IMF WORKING PAPER

WP/89/62

INTERNATIONAL MONETARY FUND

Fiscal Affairs Department

The Welfare Effects of Public Expenditure Programs Reconsidered

Prepared by Robert Holzmann *

Authorized for Distribution by Ke-young Chu **

August 2, 1989

Abstract

The paper proposes a new welfare-based measure to evaluate the distributive effects of public programs. The proposed measure differs from traditional approaches in two important ways: first, it is based on life-cycle considerations, since most public expenditure programs have an intertemporal objective (such as education, housing, or social security); second, it takes into account market imperfections (such as in capital, credit, or annuity markets), which themselves give rise to many governmental interventions. The measure and its numerical illustrations suggest that, in general, the welfare effects from public programs whose aim is to eliminate market constraints predominate those that can be achieved through interpersonal income distribution.

JEL Classification Numbers
0243, 2312

* The author is indebted to the participants in a departmental seminar for their many helpful comments on an earlier version of this paper. He is particularly grateful to Peter Heller for his ideas and comments. The author, of course, is solely responsible for the paper's content.

** This paper was prepared when Peter Heller was in charge of the Government Expenditure Analysis Division.

Contents

		Page
I.	Introduction	1
II.	The Rationale for a Reconsideration	2
	1. Cross-sectional data, lifetime income, and market imperfections	2
	2. Public programs, redistribution, and market imperfections	4
III.	An Economic Lifetime Income Definition with Imperfect Markets	7
	1. Considering an imperfect credit market	7
	2. Considering an imperfect annuity market	8
IV.	A Welfare-Based Measure for the Evaluation of Lifetime Income Distributions with Imperfect Markets	9
V.	The Welfare Effects of Public Programs: Concept and Potential Magnitudes	11
	1. A concept of measurement	11
	2. The potential welfare gains: a numerical illustration	13
VI.	Some Research and Policy Conclusions	14
Table 1.	Potential Welfare Gains of Public Programs	15
Appendix		17
Charts		
	1. Utility and Expenditure Levels with Imperfect Capital Markets	8a
	2. Utility and Expenditure Levels with Imperfect Annuity Markets	8b
	3. Measured and Economic Lifetime Income, Equally Distributed Income Equivalents, and Welfare-Level, Indifferent-Income Transitions	10a
References		19

Summary

The paper proposes a new welfare-based measure to evaluate the distributive effects of public programs. The proposed measure differs from traditional approaches in two important ways. First, it is based on life cycle considerations, since most public expenditure programs have an intertemporal objective (such as education, housing, or social security). Second, it takes account of market imperfections (such as those in capital, credit, or annuity markets), which themselves give rise to many government interventions. The measure and its numerical illustrations suggest that, in general, the welfare gains from public programs whose aim is to eliminate market constraints predominate those that can be achieved through interpersonal income distribution.

The paper begins with an introduction of the rationale of the approach, illustrated by two important public programs--social security and housing promotion. The discussion highlights the problems in the traditional evaluation of these programs, which is conventionally done on a contemporaneous basis, assuming perfect markets, and points out the advantage of an intertemporal approach that takes account of market imperfections.

The following two sections present the centerpiece of the approach: the concept of "economic" lifetime income as opposed to the conventionally measured lifetime income. The difference in the two concepts is generated by effective market constraints. Based on these two income definitions, a new measure is developed to evaluate lifetime income distribution. When this measure is used, the resulting numerical illustrations of the programs' potential welfare effects support the view that the traditional measurement may have substantially underestimated the effects.

I. Introduction

Among the western industrialized countries, public expenditure as a percentage of gross domestic product (GDP) has increased substantially over recent decades. Of the 24 member countries of the Organisation for Economic Cooperation and Development (OECD), the public expenditure share of GDP rose from about 25 percent in 1960 to over 40 percent in 1986. This rise was largely the result of increasing outlays for public social programs, which are traditionally considered instruments of personal income redistribution. Public social expenditure, comprising outlays for education, family, health, housing, unemployment, and pensions was responsible for over half of this increase. Yet, despite the major increase in financial resources for redistributive purposes, the empirical evidence for various countries suggests that the redistributive effects of public budgets remained largely constant during this period (Saunders and Klau (1985)). Does this outcome point to a failure in the redistributive aspirations of the welfare state, an inefficiency of the instruments applied, or a politically determined "churning" of resources? Or, does it result because the conventional measurement of public redistribution does not capture the major redistributive aspects of public programs?

This paper espouses the latter view and develops a new welfare-based measure to evaluate and quantify public redistributive activities in an intertemporal framework under market constraints. Following the logic of this approach, it concludes that the actual redistributive power and welfare effects of public programs may be substantially higher than conventionally measured. Furthermore, the major part of the welfare effects may be generated by mechanisms that do not require direct interpersonal income redistribution.

Redistribution through public programs is traditionally measured on a cross-sectional data basis, comparing the original market and the final personal income distribution, that is, after government intervention, and applying an appropriately chosen inequality measure. This approach, which does not take into account individual reactions to redistributive activities and their effects on market incomes, also typically ignores two important aspects of government redistributive activities: (i) the life-cycle aspect, since most public expenditure programs have an intertemporal objective (such as education, housing, or social security); and (ii) the imperfections of markets (e.g., the capital, credit, and annuity markets), since their very existence gives rise to many government interventions. The linking of life-cycle considerations and market imperfections in one approach allows the development of a welfare-based measure, which appears to be more appropriate for evaluating public expenditure programs. 1/

The paper is organized as follows. Section II introduces the rationale of the approach, illustrated with two important public programs: social security and housing promotion. Sections III and IV present the concept of economic lifetime income as opposed to the conventionally measured lifetime income. The difference in the concepts is generated by effective market constraints. Based on these two definitions of income, a new measure to evaluate the lifetime income distribution of an individual is developed. Section V uses this measure to evaluate the welfare effects of public programs and provides some numerical illustrations of the potential magnitudes involved. Section VI contains some concluding thoughts.

II. The Rationale for a Reconsideration

This section provides a rationale for using lifetime income (instead of contemporaneous income) and for taking into account market imperfections (instead of assuming an Arrow-Debreu world) when distributive effects, particularly the redistributive effects of public programs, are evaluated.

1. Cross-sectional data, lifetime income, and market imperfections

The appropriateness of applying cross-sectional analysis to distributive and redistributive evaluations has long been questioned. The use of cross-sectional data to investigate the distribution of pesonal income is challenged, because identical, but non-flat, income profiles over the life cycle for each cohort yield inequality when measured on a cross-sectional basis; when measured on a lifetime basis the income inequality is zero. However, the use of lifetime income for distributional considerations is straightforward only if perfect markets are assumed.

A comparison of the income profiles of two individuals over their life cycle can be done on an ordinal basis if their income vectors do not intersect; that is, if $y_t^1 \geq y_t^2$ for all t, then

$$y^1 = (y_1^1,\ldots,y_T^1) \geq y^2 = (y_1^2,\ldots,y_T^2), \tag{1}$$

1/ Intertemporal considerations in public finance gained importance with the work of Auerbach and Kotlikoff (1987). However, their general equilibrium approach is based on the absence of market constraints, on perfect foresight, and on homogeneous cohorts. Thus, they are able to deal with some aspects of intergenerational equity, but not with intra-generational equity on a lifetime income basis.

with y_t the income in each of the T periods. However, in the case of intersecting income profiles, a comparison requires the choice of a measuring rod; that is, a norm has to be defined over the income vectors. In a one-economy world with perfect markets, lifetime income can be defined as the present value of incomes in all periods. If all prices, including the unique interest rate that determines the discount factor, are assumed to be identical for all individuals in each period, and if identical preferences and intertemporal utility maximization are assumed, a higher lifetime income unambiguously permits the realization of a higher lifetime utility level:

$$x^1 > x^2 \iff u^1 > u^2 \tag{2}$$

with x, the lifetime income, and u, the lifetime utility level.

Under these assumptions, the inequality of the lifetime income distribution may be measured on a cardinal basis by applying any relative equality measure 1/ to the lifetime incomes of a cohort. The numerical outcome may be interpreted in money-metric welfare terms: a value of 0.8 of any (relative or absolute) equality measure can be interpreted to mean that 80 percent of the total cohort lifetime incomes would provide the same social welfare level as the actual lifetime income distribution of the cohort, provided that the lifetime incomes (and hence utility levels) of all cohort members are equal; the homothetic social welfare function (SWF) underlying the equality measure is of the Samuelson-Bergson type. We will take up the discussion of equality measures and the SWF in Section IV. However, if the assumption of perfect markets does not hold, conclusions about the degree and changes of income inequality should be considered tenuous.

Let us assume imperfections on the credit market and compare two individuals with a preference for a flat consumption profile. The first individual has an increasing income profile, with high period incomes toward the end of his life cycle, and is credit rationed; the second individual has a flat income profile, which corresponds to his consumption profile, so that credit rationing does not become effective. Both income profiles may intersect. Under these assumptions, it is difficult to find an economically meaningful discount rate to calculate lifetime income, and, furthermore, the rate will differ from one individual to the next.

In a simple life-cycle context, the shadow borrowing rate can be used in the periods when credit rationing is effective; when credit rationing is not effective, the interest rate can be used. Effective

---

1/ An equality measure G is a simple transformation of an inequality measure I, $G = 1 - I$, yielding the value 1 if incomes are equally distributed. Because these equality measures facilitate analytical presentation and interpretation, they will be used throughout this paper. A relative equality measure is invariant with respect to proportionate changes of all incomes: $G(x) = G(\lambda \cdot x)$, $\lambda > 0$.

credit rationing will depend on individual preferences and characteristics (such as the time preference rate and survival probabilities) and market parameters (such as lending and borrowing rates). If the corresponding discount rates are correctly applied over the life cycle, the lifetime incomes so calculated will be a valid money-metric measure for individual utility levels. However, if a common market rate is used to discount future income flows (e.g., the after-tax rate of government bonds), the inequalities between these conventionally measured lifetime incomes and the corresponding utility levels may point in opposite directions; that is,

$$x^1 > x^2, \text{ but } u^1 < u^2 . \qquad (3)$$

Imperfections on other markets, such as the annuity market for retirement income, or the secondhand market for consumer durables, may create further impediments for utility levels, which are not expressed in the measured lifetime incomes. A welfare-based interpretation of lifetime income inequality will therefore be erroneous if the actual or shadow prices for all individuals considered are not identical, that is, if the imperfections of markets are not taken into account.

2. Public programs, redistribution, and market imperfections

The tradition of ignoring lifetime income distributions under market imperfections also has consequences for the evaluation of the redistributive effects of public programs. For the purpose of illustration let us consider social security and housing promotion.

The problems of capturing the redistributive effects of social security, that is, of public pension programs, are well known. In a contemporaneous single period evaluation, based on cross-sectional data, social security yields high redistributive effects: through the levying of contributions, income is deducted from the active population and transferred to the retired population, which has little or no factor income. However, since each contributor is ex ante also a potential beneficiary--several periods later--the appropriateness of such contemporaneous considerations has long been questioned.

Applying the more appropriate lifetime income consideration, however, may lead to no ex ante redistribution at all. In an actuarially fair public pension program, the present value of contributions will equal the present value of benefits, and the interpersonal transfer balance is zero. In reality, of course, redistributive effects will exist, owing to immature systems, non-actuarial relations between contributions and benefits, changes in the demographic structure, or ex post--in contrast to ex ante--evaluations. These aspects, however, will be ignored in the following presentation. More important for the evaluation of redistributive effectiveness is whether the implicit assumption underlying any actuarial evaluation, namely the existence of perfect annuity and other markets, holds.

If this assumption holds, then an actuarially fair public pension program has no redistributive effects. However, given this assumption, the program could also be eliminated without incurring any welfare losses. Since the real world is characterized by imperfect annuity and other markets, public pension programs are necessary, and the conventional approach of defining the present value of pension benefits 1/ and of measuring the redistributive effects must be questioned.

With imperfect insurance markets, the existence of a public pension program will not leave the lifetime utility position of an individual unchanged, compared with a situation without this program. If the public program is structured in such a way that it reflects largely individual preferences, the effectiveness of market constraints should be reduced, and, hence, the lifetime utility of individuals should be increased. Without this program and without an annuity market, individuals would be obliged to stay in the labor market, or to leave an unintended bequest, leading to a reduction in lifetime consumption and hence to a lower utility level. With this program, individuals should be better able to transfer labor income into their retirement period and to choose their optimal consumption path.

In addition, the change in the utility level arising from the existence of this program will not be the same for all individuals. Other theoretical and empirical studies suggest that individuals in the lower (lifetime) income ranges are much more vulnerable to market imperfections; therefore, their lifetime utility increases relatively more when a public pension program is introduced. For example, the bequest motive is apparently a function of lifetime income level, leading in general to no bequests in the lower, but substantial bequests in the higher, income ranges (Menchik and David (1983)). Hence, unintended bequests would be the likely outcome for the lower income range in the absence of a public pension program, implying a substantial lifetime utility loss. On the contrary, one can assume that in the absence of this program individuals in the higher income range can largely arrange their retirement savings to fit with their planned bequests and, thus, their utility loss should be smaller.

The fact that the impact of public pension programs on individual utility levels is differentiated by lifetime income levels in the face of imperfect annuity markets suggests other redistributive effects. What is needed is a methodological framework to convert lifetime utility levels and their changes into lifetime income equivalents. Section III will present such an approach.

1/ Similar considerations recently led Bernheim (1987a) to propose the simple discounted value of future benefits (ignoring the possibility of death) as a good approximation for the relevant concept of value. He also rejected the use of the actuarial value of social security benefits in the face of market constraints. His approach differs from the proposed approach with respect to the choice of the counterfactual.

The existence of public housing promotion programs in many western industrialized countries can be traced back to imperfect credit markets. The program provides cheap public credits that allow individuals to acquire a key consumer durable--housing--at an early stage in their life cycle; without the credits, they could have acquired housing only at higher borrowing costs, if at all.

Since this program is geared toward intertemporal objectives, the evaluation of its redistributive effects in a contemporaneous period setting creates substantial problems. An approach that attributes the total credit volume to the household in the year of purchase, and subtracts the repayments in the consecutive years, would guarantee the budget identity of individual households and the public sector, but would probably fail to measure the true distributive incidence of the public budget.

In an alternative approach, the difference between the individual market borrowing rate and the program lending rate times the outstanding credit volume could be attributed to each household. Then, however, the public budget identity would not hold, since the budgetary cost per unit of credit is only the difference between the public borrowing rate and the program lending rate. In most budget incidence studies, the allocation of costs and benefits is done pragmatically, for example, by attributing the net budgetary outlays through the rental equivalent of promoted housing. Depending on the selected approach the estimated distributive effects vary, exhibiting generally only minor advantages for the middle- and upper-income range.

In a conventional lifetime income approach, assuming perfect markets, the redistributive effects may also be largely negligible. If every household takes advantage of the housing program and acquires its lifetime optimal housing, amortizing the credit at later stages in the life cycle, individual and public outlays for housing and the conventionally measured lifetime income should be approximately proportional. Thus, the transfer balance measuring the difference between benefits and payments at present value should be zero, implying negligible redistributive effects.

However, in an intertemporal framework that takes account of credit constraints, two potential welfare effects may emerge. On the one hand, lower and higher income groups may have a welfare gain from the housing program if credit constraints are effective at the beginning of their life cycle; hence, the utility level of both groups will increase. On the other hand, since credit constraints are probably more binding for the lower than for higher income groups, the increase in utility levels will be relatively higher for the former; hence, with this program, the dispersion of utility levels is reduced. Converting the lifetime utility levels into economic lifetime incomes, these redistributive welfare effects can be expressed in a new welfare measure and quantified. Section III defines lifetime income under market imperfections, and Sections IV and V describe the new measure.

III. An Economic Lifetime Income Definition with Imperfect Markets

Market imperfections for economic units--individuals or households--may take various forms during their life cycle, including limits to borrowing, non-actuarial differences between the borrowing and lending rates, rationing with non-clearing commodity markets, and nonexistent or unfair annuity markets. To define an economic lifetime income in a world of imperfect markets requires the choice of a counterfactual; the counterfactual used is a perfect economy in the Arrow-Debreu sense.

In order to present the central concept in a straightforward way, while retaining analytical simplicity, two states of the world are distinguished: in state I, the individual faces various market constraints during his life cycle, but knows the length of his life span, which is equivalent to assuming fair annuity markets. In state II, the individual knows only his period survival probabilities, and all markets function perfectly, except the market for life-insured annuities. 1/ In addition, the presentation ignores aggregate general equilibrium considerations (such as the consequences of existing or nonexisting markets for labor supply or for bequest behavior, and thus for wealth and interest rates).

In the text, the derivation of economic lifetime income is presented mainly in graphics; the formal proof is presented in the Appendix.

1. Considering an imperfect credit market

Let us consider a two-period/one-good model. In Chart 1, q_0, q_1 represent consumption in the current and future periods, and y_0, y_1 the corresponding period incomes. Optimizing the intertemporal utility function $U(q_0, q_1)$, subject to the given intertemporal budget constraint and with a perfect credit market, allows the realization of the market-unconstrained lifetime utility level v, with the consumption points q_0^*, q_1^*; $x = y_0 + y_1/(1+r) = q_0 + q_1/(1+r)$ is the measured lifetime income, with r the unique interest rate. If we introduce complete credit rationing--that is, $q_0 \leq y_0$--the individual can realize only the market-constrained lifetime utility level $\hat{v}$, with the consumption points $\hat{q}_0$, $\hat{q}_1$. As can be seen in Chart 1, with effective market constraints, measured lifetime income x may not reach the individual's highest potential utility level. The lower utility level actually achieved by the individual who spends measured lifetime income x could have been achieved with a lower expenditure level, had liquidity constraints not distorted the allocation of lifetime consumption between the working and retirement periods. The minimum expenditure to achieve the utility level $\hat{v}$ in a market-unconstrained optimum is $\hat{x}$. The individual's

1/ Life-insured annuities are annuities that yield benefits until the death of the insured. Term-insured annuities provide benefits for a specified number of years or until death, whichever occurs first. In our two-period model, both types of annuities collapse.

economic lifetime income may be represented as $\hat{x} \le x$. Only in a market-unconstrained optimum is the economic lifetime income as great as the measured lifetime income, $\hat{x} \le x$. 1/

2. Considering an imperfect annuity market

Let us consider again a two-period/one-good model. However, this time, the individual survives only the first period with certainty (i.e., the working period, during which he receives the measured lifetime income x), and the second period only with the probability S $(0 \le S \le 1)$. Hence, the intertemporal utility function incorporates S as an additional parameter, and the individual optimizes the expected lifetime utility $Eu = U(q_0, q_2; S)$. In the absence of an annuity market, the intertemporal budget constraint is $q_0 + q_1/(1+r) = y_0 = x$, and is equivalent to the constraint in the model above. Whereas the individual may not live through both periods, the budget constraint has to express this possibility in the absence of an annuity market because the present value of total consumption cannot exceed the lifetime income. Under these assumptions, the individual realizes his optimal consumption plan $\hat{q}_0$, $\hat{q}_1$ with the market-constrained lifetime utility level $\hat{v}$. In the expectation value the individual leaves unplanned bequests of $(1-S)*\hat{q}_1$. 2/

If there is an annuity market and the individual can freely buy actuarially fair annuities, the intertemporal budget constraint takes the form $q_0 + q_1*S/(1+r) = y_0$. In contrast to the situation without annuities, the constraints now require only that the expected present value of consumption equals the lifetime income. $S/(1+r)$ can be interpreted as the present value price of future consumption, which is lower when an annuity market exists than when it does not. Apparently, the access to a fair annuity market leads to a relaxation of the budget constraint for the individual, but not for the economy as a whole. Because of the income and substitution effects of the lower price of future consumption, the optimal consumption plan also changes. The new consumption plan q_0^*, q_1^* realizes the market-unconstrained lifetime utility level v. For the realization of the market-constrained utility level $\hat{v}$--at Arrow-Debreu prices--a lower minimal expenditure level $\hat{x}$, that is, the economic lifetime income, is again sufficient.

1/ An alternative measure for the economic lifetime income would be the minimum expenditure to realize $\hat{v}$ at the shadow interest rate with the effective market constraint. The so-defined economic lifetime income could not, however, be compared with the (unconstrained) measured lifetime income x, since different prices were used. A comparison would require the use of an alternative (measured) lifetime income, defined as the minimum expenditure to realize v at the shadow interest rate. In ordinal measures, the differences between both alternative economic and measured lifetime incomes are equivalent.

2/ This assumes that the individual does not consume his entire lifetime income in the first period.

Chart 1. Utility and Expenditure Levels with Imperfect Capital Markets

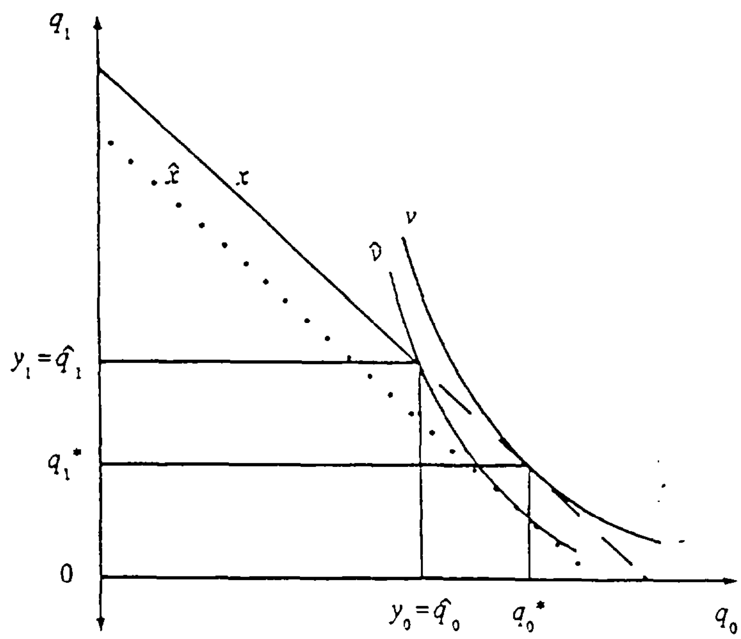
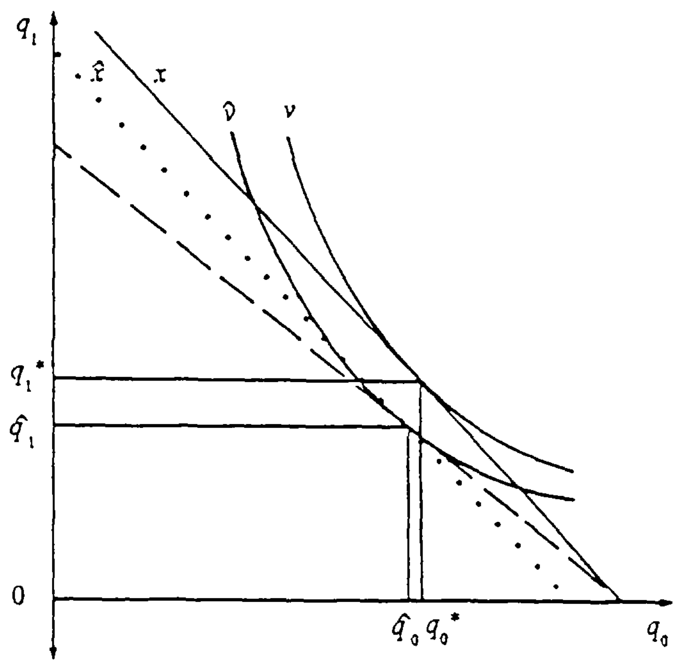


Chart 2. Utility and Expenditure Levels with Imperfect Annuity Markets



IV. A Welfare-Based Measure for the Evaluation of Lifetime Income Distributions with Imperfect Markets

The difference between measured and economic lifetime income could be used to measure the welfare losses that result from market imperfections. In order to evaluate the distributive impact of market constraints and, in consequence, of the total welfare effects of public programs, an extended approach is introduced, based on the concept of the social welfare function (SWF). The application of this concept does not restrict the use of equality measures, since any ordinal SWF implies a family of cardinal relative equality indexes; respectively, for each family of relative equality indexes, a family of SWF exists. In the case of a homothetic SWF, a unique, cardinal index is implied, which is consistent only with this SWF (Blackorby and Donaldson (1978)). In the text the concept is presented mainly with graphs, and the mathematical treatment is confined to the Appendix.

Given an SWF of the Samuelson-Bergson type,

$$w = W(V(x_1),\ldots,V(x_N)) = F(x_1,\ldots,x_N) \qquad (4)$$

that is, a function that is defined over individual utility levels, and making the conventional assumptions about its properties, 1/ market imperfections for individuals and the inequality of utility levels between individuals are both potential sources of welfare loss. The absence of market constraints would allow each individual to achieve his highest potential utility level and hence lead to a higher welfare level. Lower or no income inequality would also lead to a higher welfare level. This is the implication of the curvature assumption for the SWF. Alternatively expressed, if market imperfections and income inequality were eliminated, the current social welfare level, with reduced individual incomes, could be achieved. If this concept of welfare-level, indifferent-income transitions is applied in exchange for the (hypothetical) abolition of market constraints and income inequality, a welfare measure can be defined that not only measures both effects but also permits the separation of each effect for the individuals considered.

Graphically, this measure can be presented for a two-person economy, in which $\hat{x} = (\hat{x}_1, \hat{x}_2)$ and $x = (x_1, x_2)$ present the vectors of economic and measured lifetime income, respectively (Chart 3).

1/ We assume the SWF to be strict S-concave (which is implied in assuming symmetry and quasi-concavity, but is a weaker condition), to be increasing along its rays (i.e., a proportionate income increase for all increases the welfare level, $F(\lambda x) > F(x)$ for all $\lambda > 1$), and identical individual preferences.

A transition from measured to economic lifetime income for all individuals, if all market constraints are simultaneously abolished, leaves the level of the SWF, defined over utility levels, unchanged:

$$F(x_1, x_2) = F(\hat{x}_1, \hat{x}_2) \qquad (5)$$

with $\hat{x}_i \leq x_i$ for all i=1,2, and hence for the average economic and measured lifetime income, $\hat{m}(\hat{x}) \leq m(x)$.

As Atkinson (1970) has demonstrated, for an SWF over income levels, one can define an equally distributed income equivalent, which also leaves the level of the SWF unchanged:

$$F(\hat{x}_1, \hat{x}_2) = F(\hat{x}^e, \hat{x}^e) \qquad (6)$$

with $\hat{x}^e \leq \hat{m}$ for all S-concave SWFs.

Combining both income transitions, which leaves the welfare level constant, we can define an index according to Kolm-Atkinson-Sen, which is represented in Chart 3 as the ratio of $\underline{O\hat{x}^e}$ and $\underline{Om}$. Analytically and for N individuals, the welfare index can be written as:

$$H(x) = \hat{x}^{e(w)}/m \qquad (7)$$

with
$$m = \Sigma x_i/N$$
$$w = W(x_1,\ldots,x_N)$$
$$0 \leq H(x) \leq 1$$
$$x = (x_1,\ldots,x_N).$$

The welfare economic interpretation of this measure is straightforward: H(x) = 0.5 signifies that after the abolition of market constraints and income inequality, 50 percent of the total disposable lifetime income would be sufficient to realize the current welfare level.

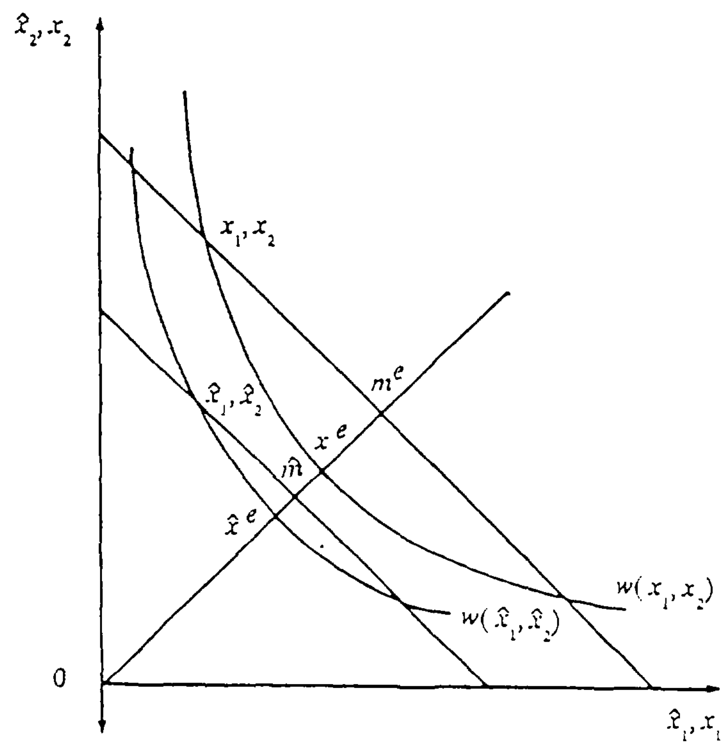
The H-index can be disaggregated into its two effects, and both multiplicatively related sub-indexes are accessible to a welfare economic interpretation. There are two useful disaggregations, which differ in their path of income transition. Without loss of generality, homothetic SWFs will be assumed; that is, x^e is independent of the social welfare level w.

$$H(x) = \frac{\hat{x}^e}{m} = \frac{\hat{m}}{m} * \frac{\hat{x}^e}{\hat{m}} = C_1 * G_1 \qquad (8.a)$$

$$H(x) = \frac{\hat{x}^e}{m} = \frac{x^e}{m} * \frac{\hat{x}^e}{x^e} = G_2 * C_2 \qquad (8.b)$$

with $0 \leq C_1, G_1, C_2, G_2 \leq 1$.

Chart 3. Measured and Economic Lifetime Income, Equally Distributed Income Equivalents, and Welfare-Level, Indifferent-Income Transitions



The economic interpretation of these sub-indexes is straightforward:

G_1, G_2 are measures for the equality of the economic and the measured lifetime income distributions, since the ratio of an equally distributed income equivalent to the corresponding mean income is the general presentation of any relative equality measure. Thus, for a concrete calculation, G is a Gini, Theil, or Atkinson equality index; the choice is up to the economist.

C_1, C_2 measure the welfare effects of market constraints with respect to the original or the equally distributed measured lifetime income. These measures are simply ratios of different means. Since the first disaggregation of the total welfare measure H--$C_1 * G_1$--is more accessible to an economic interpretation, we will use it in the following section.

V. The Welfare Effects of Public Programs: Concept and Potential Magnitudes

The index that was developed to measure the welfare effects of market imperfections and income inequality enables a new appraisal of government redistributive activities. This section sets forth an analytical concept of measurement and provides initial insights into the potential magnitudes involved.

1. A concept of measurement

An effective market constraint decreases the economic lifetime income below the measured lifetime income, as shown by the analytical model in Section III. The relevance of market constraints is increasingly reflected in economic modeling and empirical testing. 1/ Although generally indirect, the available evidence of market imperfections appears strong.

However, most public programs are implicitly or explicitly designed to substitute for nonexistent or ill-functioning intertemporal markets. Hence, the public budget may--through the tax-transfer approach--ease or even eliminate the effectiveness of market constraints, thus raising economic income to the level of the measured lifetime income. This paper focused on social security and housing promotion, but education--where grants are given to the young, who then repay them later in life--or the provision of child-care and family allowances, linked with progressive income taxation later in the life cycle, are examples of

1/ For recent research with respect to imperfect annuity markets see, for example, Bernheim (1987b), Townley (1988), and Kahn (1988). With respect to imperfect credit markets, see, for example, Stiglitz and Weiss (1981), Bester (1985), Williamson (1987), and Kanemoto (1987).

other public programs to which this concept can apply. Any public tax-transfer program that reduces the gap between economic and measured lifetime income produces welfare gains.

In addition, if the presumption holds that lower income levels are relatively more exposed to market constraints than are higher income levels, the relative gap between economic and measured lifetime income should be a decreasing function of the income level.

Let $g(x) = (x - \hat{x}(x))/x$ define the relative income gap between measured and economic lifetime income. If $g(x)$ is a decreasing function of the measured income, that is, $dg(x)/dx < 0$, the equality of the economic income must be lower than the equality of the measured income, that is, $G_1(x) < G_2(x)$. 1/ In consequence, public programs should be able to generate redistributive welfare gains that are not based on interpersonal income transfers. In the case of regressive market constraints, a public program is more likely to reduce the gap between economic and measured lifetime income for the lower income levels than for the higher income levels. Hence, economic income equality will increase. Neither potential welfare effect of public programs--the increase in economic income and a more equal distribution of economic income--is captured in the conventional approach, either on a contemporaneous period or on a lifetime income basis. That approach considers only the potential welfare effects created by interpersonal income redistribution.

To measure the total welfare effects of public programs with the proposed approach, we compare the H-measure with respect to final and market lifetime income distribution, z and x, respectively:

$$P(x,z) = \frac{H(z)}{H(x)} = \frac{C_1(z)}{C_1(x)} * \frac{G_1(z)}{G_1(x)} = \frac{\hat{n}/n}{\hat{m}/m} * \frac{\hat{z}^e/\hat{n}}{\hat{x}^e/\hat{m}} \gtrless 1 \qquad (9)$$

with $\hat{n}$ and n the average income of $\hat{z}$ and z, respectively.

1/ This result is easily verified if the well-known concept of tax progressivity is applied. $x - \hat{x}$ can be interpreted as a market imperfection tax, with x the gross and $\hat{x}$ the net income, and hence $g(x)$ as the corresponding average tax rate. For any global regressive (market imperfection) tax, that is, a tax with decreasing average tax rates over the whole income interval, the resulting equality of the net income distribution is lower than for the gross income distribution, both measured with a relative equality measure.

An efficient, that is, welfare-enhancing, public activity should lead to a ratio of greater than 1. Transformed into percentage changes, $(P(x,z)-1)*100$ may be immediately interpreted as relative welfare gains/losses through public programs, since the applied measures can be considered as money-metric indexes of the corresponding welfare levels. Welfare gains can be achieved if the market constraints on final, compared to market, incomes are made less effective--$C(z) > C(x)$--and/or if more equality is created for the final, compared with the original, economic distribution of lifetime incomes--$G(z) > G(x)$.

The maximum value of $P(x,z)$ is reached if public programs succeed in eliminating the effectiveness of market constraints (i.e., $C_1(y) = 1$) and the inequality of the cohort income distribution (i.e., $G_1(z) = 1$). Assuming that no further intercohort income transfers take place (i.e., $m = n$), this allows the disaggregation of $P(x,z)$ into three components *of potential public welfare-enhancing interference:*

$$P(x,z) = \frac{1}{C_1(x)} * \frac{G_2(x)}{G_1(\hat{x})} * \frac{1}{G_2(x)} = \frac{1}{\hat{m}/m} * \frac{x^e/m}{\hat{x}^e/\hat{m}} * \frac{1}{x^e/m} . \qquad (10)$$

The first component on the right-hand side of equation (10) refers to the potential maximum welfare gains that can be achieved if the effectiveness of market imperfections is eliminated; the second component refers to the maximum gains by movement toward the economic income distribution from the measured income distribution; and the third component refers to the maximum gains owing to the elimination of inequality in the measured income distribution. The first two effects are achieved without interpersonal--that is, intracohort--income transfers; this effect is measured by the third component.

2. The potential welfare gains: a numerical illustration

Currently, the data necessary for an empirical estimation of the welfare effects outlined above are not available. However, the exposition of potential effects in a theoretical model is rather unsatisfying unless it can be supported by some estimations of the magnitudes involved. These magnitudes can be derived through heuristic simulation, using a specified intertemporal utility function and income profiles, interest rates, and other parameters in the range of empirical observations and estimations (Holzmann (1984)). Two constraints on the capital market for the income units are analyzed: asymmetrical liquidity constraints, specified by a total liquidity constraint for the low-income individuals but no constraint for the highest-income individuals; and symmetrical constraints, specified by equal (empirical) differences between borrowing and lending rates for all individuals, linked by only partial collaterability of consumer durables/assets. The different impact of symmetrical market constraints on individuals with different lifetime incomes is generated by the utility function, which specifies minimum consumption requirements.

Table 1 illustrates the potential magnitudes of relative welfare gains of public programs under these market constraints, using the disaggregation of the P(x,z) measure in equation (10). As can be expected, the magnitudes depend substantially on the assumed subjective discount factor, d (including the pure time preference, survival probability, and the degree of risk aversion) compared to the market interest rate, r. Table 1 presents results for two parameter settings. However, various empirical studies suggest that $d - r>0$ is more likely (e.g., Bernheim (1987b), Hurd (1987)), which would strengthen our point.

The results in Table 1 suggest that the potential welfare gains from public programs geared toward the elimination of market constraints dominate, in general, those gains that can be achieved through inter-personal income distribution. In the more empirically relevant case of $d > r$, the reduction in the effectiveness of liquidity constraints through public programs could generate welfare gains of 40 percent or more (the product of the first two gains in Table 1), whereas the total elimination of inequality would achieve only half of these gains. For the latter, the corresponding Gini inequality index of around 0.18 for the lifetime income distribution constitutes the upper rather than the lower value of empirically measured inequality of cohort incomes. In addition, the results could be strengthened even more if further market imperfections, such as on the annuity market, were taken into account.

VI. Some Research and Policy Conclusions

To evaluate the welfare effects of public programs, the approach presented in this paper combines intertemporal considerations with the explicit assumption of market imperfections. Thus, the proposed approach links two developments in research and policy analysis that are currently far apart. On the one hand, a dynamic view of public sector activities is gaining increasing importance in empirical investigations of the effects of taxes and expenditure on major economic variables and welfare. The conventional assumption underlying these models is perfect markets and foresight (e.g., Auerbach and Kotlikoff (1987)). On the other hand, market constraints are receiving increasing attention in economic research and policy implementation. Two markets, in particular, are at the center of interest: the capital and the annuity markets, both of which are characterized by intertemporal transactions, since the contract extends over many years. This intertemporal aspect increases the likelihood of asymmetrical information between the buyer and the supplier of the required service and is likely to lead to nonexistent or imperfect markets. Recent economic research has highlighted how public programs may simulate private markets, even when asymmetrical information prevails. This can be achieved through

Table 1. Potential Welfare Gains of Public Programs

(In percent)

	Asymmetrical and Strong Market Constraints 1/		Symmetrical and Modest Market Constraints 2/	
	d = 0.04 r = 0.02	d = 0.02 r = 0.04	d = 0.04 r = 0.02	d = 0.02 r = 0.04
Elimination of the effectiveness of market constraints, $1/C_1(x)$	32.1	6.7	23.2	5.2
Approaching the economic to measured lifetime incomes, $G_2(x)/G_1(\hat{x})$ 3/	13.3	3.8	9.5	2.4
Equalizing lifetime incomes, $1/G_2(x)$ 4/	21.2	22.8	21.2	22.8
Total welfare gains 5/	81.4	35.7	63.5	32.3

1/ Lower income range totally, higher income range not, liquidity constrained.
2/ Empirical differences between borrowing and lending rates, and durables/assets only partially collaterable for all income levels.
3/ Based on the Gini equality index.
4/ The corresponding values of the Gini inequality index are 0.1749 and 0.1854, respectively.
5/ Multiplicative effects of the first three rows.

mandatory membership and information pooling in public programs. Although these public programs, as market substitutes, will not necessarily produce (Pareto) optimality, in many instances they can be considered as the second-best solution (e.g., Eckstein, Eichenbaum, and Peled (1985a, 1985b)).

The approach proposed in this paper is designed to analyze and quantify the redistributive and welfare effects of public programs in an intertemporal setting under market constraints. The presented welfare measure and the quantitative illustrations suggest the following policy conclusions: first, the welfare effects of public programs designed to deal with uncertainty and income redistribution over the life cycle are likely to be much larger than conventionally measured. This may explain the programs' increasing importance in public activities, the rising share of GDP they have consumed in recent decades, and the political support they have enjoyed.

Second, the welfare effects of these programs were mainly achieved through the reduction or elimination of the effectiveness of market constraints, but not through interpersonal income redistribution. In a world with imperfect markets, which hurt the lower income groups to a much greater extent, the welfare effects of eliminating the effectiveness of market constraints can be a multiple of those potentially achieved through a more equal income distribution.

Third, the results lend themselves to a market-oriented interpretation and suggest that a direct reduction of market imperfections could generate substantial welfare gains and exhibit important, positive redistributive effects. Hence, public activities that aim at creating and improving capital and annuity markets (through appropriate incentives and regulations) will not only have a positive distributive impact, in particular on the lower-income groups, but may also allow a reduction of public programs, which are designed as substitutes for imperfect markets.

The proposed approach, of course, requires various extensions in addition to further research. First, it presents a rather rosy picture of public programs, stressing their potential optimal character while ignoring any potential shortcomings attached to the political process. Second, at the current stage, the approach does not take into account feedback from the impact of various public programs on individual behavior, and hence the programs' impact on micro- and macroeconomic variables. The consideration of second-round effects seems particularly necessary in an intertemporal framework. It would require, however, an extended intertemporal (applied equilibrium) model--a manifestly formidable task. Finally, for an empirical implementation, the current approach requires information about market constraints, which is not at hand, and specifications, such as utility functions, that are questionable. Hence, an adjusted approach, which aims at measuring only the incremental welfare changes against similar program changes, may be more useful and more conducive to empirical testing.

1. Measured and economic lifetime income

We define

$$q = (q_{11},\dots,q_{1T},\dots,q_{J1},\dots q_{JT}), \qquad q \in R^{JT} \tag{1}$$

as the intertemporal commodity vector of J goods over T periods. Analogously we define a present value intertemporal price vector p, and assume a concave and monotonically increasing intertemporal utility function U(q), and a well-defined lifetime income measure $x \in R^1$.

Letting q, p, and x be defined as above, the indirect intertemporal utility function is

$$V(x,p) = \max_q \{ U(q) \mid p'q \le x \}. \tag{2}$$

Any additional set of constraints on the individual behavior owing to market imperfections, we express in the form $f(x,p,q) \le 0$. With this assumption, we can define a constrained lifetime utility level $\hat{v}$, derived from the constrained indirect utility function $\hat{V}(x,p)$:

$$\hat{v} = \hat{V}(x,p) = \max_q \{ U(q) \mid p'q \le x,\ f(x,p,q) \le 0 \}. \tag{3}$$

For the relation between market-constrained and market-unconstrained utility level, the inequality

$$\hat{v} = \hat{V}(x,p) \le V(x,p) = v \tag{4}$$

always holds for any x and p.

If we consider the dual problem, that is, the expenditure function E(.) for the utility levels $\hat{v}$ and v, respectively, but without market constraints, we can define

$$\hat{x} = E(\hat{v},p) = \min\{\alpha \mid V(\alpha,p) \ge \hat{V}(x,p)\} \tag{5}$$

so that $V(\hat{x}(x,p),p) = \hat{V}(x,p)$ for any x,p; analogously we can do so for $x=E(v,p)$. x is the measured lifetime income and $\hat{x}$ is the economic lifetime income, both measured at Arrow-Debreu prices p, and the inequality $\hat{x} \le x$ always holds, since E(.) is increasing in v.

2. The new welfare measure H(x)

Letting i index individuals, $i \in \{1,\dots,N\}$, and given a Bergson-Samuelson SWF, which is S-concave and increasing along its rays, we have

$$F(x,p) = W[V_1(x_1,p),\dots,V_N(x_N,p)] = W[V(x,p)], \tag{6}$$

and we can define the usual equally distributed income equivalent:

$$x^e = \gamma(x,p) = \min\{\alpha > 0 \mid W\{V(\alpha 1,p)] \geq W[V(x,p)]\} \tag{7}$$

and the same in the presence of added constraints:

$$\hat{x}^e = \gamma(x,p) = \min\{\alpha > 0 \mid W[\hat{V}(\alpha 1,p)] \geq W[\hat{V}(x,p)]\} \tag{8}$$

with $1 = (1,\dots 1) \in R^N$.

We define the welfare measure (keeping in mind that the functions are defined for Arrow-Debreu prices) by

$$\begin{aligned} H(x) &= \hat{x}^e / m, \qquad m = m(x) = \Sigma\, x_i/N \\ &= \frac{\hat{m}}{m} * \frac{\hat{x}^e}{\hat{m}}, \qquad \hat{m} = \hat{m}(\hat{x}) = \Sigma\, \hat{x}_i/N \\ &= \frac{\hat{x}^e}{x^e} * \frac{x^e}{m}. \end{aligned} \tag{9}$$

$x^e/m(x)$ is the general representation of any (relative) equality index, since any homothetic SWF implies only one equality index, which is only consistent with this SWF (Blackorby and Donaldson (1978)). The corresponding homothetic welfare function has the form

$$W(x) = m(x) * G(x) = m(x) * \frac{x^e}{m(x)} \tag{10}$$

which allows the straightforward interpretation of H(x), and its sub-indexes, as money-metric indexes of welfare losses due to market constraints and income inequality.

References

Auerbach, A.J., and J.L. Kotlikoff, Dynamic Fiscal Policy (Cambridge: Cambridge University Press, 1987).

Atkinson, A.B., "On the Measurement of Inequality," Journal of Economic Theory, Vol. 2 (September 1970), pp. 244-63.

Bernheim, D.B. (1987a), "The Economic Effects of Social Security," Journal of Public Economics, Vol. 33 (August 1987), pp. 273-304.

_____ (1987b), "Dissaving after Retirement: Testing the Pure Life Cycle Hypothesis," in Issues in Pension Economics, ed. by Z. Bodie, J. Shoven, and D. Wise (Chicago: University of Chicago Press, 1987), pp. 237-73.

Bester, H., "Screening vs. Rationing in Credit Markets with Imperfect Information," American Economic Review (Nashville, Tennessee), Vol. 75 (September 1985), pp. 850-55.

Blackorby, C., and D. Donaldson, "Measures of Relative Equality and Their Meaning in Terms of Social Welfare," Journal of Economic Theory, Vol. 18 (June 1978), pp. 59-80.

Eckstein, Z., M.S. Eichenbaum, and D. Peled (1985a), "The Distribution of Wealth and Welfare in the Presence of Incomplete Annuity Markets," Quarterly Journal of Economics, Vol. 100, pp. 789-806.

__________ (1985b), "Uncertain Lifetimes and the Welfare Enhancing Properties of Annuity Markets and Social Security," Journal of Public Economics, Vol. 26, pp. 303-26.

Holzmann, R., "Lebenseinkommen und Verteilungsanalyse: Ein methodischer Rahmen fuer eine Neuorientierung der Verteilungspolitik," Studies in Contemporary Economics, Vol. 9 (Berlin: Springer-Verlag, 1984).

Hurd, M., "Savings of the Elderly and Desired Bequests," American Economic Review (Nashville, Tennessee), Vol. 77 (June 1987), pp. 298-312.

Kahn, J.A., "Social Security, Liquidity, and Early Retirement," Journal of Public Economics, Vol. 35 (February 1988), pp. 97-117.

Kanemoto, Y., "Asymmetric Information in the Credit Market and Discount Rates for Public Investment," Journal of Public Economics, Vol. 34 (December 1987), pp. 291-309.

Menchik, P.L., and M. David, "Income Distribution, Lifetime Savings, and Bequests," American Economic Review (Nashville, Tennessee), Vol. 73 (September 1983), pp. 672-90.

Saunders, P., and F. Klau, "Role of the Public Sector: Causes and Consequences of the Growth of Government," OECD Economic Studies (International), No. 4 (Spring 1985).

Stiglitz, J.E., and A. Weiss, "Credit Rationing in Markets with Imperfect Information," American Economic Review (Nashville, Tennessee), Vol. 71 (June 1981), pp. 393-410.

Townley, P.G.C., "Social Security and the Failure of Annuity Markets," Journal of Public Economics, Vol. 35 (February 1988), pp. 75-96.

Williamson, S.D., "Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing," Quarterly Journal of Economics, Vol. 102 (February 1987), pp. 135-45.