 5 to 0.730).

The "Diff. 2000" column in Table 5 represents the percentage of each nation's *Y* that is released through the reduction in military expenditure, while the "Proj. 2002" column is the percentage of each nation's *Y* that would be allocated to its net transfer fund contribution. In the case of rich nations with relatively low military spending, the latter is greater than the former, meaning that some of the net contribution would have to come from sources other than reduced military spending. This is actually true of most nations among the richest 20, including all seven nations with PCY higher than that of the United States. For the United States, however, with its relatively high military expenditure percentage, its net contribution obligation of 0.796 is actually less than its military expenditure reduction of 0.835. A small number of other nations in the richest 20 are in this category: Singapore, the United Kingdom, Italy and Spain.

Obviously, for a real-world WEEP to be politically feasible, the large majority of rich nations would have to agree to participate. No doubt there would be a certain amount of "horse trading" as nations jockey to reduce their respective burdens. On the other hand, the most striking feature about the net transfer fund contributions shown in Table 5 is how small they are. Recall that these are percentages and not proportions. Without exception, the projected net transfer fund contributions, for all the rich nations throughout the planning period, are less than one percent of their national incomes. Quite possibly the prospect of initiating such a grandiose humanitarian project, embodying as it does the highest standards of cooperation and enlightened self-interest, will inspire such emotions of enthusiasm and solidarity that most nations will agree to contribute more than the minima specified by the formal rules. Possibly the spirit of mutual endeavor will permeate the various national populations to such an extent that most people will be able to perceive that the true costs of the project are in terms of reduced economic growth among the rich nations—and that these costs are likely to be very minor.

IV. Sensitivity Analysis

As far as the prospects for significantly reducing global economic inequality within the foreseeable future are concerned, pessimism reigns supreme within the contemporary economics profession. Thus the reaction of the typical economist to the benchmark WEEP simulations

reported here will certainly be that they are impossibly optimistic. The typical economist will suspect strongly that these are "knife-edge" results that would be overturned by slight variations in parameter values away from their favorable benchmark values. In order to respond to this suspicion, a great deal of sensitivity analysis was undertaken. It would be impractical to report this analysis in detail, but some illustrative results will be presented to convey three central conclusions suggested by the analysis: (1) the positive benchmark results are reasonably robust against variation in most of the parameters of the model; (2) the simulation results are, however, highly sensitive to the critical parameter ξ, and sufficiently adverse variation in the ξ parameter will eliminate the effectiveness of the WEEP in raising the economic growth of the poor nations; (3) even if the ξ value is extremely adverse so that the WEEP does little good for the poor nations, undertaking the WEEP would nevertheless have a very minor retarding effect on the economic growth of the rich nations.

A. *Reasonable Robustness*

Table 6 shows the effect of selected parametric variation on one of the fundamental success indicators of the World Economic Equalization Program: the Weighted Mean Ratio (*WMRatio*) in the terminal period of the planning interval (t = 50, corresponding to the year 2050). Defined by equation (23) above, *WMRatio* is the weighted mean of the ratio of each nation's per capita income to the richest nation's per capita income, where the weights are each nation's proportion of the total population of the 140 nations included in the World Bank dataset. The higher this ratio, the more equal is the international distribution of income. The computed value of this measure using actual data for 2000 is 0.1195. According to the benchmark simulation without a WEEP, this measure is estimated to fall to 0.0878 in 2050. According to the benchmark simulation with a WEEP, this measure to estimated to rise to 0.6127 in 2050.

Table 6 consists of four sections, each of which shows the effect on *WMRatio* in period 50 of symmetric variation in two parameters around their respective benchmark values, holding all other parameters at their benchmark values. For example, the first section of the table pertains to α^* and ν, the respective benchmark values of which are α^* = .2 and ν = 1. α^* is varied through .1, .15, .2, .25, and .3 while ν is varied through .8, .9, 1, 1.1 and 1.2. The middle cell of the 5x5 matrix of results corresponds to the benchmark case in which the terminal *WMRatio* = 0.6127. It is observed that the level of equality attained by the WEEP is negatively related to α^* and positively related to ν. The worst-case scenario in this section of the table is for α^* = .3 and ν =

.8, in which case *WMRatio* = 0.1469. This is actually the worst-case scenario in the entire table.

The second section of Table 6 indicates that terminal-period equality is negatively related to k_1 and positively related to τ_o. The worst-case scenario for these two parameters is $k_1 = 35$ and $\tau_o = 0$, in which case *WMRatio* = 0.4874. The third section indicates that terminal-period equality is negatively related to a and also negatively related to b. The worst-case scenario for these two parameters is $a = 1750$ and $b = .95$, in which case *WMRatio* = 0.2760. The fourth section of the table indicates that terminal-period equality is positively related to ϕ and negatively related to γ. The worst-case scenario for these two parameters is $\phi = -.050$ and $\gamma = .050$, in which case *WMRatio* = 0.4138. These results are all economically plausible. For example, in the fourth section of the table, the ϕ parameter governs the rate of change of technological progress while the γ parameter governs the rate of change of population growth. It is plausible that if technological progress speeds up, this will improve the prospects for equalization, while if population growth speeds up, this will reduce the prospects for equalization.

It is made plain by Table 6 that if the parameter values of the WEEP model are sufficiently adverse, then simulations of a WEEP will be pessimistic. For example, if we set every one of the eight parameters covered by Table 6 at their worst-case scenario values, the terminal-period *WMRatio* would be 0.0219. Even in this worst case, however, a WEEP would entail vestigial improvement, since with these parameter values *WMRatio* in period 50 without a WEEP would be 0.0217. Also it is important to emphasize that with the worst-case scenario parameter values, the fit to the observed data over the validation interval 1970-2000 is quite poor. For example, the *WMRSQ* is .2832 relative to the *WMRSQ* with the benchmark parameter values of .7642.

In any event, it is only preconception—quite possibly erroneous preconception—that would insist that adverse parameter values are more probable than favorable parameter values, and that pessimistic projections are more probable than optimistic projections. Among the four sections of Table 6, there are a total of 100 *WMRatio* values. Of these 100, only 5 are less than 0.2500. Relative to the expected without-WEEP *WMRatio* in 2050 of 0.0878, every one of the values in Table 6 represents a substantial improvement.

B. *The Critical ξ Parameter*

If pessimism about the potential impact of a real-world WEEP is in fact justified, if in fact such a program would have little impact on the world economic inequality situation, the most likely reason why the benchmark WEEP model simulations are producing misleading results has

little to do with over-optimistic values of structural parameters such as those included in Table 6. The most likely reason is rather the over-optimistic benchmark value of the ξ parameter. It was shown above in the exposition containing equations (1) through (10) that this parameter governs to what extent economic inequality among nations is a function of inequality in generalized capital stocks, and to what extent it is a function of inequality in total factor productivity. The central premise of the World Economic Equalization Program is that economic inequality is mostly or entirely a function of inequality in generalized capital, and the benchmark WEEP model simulations incorporate the best-case scenario: that $\xi = 0$ and all differentials in per capita income among nations are the result of differentials in their generalized capital stocks.

Table 7 shows the consequences of relaxing this assumption. The parameter ξ is varied from its minimum possible value of 0 to its maximum possible value of 1 by increments of 0.05. For each value of ξ the table reports the period-50 *WMRatio*, *MinRatio* and *RangePCY*. It is observed that the equalizing effect of a WEEP is steadily degraded as the value of ξ increases. It should also be noted, however, that unless the ξ value becomes quite large, a substantial amount of economic equalization still takes place. For example, if ξ is at its midpoint value of 0.50, the terminal-period *WMRatio* is 0.2102, which is a significant improvement over the expected without-WEEP *WMRatio* in 2050 of 0.0878. Far more important, however, is the indication in the final two numeric columns of Table 7, which report respectively the period-50 per capita income (PCY) of the United States and the period-50 per capita income of India. The United States is representative of the rich donor nations while India is representative of the poor recipient nations. We observe that while terminal-period U.S. PCY and Indian PCY are both adversely affected by increasing ξ, the effect is far stronger for India than it is for the United States. This suggests that if a real-world WEEP were unsuccessful, it would be unsuccessful in terms of not achieving much acceleration in the economic growth of the recipient nations. But it would not be unsuccessful in terms of having a substantial adverse effect on the economic growth of the rich nations. That is to say, if the rich nations are investing heavily in a real-world WEEP and the program is not having the desired effect, this would be bad news far more to the populations of the recipient nations than to the populations of the donor nations. The rich nations would continue to grow at a brisk rate even if the WEEP is a near-total failure as far as the poor nations are concerned. If the program is inevitably destined for failure, whether because the real-world ξ is close to 1 or some other reason, then soon enough the rich nations would give up on the effort. But the very significant indication of the last two columns of Table 7 is that such an experiment

would not be especially costly to the rich nations. Clearly this indication—if valid—supports the sensibility of inaugurating a real-world WEEP on a tentative and experimental basis in the hope that it will succeed.

V. Conclusion

This research has developed a model designed to provide formal evidence on the potential performance of a very large-scale economic development assistance effort—a "global Marshall Plan" of the sort long proposed by visionaries—termed herein the World Economic Equalization Program (WEEP). The empirical basis of the WEEP model consists of a World Bank dataset containing per capita income y and population P from 1970 through 2000 for the 140 nations in the world that had populations of 1,000,000 or more in 1970. This dataset is used to validate the WEEP model. The benchmark numerical parameter values of the model are consistent with a priori economic theory, lie within the boundaries of plausibility established by relevant empirical literature, and produce model results in per capita income over the 1970-2000 interval that match the observed values to a reasonable degree of accuracy.

Following validation, two benchmark simulations of the WEEP model are run for the 51-year interval 2000-2050: the "without-WEEP" simulation and the "with-WEEP" simulation. According to the without-WEEP simulation, the observed trends during the 1970-2000 interval may be expected to continue through the 2000-2050 interval: the richer nations will grow faster than the poorer nations, the absolute gap between the richest and poorest nations in the world will get larger, and aggregate measures of world economic inequality will continue to gradually but steadily rise. The with-WEEP simulation shows a far more attractive possibility. It shows a pattern of tremendous acceleration of the economic growth of the poor nations, at the cost of only a very slight retardation of the economic growth of the rich nations. The remarkable results of the benchmark without-WEEP and with-WEEP model simulations provide hard evidence that humanity has within its grasp an effective antidote to the greatest single hazard (now that the Cold War has dissipated and the near-term threat of nuclear holocaust has greatly receded) to continued human progress in the contemporary age.

Sensitivity analysis establishes that these results are reasonably robust against parametric variation in most of the model parameters. While this analysis demonstrates that combinations of parameter values exist under which a real-world WEEP would be a failure, there is no justification for assuming that the real-world values of the relevant parameters would be unfavorable.

Special attention is paid to the critical ξ parameter that governs to what extent economic inequality among nations is a function of inequality in generalized capital stocks, and to what extent it is a function of inequality in total factor productivity. It is shown that as this parameter takes on less favorable values, the performance of the WEEP is drastically degraded. However, it is also shown that the costs of failure would be borne mostly by the poor nations, in the sense that the economic growth of the rich nations would not be greatly reduced even if ξ takes on a very unfavorable value. These results clearly argue toward the implementation of a World Economic Equalization Program in the real world—at least on a tentative and provisional basis.

A. *Objections Considered*

Given the reigning pessimism with respect to the near-term economic prospects for the LDCs, the immediate reaction of many if not most contemporary economists to the results described in this paper will be that they are "too good to be true"—that they fall beyond the remotest bounds of believability. There are a multitude of plausible objections that can and probably would be lodged against these results. However, sensible responses may be offered to these objections. Let us consider briefly a few of the more important objections.

Deficiencies of the WEEP Model. The objection here is that the WEEP model is too simplistic and unrealistic for the results derived from it to be taken seriously. For example, it ignores international trade and investment, it utilizes very simple mathematical forms for the production and consumption functions, and it takes no account of complicating factors within the national economies, such as different levels of domestic income inequality within different nations. It also ignores implementation lags, so that the improvement of the economic condition of the poor nations is unrealistically rapid.

I would respond that simplicity is relative. While the WEEP model does not attain the scale and complexity of the larger general equilibrium models and macroeconometric models in usage today, it is not below the average scale and complexity of economic models routinely utilized in the analysis of economic policy issues. Another important point is that the "simplicity of the model," in and of itself, does not necessarily bias the results in one direction or the other. The relative simplicity of the WEEP model does not necessarily predispose it to showing that a real-world WEEP would be highly successful. To the contrary, one obvious counter-example might be proposed to suggest that the simplicity of the WEEP model might bias it *against* showing successful results from the proposed World Economic Equalization Program. The WEEP model

does not incorporate trade among nations, and a strong consensus exists among contemporary economists that international trade is highly beneficial to all participants. Presumably, therefore, a model that incorporated the various "expansionary feedback effects" of international trade might display an even higher level of success for a worldwide economic development effort.

Ignores Absorptive Capacity. In the early days of the organized foreign aid effort of the rich nations, research was carried out that estimated the foreign aid requirements of developing nations to reach the "take-off" condition elaborated in W. W. Rostow's theory of the stages of economic growth (e.g., Hollis Chenery and Alan Strout, 1966). Much emphasis was placed in this research on the absorptive capacity of the recipient nations. There would be no point in providing these nations with anything more than their absorptive capacity, since the surplus would inevitably be wasted. The notion of absorptive capacity runs counter to the usual presumption in economics of smooth, continuous functions, and it may be somewhat suspect also because it provides such a convenient rationale for parsimonious foreign aid allocations. In any case, absorptive capacity, while it may be a valid concept with respect to specific types of capital, cannot apply to the broad category of generalized capital enunciated here. Generalized capital, to reiterate, encompasses any and all types of physical and human capital, and covers everything from factories through education/training to roads and schools. While there may be lags between the installation of generalized capital and its becoming effective in overall production, there can be no such thing as absorptive limits on capital in this very broad sense.

Results Inconsistent with Past Experience. The argument here is that if it were true that extreme differentials in per capita income were the result of extreme differentials in generalized capital stocks, then the foreign aid programs of the past would have achieved a much higher level of success. After all, according to the premise underlying the idea of a World Economic Equalization Program, the generalized capital stocks of the poor nations are tiny and virtually microscopic relative to the generalized capital stocks of the rich nations. This explains the tremendously accelerated growth of the poor nations at the same time that the rich nations experience only a minor retardation of growth: the Marginal Products of the extremely small generalized capital stocks of the poor nations are huge in relation to the Marginal Products of the extremely large generalized capital stocks of the rich nations. But if this were actually the case, would we not have witnessed a much greater payoff to the foreign aid receipts of the poor nations during the last half-century? True, the amounts of foreign aid provided to the poor nations were small in relation to those envisioned by the proposed World Economic Equalization Program, but

they were still fairly substantial in an absolute sense. For example, many LDCs at certain points in time have received amounts comparable to the amounts that were received by the Western European nations during the operation of the Marshall Plan from 1948 to 1952—but these LDCs did not emulate the explosive growth of the Western European recipient nations during that period.

The most plausible answer to this argument is that the foreign aid flows of the past, while they have been large in an absolute sense, were small in relation to the need, and for most of the LDCs did not constitute the necessary "critical mass" to initiate rapid economic progress. In nuclear physics, the critical mass is that quantity of uranium that when compacted will initiate a nuclear explosion. This basic concept has applications outside of nuclear physics. For example, in behavioral psychology, the "threshold of perception" refers to that minimum level of sensory stimulation required for the individual to become consciously aware of the stimulation. This concept may also be relevant to the success or failure of real-world economic development assistance efforts. Quite possibly the principal reason for the poor performance of the recipient nations in the past has been the fact that the resources provided fell short of the necessary critical mass. Graft and corruption may play an essential role in this phenomenon. Past foreign aid expenditures were sufficiently limited that no one involved in the disbursement and utilization of these funds, whether in a rich donor nation or a poor recipient nation, had any confidence that they would have a noticeable improving effect on aggregate economic growth. Therefore, when individuals diverted these funds to their own personal uses, they eased their consciences with the thought that they were not doing any appreciable harm to the larger society or to the human interest as a whole. If, on the other hand, a massive, coordinated, worldwide effort were being made to overcome the world economic inequality problem—an effort sufficiently ambitious to arouse meaningful hopes for success—the attitudes of those personally involved in foreign development assistance programs might be much improved, and the effectiveness of the programs thereby greatly enhanced.

Ignores Implementation Questions. The argument here is that the research presented has nothing at all to say on the numerous applied policy questions in the area of foreign aid, questions that have intrigued and puzzled a generation of economists. But unless clear and cogent answers are provided to these questions, and these answers are duly incorporated into the actual operation of the World Economic Equalization Program, the program would just be "throwing money at the problem" on a massive scale—the overwhelmingly probable consequence of which would be

profligacy and waste on an equally massive scale. One such question, for example, is what would be the appropriate proportions, of the total amount of foreign aid provided to each recipient nation under the WEEP, to be allocated to plant and equipment, education and training, and social infrastructure?

It is quite true that this research has nothing to add to the discussion of these kinds of questions. But it is necessary to proceed one step at a time. The purpose of this research is to demonstrate the possibility that a sufficiently massive worldwide economic development assistance program might be dramatically successful. Once this possibility has been established and fully appreciated, then would be the time to get into the details of program functioning. It is not necessary to resolve all the myriad implementation issues in advance of deciding whether or not to undertake a World Economic Equalization Program. Indeed, if resolution of all these issues were made a precondition for deciding the basic question of whether or not to initiate a WEEP, then this decision would probably never be made. Effective development policy has been debated for decades, with little perceptible progress toward definite conclusions. The ephemeral prominence of the Washington consensus is instructive in this regard. No sooner had the "consensus" achieved widespread recognition when the various economic setbacks of the latter 1990s cast grave doubt on the sensibility of some of its prescriptions, and such major players as the World Bank began to distance themselves from it. (See, for example: Robin Broad and John Cavanaugh, 1999; John Williamson, 2000; Moises Naim, 2000).

B. *The Feasibility Question*

Finally, another important objection to this research rests on the premise—not that the research is necessarily flawed and misleading—but simply that it is irrelevant. So great is the opposition within rich nations to a major expansion of foreign assistance that this policy change is simply not on the current political agenda. In light of this, some economists might question the wisdom of devoting scarce intellectual resources to such a seemingly pie-in-the-sky policy proposals as a World Economic Equalization Program. To begin with, I would respond by saying that if ever economic inquiry becomes confined exclusively to policy proposals that seem politically feasible in the short term, this would significantly weaken the scientific pretensions of the discipline, and also significantly reduce the possibility that economics will ever make a discernable contribution to the future socioeconomic progress of human civilization. Moreover, I would suggest that no public consensus based on seriously faulty premises is likely to be stable.

Strong opposition currently exists to any and all proposals for a major expansion in foreign development assistance because it is assumed that such an expansion would impose heavy costs on the citizens of the rich nations without yielding substantial benefits for the citizens of the poor nations. The results from this research cast serious doubt on these assumptions.

So long as the economic gap persists, the rich nations will be required to enforce strict immigration restrictions to prevent a flood of immigrants from throwing their economies into chaos, and will be forced to maintain substantial military power, including nuclear weapons, to ensure that the poor nations do not ever contemplate a forcible redistribution of world income. It is not simply a matter of direct aggression of poorer nations against the richest nations, as in an invasion of the United States by Mexico. The aggression of Iraq against Kuwait that resulted in the Gulf War was fundamentally motivated by the spirit of forcible redistribution, and it was a costly episode to all concerned. Armed conflicts between LDCs over land and resources, such as the Iran-Iraq border war of 1980-1988, create unstable situations that might engulf the rich nations in war. The hatred that motivated the terrorists of 9/11 cannot be entirely attributed to religious and ideological factors—to some extent also it was a consequence of resentment against the economic prosperity of the rich nations. In sum, the persistence of a large gulf between the living standards of the rich nations and the poor nations does not provide a firm foundation for the future advance of human civilization.

Although few would question the basic desirability of economic convergence among the nations of the world, the currently accepted policy of the rich nations is to supply limited amounts of economic development assistance to the poor nations, in the hope that eventually, sooner or later, they will commence a period of rapid economic growth that will carry them to the same levels of prosperity as prevail within the rich nations. The poor nations are admonished to make themselves institutionally, politically and culturally as much alike as possible to the rich nations, in the hope that institutional, political and cultural similarity will result in economic similarity. The standard lecture of the present day may be summarized as follows: “We (the populations of the rich nations) achieved our high level of prosperity by working very hard, enforcing strict respect for private property, maintaining a high level of laissez faire within the domestic economy, and by opening our national borders to international trade and investment. You (the populations of the poor nations) should go and do likewise, and then you too will reap, as we have, the benefits of economic prosperity.”

Although containing kernels of truth, on the whole this lecture is probably quite naive.

While not denying that hard work, strict respect for private property, and so on, may well be necessary conditions for rapid economic growth and attainment of a high level of material prosperity, they are probably not sufficient conditions. A very basic appreciation of modern economic history suggests that the conditions that generated the economic rise of the rich nations of today are not reproducible. The United States, the nations of Western Europe, and a handful of other nations scattered around the world, rose to their present heights during the 250-year period between 1750 (to select a convenient date) and the present time. This period of time saw two major economic conditions that will never again occur: the incorporation of the immense natural resources of the North American continent into that part of the world economy centered in Western Europe, and the discovery, application and exploitation of tremendous reserves of fossil fuels in coal and oil. The availability of large quantities of open land in North America provided an outlet for the surplus population of Western Europe, and the usage of coal and oil greatly reduced the cost of energy. These conditions are nonreproducible. There are no new continents, loaded with natural resources, on the earth today that are available for settlement and exploitation. And we are very unlikely to discover any new sources of cheap energy comparable to the past discovery of coal and oil.

No doubt good institutions are helpful, but in the main economic prosperity is determined by resources—human resources, natural resources, and capital resources. Good institutions will not help very much if there is a basic scarcity of resources. The poor nations of today have plenty of raw labor power. But people have to be educated and trained for their raw labor power to be maximally productive. Education and training are costly. As to natural resources, some LDCs have more than others, but the natural resource situation is what it is, and no one has any appreciable control over it. But where the rich nations can help the poor nations is in meeting a large proportion of the costs of educating and training the population, and of providing large quantities of physical capital in the form of both social infrastructure and commercial plant and equipment. Relative to these kinds of resources, sermons about free market efficiency, the bureaucratic deficiencies of publicly-owned enterprises, and the mutual advantages of free trade, are of severely limited value. A World Economic Equalization Program would provide the developing nations with the tangible resources they almost certainly will need if they are to have any reasonable hope of economic convergence with the rich nations within the foreseeable future. In the absence of such a program, hopes for meaningful economic convergence are most likely based on little more than wishful thinking.

References

Barr, Stringfellow. *Citizens of the World*. Garden City, NY: Doubleday, 1953.

Broad, Robin, and John Cavanaugh, "The Death of the Washington Consensus?" *World Policy Journa1* 16(3): 79-88, Fall 1999.

Burnside, Craig, and David Dollar. "Aid, Policies, and Growth," *American Economic Review* 90(4): 847-868, September 2000.

Chenery, Hollis B., and Alan M. Strout, "Foreign Assistance and Economic Development," *American Economic Review* 56(4): 679-733, September 1966.

Church, George J. "The Case for a Global Marshall Plan," *Time*, June 12, 1978.

Dollar, David, and Lant Pritchett. *Assessing Aid: What Works, What Doesn't, and Why*. New York: Oxford University Press for the World Bank, 1998.

Horowitz, John B., and Cecil E. Bohanon, Cecil E. "Income Redistribution: An International Perspective," *Public Choice* 89(3): 305-323, December 1996.

Melman, Seymour. *The Peace Race*. New York: Ballentine, 1961.

Naim, Moises. "Fad and Fashion in Economic Reforms: Washington Consensus or Washington Confusion?" *Foreign Policy Magazine* 118: 87-103, Spring 2000.

Tinbergen, Jan. *World Security and Equity*. Aldershot, UK: Edward Elgar, 1990.

Williamson, John. "What Should the World Bank Think about the Washington Consensus?" *World Bank Research Observer* 15(2): 251-264, August 2000.

Yunker, James A. *Common Progress: The Case for a World Economic Equalization Program*. Westport, CT: Praeger, 2000.

Table 1 — Benchmark Parameter Values

Symbol	Explanation	Value
α^*	adjusted output elasticity of generalized capital	0.2
ν	degree of homogeneity	1.0
k_1	initial-period ratio of generalized capital to output in the richest nation	25
ξ	*K* differential vs. *A* differential coefficient	0
τ_0	initial-period rate of change of disembodied technological progress	0.01
ϕ	second rate of change of disembodied technological progress	0
a	intercept of the consumption function	1250
b	slope of the consumption function	0.85
m_i	military obligation proportion	varies
$g_{i,0}$	initial-period population rate of change	varies
γ	second rate of change of population	0
δ	physical depreciation coefficient	0

Table 2 — Inequality Measures 1970-2000, Model versus Actual

Year	*WMRatio*		*MinRatio*		*RangePCY*	
	Model	Actual	Model	Actual	Model	Actual
1970	0.1032	0.1032	0.0026	0.0026	35397	35397
1975	0.1034	0.1095	0.0026	0.0028	37208	36054
1980	0.1035	0.1096	0.0025	0.0029	39124	39727
1985	0.1032	0.1093	0.0024	0.0022	41151	41629
1990	0.1024	0.1085	0.0024	0.0022	43297	45852
1995	0.1013	0.1175	0.0023	0.0023	45570	43537
2000	0.0998	0.1195	0.0022	0.0025	47978	46621

Table 3 — Projected Inequality Measures 2000-2050,
with and without a World Economic Equalization Program

Year	*WMRatio*		*MinRatio*		*RangePCY*	
	with	without	with	without	with	without
2000	0.1195	0.1195	0.0025	0.0025	46621	46621
2005	0.2428	0.1169	0.1675	0.0024	40895	49023
2010	0.3161	0.1139	0.2041	0.0024	41109	51564
2015	0.3966	0.1110	0.2733	0.0023	39479	54253
2020	0.4506	0.1082	0.3478	0.0022	37272	57099
2025	0.4909	0.1051	0.4037	0.0022	35867	60115
2030	0.5233	0.1017	0.4474	0.0021	34987	63309
2035	0.5505	0.0982	0.4805	0.0020	34639	66696
2040	0.5739	0.0947	0.5035	0.0020	34868	70287
2045	0.5944	0.0912	0.5232	0.0019	35286	74095
2050	0.6127	0.0878	0.5403	0.0019	35861	78137

Table 4 — Burden of the WEEP
Foregone Growth for the 20 Richest Nations

Nation	PCY 2000	PCY 2050 without WEEP	PCY 2050 with WEEP	percentage difference
Switzerland	46,737	78,283	78,010	–0.348
Japan	44,830	74,551	74,252	–0.401
Denmark	38,521	69,208	68,853	–0.513
Norway	37,954	67,291	66,942	–0.520
Austria	32,763	63,007	62,572	–0.691
Germany	32,623	63,291	62,871	–0.664
Finland	32,024	61,805	61,385	–0.681
United States	31,996	58,804	58,445	–0.609
Sweden	31,206	61,273	60,862	–0.671
Netherlands	30,966	59,701	59,290	–0.689
Belgium	30,830	61,533	61,098	–0.708
France	29,811	59,307	58,925	–0.644
Singapore	28,230	52,152	51,972	–0.346
Ireland	27,741	56,721	56,327	–0.695
Hong Kong	24,218	51,832	51,563	–0.519
Australia	23,838	52,570	52,319	–0.478
Canada	22,541	52,666	52,399	–0.509
United Kingdom	21,667	54,880	54,605	–0.500
Italy	20,885	54,658	54,366	–0.535
Spain	17,798	52,782	52,551	–0.438

Table 5 — Burden of the WEEP
Military Expenditure % Reduction and Net Transfer Fund Contribution %

Nation	Military expenditure (% of *Y*)			Net transfer fund contribution (% of *Y*)		
	Actual 2000	Proj. 2000	Diff. 2000	Proj. 2000	Proj. 2025	Proj. 2050
Switzerland	1.380	1.035	0.345	0.835	0.835	0.835
Japan	1.000	0.750	0.250	0.831	0.808	0.780
Denmark	1.700	1.275	0.425	0.817	0.738	0.691
Norway	2.260	1.695	0.565	0.815	0.723	0.656
Austria	0.860	0.645	0.215	0.799	0.649	0.568
Germany	1.620	1.215	0.405	0.798	0.650	0.575
Finland	1.640	1.230	0.410	0.796	0.633	0.542
United States	3.340	2.505	0.835	0.796	0.610	0.473
Sweden	2.240	1.680	0.560	0.772	0.621	0.530
Netherlands	1.820	1.365	0.455	0.765	0.602	0.494
Belgium	1.500	1.125	0.375	0.761	0.619	0.536
France	2.900	2.175	0.725	0.730	0.572	0.485
Singapore	4.700	3.525	1.175	0.681	0.406	0.201
Ireland	1.060	0.795	0.265	0.666	0.482	0.389
Hong Kong	1.000	0.750	0.250	0.553	0.314	0.182
Australia	2.080	1.560	0.520	0.541	0.322	0.217
Canada	1.440	1.080	0.360	0.498	0.298	0.220
United Kingdom	2.740	2.055	0.685	0.468	0.324	0.317
Italy	1.940	1.455	0.485	0.440	0.305	0.307
Spain	1.380	1.035	0.345	0.327	0.216	0.227

Table 6 — Comparative Statics Analysis
Effect of Selected Parametric Variation on Economic Equalization

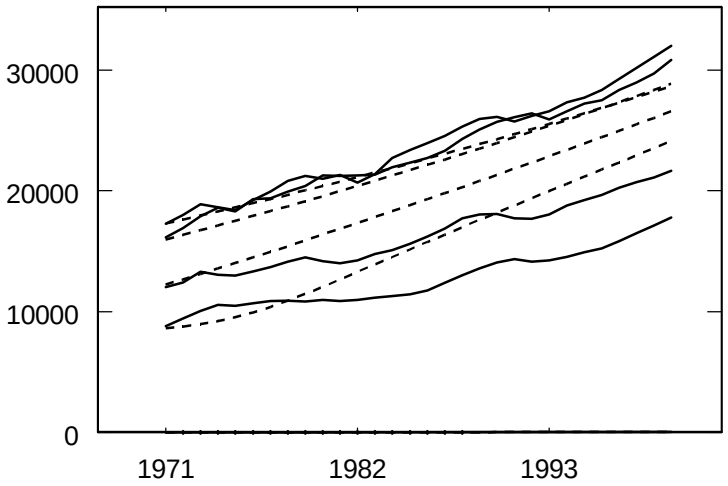
	Weighted Mean Ratio (*WMRatio*) in Period t = 50 (2050)				
	α^* = .1	α^* =.15	α^* =.2	α^* =.25	α^* =.3
ν = .8	0.3038	0.2787	0.2445	0.1998	0.1469
ν = .9	0.5265	0.4925	0.4064	0.2798	0.1579
ν = 1	0.8253	0.7277	0.6127	0.4539	0.2115
ν = 1.1	0.8213	0.8089	0.7940	0.7211	0.4582
ν = 1.2	0.6958	0.6800	0.6597	0.6365	0.6037
	k_1 = 15	k_1 = 20	k_1 = 25	k_1 = 30	k_1 = 35
τ_0 = 0	0.6207	0.5774	0.5426	0.5133	0.4874
τ_0 =.005	0.6529	0.6124	0.5804	0.5540	0.5316
τ_0 =.010	0.6819	0.6433	0.6127	0.5876	0.5664
τ_0 =.015	0.7089	0.6717	0.6422	0.6178	0.5972
τ_0 =.020	0.7342	0.6984	0.6697	0.6459	0.6256
	a = 750	a = 1000	a = 1250	a = 1500	a = 1750
b = .75	0.7147	0.7099	0.7045	0.6976	0.6897
b = .80	0.6851	0.6781	0.6691	0.6578	0.6434
b = .85	0.6432	0.6303	0.6127	0.5889	0.5572
b = .90	0.5721	0.5387	0.4876	0.4075	0.3029
b = .95	0.3493	0.2857	0.2833	0.2813	0.2760
	ϕ = -.050	ϕ = -.025	ϕ = 0	ϕ =.025	ϕ =.050
γ = -.050	0.6100	0.6217	0.6409	0.6760	0.7494
γ = -.025	0.6016	0.6133	0.6331	0.6693	0.7448
γ = 0	0.5798	0.5921	0.6127	0.6510	0.7308
γ = .025	0.5252	0.5383	0.5608	0.6033	0.6919
γ = .050	0.4138	0.4292	0.4561	0.5065	0.6082

Table 7 — Comparative Statics Analysis
Effect of Critical Parameter ξ on Economic Equalization

ξ	*WMRatio* ($t = 50$)	*MinRatio* ($t = 50$)	*RangePCY* ($t = 50$)	U.S. PCY ($t = 50$)	India PCY ($t = 50$)
0.00	0.6127	0.5403	35,861	58,445	46,900
0.05	0.5739	0.5074	38,430	57,870	43,610
0.10	0.5351	0.4705	41,310	57,316	40,285
0.15	0.4963	0.4286	44,576	56,781	36,907
0.20	0.4575	0.3854	47,948	56,266	33,510
0.25	0.4185	0.3414	51,379	55,769	30,182
0.30	0.3791	0.2977	54,788	55,291	26,820
0.35	0.3389	0.2499	58,515	54,831	23,341
0.40	0.2976	0.2016	62,280	54,388	19,739
0.45	0.2545	0.1528	66,087	53,963	16,264
0.50	0.2102	0.1255	68,223	53,556	12,206
0.55	0.1740	0.1088	69,522	53,165	9,219
0.60	0.1557	0.0966	70,474	52,791	8,007
0.65	0.1430	0.0848	71,396	52,433	7,046
0.70	0.1316	0.0732	72,298	52,091	6,112
0.75	0.1206	0.0612	73,235	51,764	5,172
0.80	0.1097	0.0495	74,150	51,452	4,225
0.85	0.0992	0.0378	75,065	51,156	3,291
0.90	0.0890	0.0258	75,997	50,874	2,349
0.95	0.0794	0.0139	76,927	50,607	1,416
1.00	0.0723	0.0022	77,837	50,355	645

FIGURE 1
ACTUAL VERSUS MODEL PER CAPITA
INCOME GROWTH, 1971-2000

(a) FOUR REPRESENTATIVE HIGH-INCOME NATIONS



(b) FOUR REPRESENTATIVE LOW-INCOME NATIONS

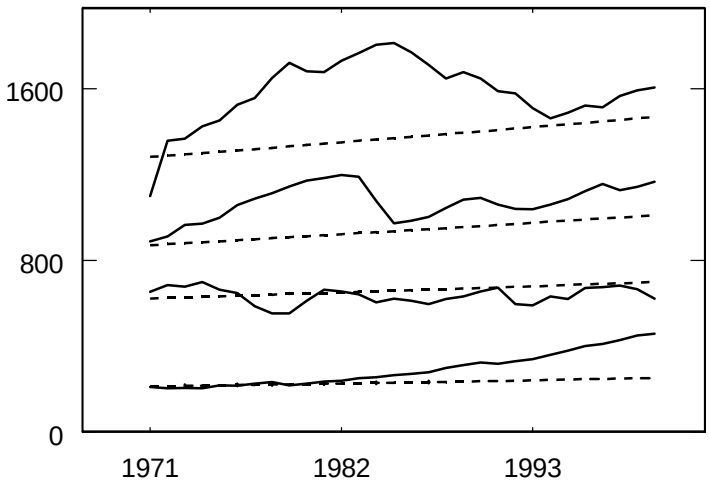
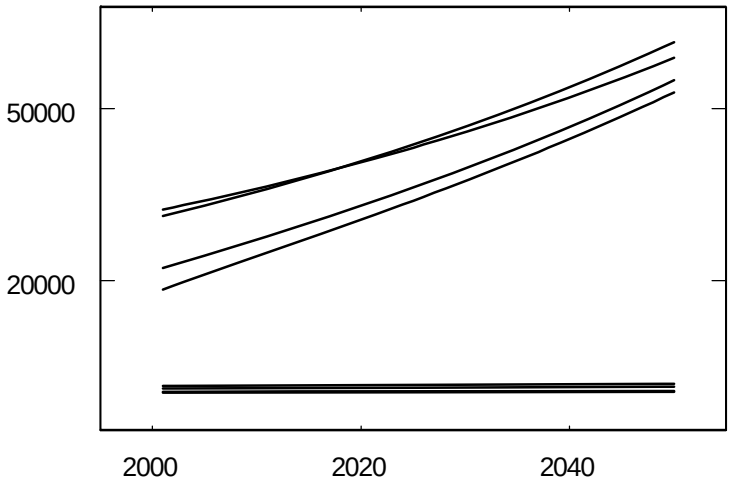


FIGURE 2
PER CAPITA INCOME GROWTH, 2001-2050
WITH AND WITHOUT A WEEP IN OPERATION

(a) PROJECTED PER CAPITA INCOME GROWTH WITHOUT A WEEP: EIGHT REPRESENTATIVE NATIONS



(b) PROJECTED PER CAPITA INCOME GROWTH WITH A WEEP: EIGHT REPRESENTATIVE NATIONS

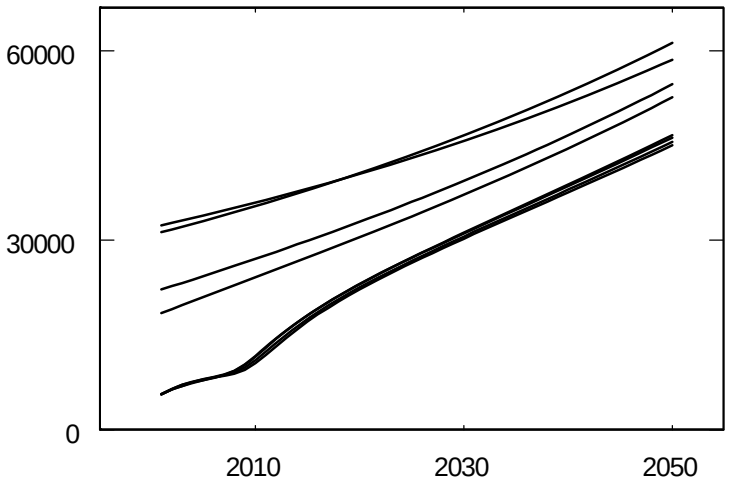


FIGURE 3
ACTUAL PER CAPITA INCOME GROWTH,
1971-2000