METHODS OF INFLUENCING THE DISTRIBUTION OF WEALTH:
A SIMULATION STUDY

by

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Major Professor
Über die Gerechtigkeit

Me-ti sagte: Erst wenn die Gleichheit der Bedingungen geschaffen ist, kann von Ungleichheit gesprochen werden. Erst wenn die Füsse aller gleich hoch stehen, kann entschieden werden, wer höher ragt.

Bertold Brecht
Me-ti/Buch der Wendungen

About equality

Mo Tzu said: Only when equality of opportunities is accomplished can one speak of inequality. Only when all feet have reached equal heights can it be decided who towers highest.

Mo Tzu / Bertold Brecht
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Chapter One

INTRODUCTION

This paper deals with the size distribution of wealth in a twofold way. The first part describes the influence this distribution has throughout the economy, while the second part investigates the variables that influence this size distribution.

These subjects are not weighted equally. The first is designed to be only a justification for further analysis. In other words, if this variable had no impact, there would hardly be a reason for further study of the subject.

Three major problems are connected with this topic:

1. Wealth has to be defined.
2. It has to be described how the impact of a variable on the size distribution of wealth is to be measured.
3. It has to be outlined, what form of distribution is looked upon as appropriate or desirable. A desirable situation shall be said to be attained when the majority of the voters prefer no further changes.
1.1 Definitions

In general, wealth can be defined on a personal and on a national basis. The first refers to a set of valuable goods which some individual possesses, and which can be exchanged at predetermined prices. These can be either real or financial assets. The national wealth, on the other hand, is the stock of "real capital" of a country since financial assets are consolidated due to net lending and borrowing being zero. This assumption holds for a closed economy which shall be assumed. The stock of capital may consist of productive capital as well as of consumer durables as long as the following condition is met. These goods must be capable of being passed from one generation to the next. Their value, however, need not be invariant to this process.

In this case it is not necessary to dive into that subject extensively, but the following conditions have to be met.

1. Wealth cannot be increased by goods that are purchased for consumption purposes only. If this condition is relaxed, it would not be possible to determine uniquely the value of wealth over time.

2. As a general term, wealth consists of two forms, physical wealth and human capital. Within this paper the term wealth shall be defined to mean only physical wealth, and human capital shall be treated as a separate category.
The reason for this is, among others, that it disappears completely with the death of the person incorporated.

The size distribution of wealth is defined as the relative share of wealth owned by a defined fraction of the population. In this case households are used as the smallest physical units that can own wealth. To reduce limitations, households are considered to consist of one person only, when appropriate.

It is assumed that a distribution of any variable can uniquely be determined by its inequality, however inequality may be defined. The aptitude of any policy is considered to be the degree to which changes in this inequality may ensue from it.

Although there have been many objections against it, the Gini-Coefficient together with the Lorenz-Curve will be used

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for measuring the inequality of a distribution. In addition, there will be support for further coefficients of variation, such as variance, the coefficient of variation, and the mean/median relation for determination of the kurtosis. These can be used by persons agreeing with Atkinson about the unreliability of the Gini-Coefficient.

A simple example may show the use of both Gini-Coefficient and Lorenz-Curve as well as the points mainly criticized. On the X-axis the cumulative percentage share of the households is represented in increasing order. The 5-percent mark refers to the "poorest 5 percent of households" concerning the variable that is referred to on the Y-axis. The percentage of wealth that can be attributed to that 5 percent of households is marked at the Y-axis. Further points can be determined by similar means, until the X-axis is completely filled up to the total level of 100 percent.

The Lorenz-Curve is the connecting line of those points. This curve is convex. The greater the area between the Lorenz-Curve and the 45-degree-line, the so-called equality line, the greater is the inequality. The Gini-Coefficient is the relation of the shaded area to the total triangle underneath the equality-line.

Figure 1.1 contains two different Lorenz-Curves with identical Gini-Coefficients. The dashed line represents a distribution that is especially unequal in the upper part, meanwhile the solid curve refers to an emphasized inequality in the lower.
THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.
Figure 1.1: Two different Lorenz-Curves representing identical values of Gini-Coefficients.

If redistribution were used to move from one of those cases to the other, the Gini-Coefficient would remain unchanged. It is, however, easy to identify such a situation with a close look at the Lorenz-Curve.

In such a case inequality measures really do not help any longer. It has to be decided in which part of the population (lower or upper) inequality is less likely to be accepted.
This book contains numerous pages which the original printing being skewed. The top of the page to the bottom. This is as received from the customer.
1.2 Methodology Used

A microsimulation model will be used to describe the behavior of the citizens of a fictitious nation. A sample of households is attributed with a stochastic time-invariant behavior. The persons in these households marry, have children, work, and receive income. They consume, pay taxes, pay for the education of their children, and after their death, their wealth is bequeathed to their heirs.

The total wealth of these households is recorded every year, and in every tenth year a table listing the size distribution of that wealth is created. These tables are used to measure inequality and its change over time.

The stability of the stochastic system is cross-checked with re-evaluating it, using a different seed for the random number generator.

The influence of various policy parameters is determined, namely taxes to be levied, with identical runs of the same model using different values for these parameters.

To find out if the effectiveness of policy parameters is

stable, the inequality of the initial wealth distribution is varied. A distribution may be defined uniform when all units have the same probability to occur in a region fixed by mean and distance. A normal distribution, on the other hand, stands for a standard normal distribution of qualification and abilities and, therefore, an efficiency-oriented distributive justice.

The lognormal distribution such as the third one can be varied in order to create a distribution with any desired Gini-Coefficient. A distribution with a realistic Gini-Coefficient of 0.4 is chosen to be representative for the present inequality of the size distribution of wealth in the United States.

An overall runtime of 100 years, or roughly five generations, is assumed. This value may be relatively high considering the length of periods without dramatic changes in the political order. On the other side, it is relatively low, when it is taken into account that traditional ways of redistribution (e.g. inheritance tax) apply only once in a generation.

The author assumes 100 years to be a value that conflicts not too much with any of these points, although he freely admits that this topic may need to be reconsidered when looking at a specific development.

6. In 1950 the value was 0.372. It was taken from Table 1 in Atkinson [1970], op.cit., p. 259.
Chapter Two

DOES THE SIZE DISTRIBUTION OF WEALTH MATTER?

This chapter concerns itself with what kind of impact the size distribution of wealth and its change have on the various indicators that describe economic activity.

It is no exaggeration to say that this chapter will discuss points which economists have never agreed upon and are still refusing to agree upon.

Any attempt of redistribution, that is of changing the distribution, has to be justified. That means, it has to be proved that the situation before the change is inferior to the situation afterwards.

In this paper, the value judgements expressed by the author should be viewed as arising from a voter’s point of view, and not from the point of view of an economist. The responsibility of the economist is to use his expertise to express the probable outcome of accepting a given value judgement.
2.1 Historic Outline

The roots of distribution and redistribution originate in two philosophical mainstreams, utilitarianism and egalitarianism.

1 Economic utilitarianism may be sketched using Little's terminology as "maximizing economic welfare" and, consequently, a part of happiness.

2 Cross-references can be found in Bentham's classical ideas as well as in Rawls' view of justice much later on. It is the relation to egalitarianism that makes the difference between both philosophers' ideas. Egalitarianism, in the way recalled by Rousseau, is a part of most countries' constitution manifested as explicitly named human rights.

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Controversies arose when John Stuart Mill emphasized the difference between the two economic categories nowadays called normative and positive economics; he suggests that economists restrict their efforts to the Latter.

Classical economists forgot completely about egalitarianism, or interpreted it in such a way that the results were not obvious to those who favor egalitarianism.

Marshall and Pigou re-integrated distribution and the idea of equality into economic thought while defining welfare in terms of distributional equality.

There has also been the well known attempt to define rules of redistribution within the boundaries of positive economics that is related to Hicks, Kaldor, and Scitovsky, and ranks

5. continued: Josef/Sumption point out that if egalitarianism is backed with Rousseau rather than Marx the necessity of introducing a totalitarian state in order to realize the ideas can be avoided. See Keith Josef and Jonathan Sumption, Equality, (London: John Murry, 1979), pp. 8-11.


situations of wellbeing without using normative ideas.

All attempts to circumvent the problem of normative versus positive economics using social welfare functions may also be categorized into that group.

All these proposals and ideas could not prevent an enormously broad range of opinions in the actual debate concerning distribution of wealth and income and the methods of influencing it.

2.2 Distribution and Economic Theory Today

The actual discussion, whether redistribution as a means of correcting the outcome of the market process is feasible or not, provides a subject for much disagreement.

Advocates of the so-called neoclassical position point out that any attempt to reverse the result of the market process

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9. See the so-called Hicks-Kaldor-Criterion or Scitovsky-Criterion, both based on the Pareto-Criterion in the following papers, respectively.

leads away from the only path towards prosperity and freedom.

Some economists interpret this idea even more extremely by demanding further changes in the economic order. Such changes are designed to favor the rich more and more, and to impose a greater part of the tax burden on the poor. In the minds of these economists redistribution is an impediment and egalitarian ideas keep people from being better off.

It is obvious that such arguments are not based on ideas of utilitarianism or egalitarianism. As Feldstein pointed out, they are closer to a principle that could be described as "everybody is entitled to his property, and no redistribution is justified," a philosophy mostly related to Nozick's writings.

The opposite end of the range could probably be marked by Meade's arguments. He uses equity (not equality) and efficiency


in the use of resources in his analysis, and concludes that this necessarily requires an equalization of the ownership of private property as well as an increase in the share of property in social ownership. Although this proposal provides results opposite to Ture's and talks about equity, it uses the same framework and identical tools. Meade's analysis focuses on labor as a limiting factor of production rather than capital stock. He states that the lack of wealth in the longrun is due to the fact that a specific distribution prevents investment in the "human capital" necessary to develop labor to its greatest capacity.

It is the ambiguity of these outcomes that causes doubt as to whether longrun analysis is an appropriate approach for determining the amount of redistribution. Quoting Keynes' famous "in the longrun we are all dead," Bowie and Simon state that it is improper to permit the intrinsic longrun progress to rectify all unjust distributions. They argue that this point of view is appropriate only when dealing with the same persons now and later on.

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16. Meade does not mention Human Capital or an equivalent term explicitly, but his interpretation can be backed with his demand for "equal chances of promotion" for people with "equal innate abilities". See Meade, op.cit., p. 76.

Referring to the neoclassical point of view, Dahrendorf epitomizes his interpretation into an "inequality produces hope and hope is the stimulus of progress."

He emphasizes the position that economists should use normative ideas in dealing with distribution, pointing out that egalitarianism is already an institutionalized part of most constitutions and judicial systems. His chain of arguments starts with "all men are equal before the law" and goes via political rights like free speech and universal suffrage to citizenship rights like minimum wage, education, and health provisions.

His rationale for supporting and keeping those rights is "domestication of power", and he argues that without it, citizenship rights would hold as little meaning as "equal rights before the law" would hold without political rights.

The last group of economists to be mentioned in the context of distribution is what shall be called the neo-fiscalsists. Economists like Lester Thurow describe the size distribution of income and wealth as one of the main, perhaps the primary source of instability and economic crises. Improving economic conditions for these economists starts with remodeling this size

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19. ibid., pp. 3-4.
distribution. He is also one of the defenders of equity, arguing that the efficiency approach is not free of value judgements.

After sketching the main "economic ideologies" and checking them for appropriateness, the author believes that the underlying assumptions for these theories or hypotheses vary to such a degree that all arguments based upon one set of general economic assumptions will be unacceptable to the other group.

His arguments will, therefore, be less fundamental and more pragmatic, and he hopes that this approach has a higher chance of being accepted by all. But there exists a problem here. We will not be able to determine uniquely the optimal distribution. We will try to find the area of possible forms by ruling out those not compatible with the efficiency rules applied.

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21. ibid., p. 22.
2.3 How Much Redistribution? — A Pragmatic Approach

Reducing the acceptable area of distribution is normally a process that starts at the boundaries.

There is, for example, little discussion about the fact that complete equality in wealth or income would reduce the economic output by means of reducing the incentives to work.

The laziest person determines the amount of goods produced per capita. As complete insight and no special preferences for work (workaholics) are assumed, rational behavior can be described as not working more than the laziest, because any further money earned would equally be shared among those with less work done. Bowen shows further sources of "necessary inequality" relaxing the complete substitutability of work. Workers with scarce qualifications will have to be paid unequal rewards to induce them to perform socially necessary tasks.

Complete inequality could be defined as a situation in which one person keeps all the wealth and thus all the productive capital of a society and all other persons receive only the labor income necessary to keep them at work. Such an extreme case of inequality is similarly inferior, as there is obviously a monop-

sony in the labor market and the produced output is smaller than the one that could be realized with a competitive market form. Furthermore, it is often argued that organizational forms exceeding a given, predetermined size are less efficient than smaller ones.

23 Gans suggests a rule of behavior similar to the one used for minimum inequality at the low-income tail. He defines a minimum level of inequality needed at the top level to be "the lowest maximum at which people continue to be willing to do unpleasant or highly responsible work, or take needed investment or other risk."

Putting these two results together it is theoretically possible to cut off the tails of the range of such distributions. But with that not much has been gained. Neither is it possible to determine how much of the tails to cut, nor is there any information about how to proceed within the remaining range.

Further boundaries can be determined by looking at the intergenerational redistribution. Economists who favor savings over consumption without providing reasons assume implicitly that every generation shows an altruistic attitude towards the successive generation. Replacing this assumption with the alternative

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version of all generations being equally well off implies that 
the necessary rate of saving is reached already, when the growth 
rate of the net capital stock equals the growth rate of popula-
tion. This holds only, provided any technological advances are 
accounted for in the calculation of the growth rate of the net 
capital stock. As complete substitution among production factors 
cannot always be assumed, the stock of human capital must in-
crease at the same rate.

This argument rules out all situations in which the 
condition of a sufficient rate of growth cannot be fulfilled.

Another argument sometimes cited deals with the relation 
of inequality of wealth distribution to the likelihood of revolu-
tionary changes in the political and economic order. Although 
there is no full agreement over whether concentrations of wealth 
in czaristic Russia favored the Russian Revolution or not, it 
is often argued that the revolution of 1968 in Europe would have 
been more successful if the students had been able to reach the 
workers. Since these workers saw the danger of losing property, 
they did not join.

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25. Lipsky enumerates as one prerequisite of a revolution 
"a widespread critique of the management of economic affairs 
directed against the waste of material and human resources". 
Mortimer Lipsky, A Tax on Wealth, (Cranberry N.J.: A.S. Barnes 

26. See Aubrey Jones, "The Economics of Equality," Aubrey 

27. op.cit., p. 29.
Regarding the human capital argument mentioned above there are conceivable situations in which the productive capacity of a society is reduced because inequality prevents human capital from being developed to its maximum extent. In other words, not everybody owns or can borrow the physical capital necessary to pay for the education. This happens if the following conditions are fulfilled:

- there is no complete substitutability between labor and capital;
- human capital has a higher productivity in this case, that means the rentability of resources used for human capital is higher than if used for physical capital;
- the desire for maximum growth of the economy is assumed.

Chester argues that all these conditions are valid nowadays and points out that people with equal abilities no longer have the same chance of attaining equivalent careers.

2.4 Redistributive Assumptions Used

The following points are these which the author feels best justify his support for redistribution of wealth.

- Redistribution is not a topic of normative economics alone. There are also arguments using the framework of positive economics that provide some justification for redistribution.

- Most countries have a tax system with in some sense progressive rates. It can therefore be assumed that the majority of voters in those countries has already approved redistribution as a part of fiscal policy and does not object to corrections of the market-determined size distribution.

- Since the "uncorrected" economy follows a strong motion towards inequality, it would be difficult to generate a counter-motion that is too strong.

29. Reasons for increasing inequality are discussed in Chapter Three in detail. Some proof of the statement can be derived from the fact that the economic situation after World War II provided a lot of variables which decreased inequality in general. These, and the existing progressive tax systems, could not provide a decrease in inequality.


For "equalizing economic variables and circumstances" see Ian Bowen, op.cit., pp. 67-68.
Concentration on the lowest deciles of the distribution is more important than a general reduction of inequality. Providing a minimum amount of wealth is the first step. This minimum amount should be at least high enough to cover the education expenditures necessary to develop each person's given physical abilities.

The author finds the analyses of both Okner/Pechman and Stiglitz to be convincing. They point out that neither income taxes (Okner/Pechman) nor inheritance/gift taxes (Stiglitz) are capable of realizing any significant degree of redistribution.

30. This is further supported by studies which provide proof for the hypothesis that a higher average of schooling has an equalizing effect on the income distribution. See, for example, C.R. Winegarden, "Schooling and Income Distribution: Evidence from International Data," *Economica* 46 (February 1979), pp. 85-86.

Chapter Three

THE MODEL AND ITS ASSUMPTIONS

Before going into a detailed discussion of the hypotheses to be tested here, it is appropriate to explain the assumptions necessary to simulate the behavior of a society.

Any mutual influence between these assumptions and the parameters used are ignored for the sake of simplicity and convenience.

Simulation as a method is not yet widespread in the study of economics. At the moment, the most common models are still based on mathematical determination or some type of statistical regression.

Both are used first and foremost to verify economic theories and to predict behavior based on those theories.

3.1 Simulation as a Method

Starting in the early sixties simulation was introduced as a method for dealing with topics for which other tools were not applicable.
Generally, simulation is either discrete or continuous. Continuous simulation is not appropriate within social sciences, since it is not possible to keep and store enough observations to plot a smooth function curve on a graph. Theoretically, of course, the time intervals could be reduced, as inventories are made daily in the retail sector and some wages are expressed as an hourly rate.

But despite this advantage there are still limits regarding the degree to which these time intervals can be reduced. Therefore, it is necessary to use discrete simulation in social sciences.

There are two main types of applications which use simulation in the study of economics. Descriptions of these types of application follow in the next two subsections.

3.1.1 Simulation in a Macroeconomic Context

In the macroeconomic context simulation allows conclusions to be made about hypothetical situations, when such conclusions could not be arrived at using econometrics, due to the lack

1. This discussion may be found in any textbook on simulation, for example, J.H. Mize and J.G. Cox, Essentials of Simulation, (Englewood Cliffs, N.J.: Prentice-Hall, 1968), pp. 4-12.
of a suitable data set.

Most macroeconomic simulation applications use DYNAMO as a computer-language and deal with long-run or longest-run predictive models.

Although there has been made some effort to apply this kind of software to a short-run or medium-run problem, not very much success has yet been achieved.

Further research that applies the advantages of short-run and medium-run simulation is developing, but it suffers from the fact that it cannot provide results significantly different from those obtained by the well-established econometric methods.

2. See Armin Bohnet and Gunter Brückner, "Entwicklung eines system-analytischen Problemlösungsverfahrens und seine Anwendung auf ein gesamtwirtschaftliches Diagnose- und Prognosemodell," (Giessen: 1982), pp. 4-7 for discussion of further reasons for application of simulation to macroeconomic problems.

3. DYNAMO is based on Forrester's concept of "System Dynamics". DYNAMO was developed by MIT and used in the models WORLD1 through WORLD3 to be presented at the Club of Rome and published later on by Meadows.

   See Jay Forrester, World Dynamics, (Cambridge, Mass.: Wright-Allen, 1971),

4. See Bohnet/Brückner, op.cit., pp. 13 for extensive discussion.
3.1.2 Simulation in a Microeconomic Context

Simulation in a microeconomic context contains two characteristics that are lacking in the previous simulation technique.

1. The decisions of individual households need not be averaged, as it is done while using algorithms.

2. Aggregating this information on a macroeconomic level microsimulation can be used to prove the rationale of macroeconomic conclusions.

As was pointed out by Orcutt in his pathbreaking book, the advantage of microsimulation used in a socio-economic system model is to have "a wide decentralization of decision making." 5

Microsimulation formalizes and standardizes the algorithms for describing individual behaviors. A specific individual is created afterwards changing this standardized behavior on a random base.

Some use of this simulation technique has been made in fields related to this study. Frederic Pryor's research relates probably closest to the topic of this paper. He concentrates

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5. See Orcutt et al., op.cit., p. 3.
6. ibid., p. 9.
mostly on determining the influence of personal behavior involving, for example, marriage and inheritance on the distribution of wealth and income. Some of his findings will be used as input in the model to be presented below.

\[3.2\] Models on the Size Distribution of Wealth

Distribution of wealth has often been the subject of models, either theoretical or empirical. A good survey is presented by Blinder.

All these models have one characteristic in common that distinguishes them from the approach used in the model to be presented below. They try to find reasons that explain the shape of the size distribution of wealth that is prevailing in all developed and developing western countries.


These reasons have to be discussed because they can play a role in the model to be used in this paper. The following reasons should be named:

1. Some authors have suggested that there is something like a steady state inequality, a stable form of inequality, to which the system automatically returns, whenever disturbed exogenously. In a second step one tries to find rules of human behavior, that explain this positively-skewed (and at the same time steady state) size distribution of either wealth or income. Gambling behavior with prices and risks, the relation of abilities and earnings, or the human capital approach have been put forth as explanations.

2. Other authors tried to find this behavior source in the history of the country, the type of social order or the level of development.

10. See, for example, Kenneth E. Boulding, op. cit., p. 3.


12. Rhodes found that the conditions under which a system with groups of persons with different skills automatically leads to a Pareto-Distribution. See E.C. Rhodes, "The Pareto-Distribution of Incomes," Economica 11 (February 1944), pp. 10-11.

13. The Human Capital approach was mentioned earlier and will be discussed in detail later on. See Gary S. Becker, op. cit., and Jacob Mincer, op. cit., for references.

14. Cross-sector studies have been done by Kuznets and Kravis. Kuznets argued that the absence of a middle class is responsible for higher inequality, whereas Kravis found out that
All these results highlight backgrounds responsible for the generation of a distributional situation. Historic or regional differences will not enter the model used in this paper, because it is assumed that the influence of dramatic changes in the sociological structure of a nation can be neglected due to the reduced reference period. For this reason the "gambling approach" is also not included.

Furthermore, development processes are ruled out because the fictitious country is assumed to be already developed.

All other attempts of explaining inequality, however, will be represented in the stereotypes that describe the behavior of the homo economicus in the model presented.

These are abilities, earning structures, and the human capital approach.

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14. continued:
inequality decreases generally as the level of development increases.
3.3 The Details of the Model Used

In the case of governmental redistribution it is judged permissible to disregard all those factors that originate in the private sphere like lottery prices and charitable money transfers. Political events that are supposed not to happen regularly like wars, civil wars, and revolutions are also disregarded because of the reduced reference period.

3.3.1 Constants, Variables, and Parameters

The remaining changes in the size distribution are caused either by a change in the fiscal policy of a country or by changes in the human behavior resulting from those policy changes, as international influences are disregarded for reasons of simplicity. Such secondary effects are neglected since they would make the model unmanageably complex. The only secondary effect considered is the increased labor income due to public expenditures in education.
This leaves the following types of elements:

- **Constants**
  -- all human attributes of a person like behavior towards risk, abilities, etc.,
  -- the socio-economic situation,
  -- and class structures.

- **Variables**
  all individuals' yearly income, consumption, taxes paid, losses, etc.,

- **Parameters**
  -- tax structures,
  -- public expenditures for education,
  -- the size of the initial distribution of wealth.

The following subsections provide a short description of the parameters.

### 3.3.1.1 Taxes in the Model

Only the following taxes will be taken into consideration:

- income tax,
- inheritance tax / gift tax,
- general wealth tax.
These simulated taxes do not necessarily correspond with existing taxes in the United States. It must also be pointed out that in real life other taxes probably influence the size distribution of wealth.

But in every model certain simplifying assumptions have to be made in order to keep the model manageable. Furthermore, it can be assumed that the results obtained will not be biased generally because the study focuses only on the change of indicators and uses ceteris paribus conditions.

Any other simplifications and the underlying reasons will be listed when the topic concerned is described in detail.

3.3.1.2 Public Expenditures for Education

As was described in Chapter Two, many authors assume that education influences the size distribution of wealth.

This parameter is used in special variants of the model. It will, therefore, be discussed in Chapter Four together with the other hypotheses to be tested.

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15. They coincide, however, with the tax classification scheme in most textbooks. See, for example, Bernard P. Herber, Modern Public Finance, (Homewood, Ill.: Richard D. Irwing, 1979), pp. xii-xiii.

16. Sales taxes should be mentioned as the most important of those. They are normally assumed to be regressive.
In the basic model used for all versions there will be no expenditures for education that leave children in a situation different from the one chosen by their parents.

Some additional aspects of the topic education will be discussed in subsection 3.3.2.2.

3.3.1.3 The Initial Size Distribution of Wealth

The third parameter in the model is the initial distribution of wealth. Reasons could be found to support many forms of distributions. The three following have been chosen:

- a uniform distribution
  In a uniform distribution all experimental units are taken from within a range defined by some distance from the mean. Within that range, all units are equally distributed. The width of the zone expresses a stochastic component which encompasses possible variations. If those were disregarded, this zone would narrow and the result would be an equal distribution.

- a normal distribution
  The normal distribution was chosen because many studies proved that abilities and skills are distributed this way and there might be some justification for a redistribution towards such a normal distribution. In addition, the normal distribution is known to be very
stable.

- a lognormal distribution

The lognormal distribution is the most "realistic" one, as it can be adapted to fit every Gini-Coefficient. Much discussion among economists was concerned with the question of whether the lognormal or the Pareto-Distribution is the one which best describes reality.

Choosing the lognormal distribution was somewhat arbitrary. Since algorithms are not used, however, this does not make an enormous difference. The appropriateness of the lognormal distribution is proved by Aitchison and Brown.

The data from the aforementioned study were used to create the data for the lognormal distribution used here, corresponding to a Gini-Coefficient of 0.4.

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17. These findings have been made pretty early. Pigou, for example, mentions them as he tries to explain why income distributions and skill distributions are different. See A.C. Pigou, The Economics of Welfare, (London: Macmillan, 1920), p. 128.

18. See Alan S. Blinder [1974], op.cit., pp. 9-12 for a brief discussion.


20. Calculations are based on Table A 1, op.cit., pp. 154-155.
3.3.2 The Decision Processes in the Model

In this model decisions are made by the households. A decision is defined to be any reaction to an exogeneous stimulus or a consequence of an inherent bias. Children cannot make their own economic decisions, even regarding the management of their own property.

A household starts with the marriage and ceases when both spouses have died.

The highlights and main decision points are:
- the marriage of a couple and the birth of the children,
- the education of the children,
- the marriage of the children,
- the death of the last spouse.

21. This is not a rigid restriction as inheritance can only be passed on a distance of one generation. See details later on.
3.3.2.1 Marriage -- A Household Starts

Marriage plays an important role not only for the single family, but also in influencing the nationwide size distribution of wealth.

The long-run development of this distribution will depend in part on the number of persons who marry within their social class. Pryor demonstrated this effect in his simulation study providing various forms of "marriage rules" together with the "resulting" inequality value. A high class-orientation tends to increase inequality, meanwhile a classless system of marriages does the opposite.

More importantly, it is necessary to specify realistic and practical marriage rules. It is not easy to study marriage behavior within and in between wealth classes. Many arbitrary assumptions have to be made. However, Harbury and Hitchens provided helpful information pointing out that there is a significant preference for marrying within a class. This behavior is especially typical for the "top end of the class scale" and within that class women are, first and foremost, subject to the

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intention of a class-adequate marriage.

Coleman published a lengthy list of correlation coefficients for a sample of married couples. These data also support the above analysis.

Before describing the rules finally chosen some simplifications should be outlined.

- Every person marries only once in his life.
- There is no divorce.
- Once a person has decided to stay unmarried for any reason, he will never change his mind.

In this model every person is assigned a year which is used to determine the year of marriage. This is done at the person's "birth." As a means of simplification, and for technical ease, it is assumed that the initiative of marrying is with the man.

Once his predetermined marriage year has come, he runs through the following procedure to look for a "matching" woman. To find a "matching" woman, both age and wealth class must be considered.

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A woman is considered to be matching in age if her year of marriage lies in the range of his marriage year ± 5 years. If there is more than one woman that matches this condition, all candidates are ranked by a hierarchy of age. That means, the older woman marries first. This condition is designed to overcome the limitations that arise from women not being able to take the initiative for marrying. It can be argued that a range of ten years may be too wide. This wide range was chosen, however, because cases of a smaller range with this small sample size would result in too many unmarried people.

The condition of an appropriate wealth class is met by women belonging to the same wealth class. This is the man's first consideration. If there are not any women available to him in this class, he checks the classes above and below, successively. As there are only three classes to be used in the model, only a man belonging to the middle class has this full choice. Men of boundary classes have only one "neighboring class" to check in addition to their own.

A man remains unmarried if he was unable to find a woman in any of the classes open to him.

Unmarried men do not have children. Adoption is disregarded.

25. A technical term not appropriate for reasons of good taste would be "first come, first served."
ded. Special precautions have to be taken to guarantee the existence of possible heirs for these bachelor families. All surviving brothers and sisters will equally share this household's bequests.

If this bachelor was the only child in his parents' family, or if his brothers and sisters have already died, a inheritance tax rate of 100% is assumed.

A marriage forms a new household which becomes a member of the sample, earns its own income, and pays its own taxes.

To handle this properly, the following steps are executed:

Step 1. Pool the spouses' human capital. Both spouses are assumed to belong to the labor force. This might be restrictive, but it can be argued that the majority of working-age women are in the labor force. Furthermore, this procedure keeps track of the bias in income taxes that might arise otherwise, because tax allowances due to income-splitting rules have not been integrated.

Step 2. Determine the wealth class of the family. It is assumed that the wealth of the parents' will determine the wealth class of the young family, and not the effective physical capital of that young family itself.

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26. See Bernard P. Herber, op.cit., p. 150.
Step 3. Determine the genealogical interrelations. A cross-reference system is created to determine and keep a record of the successors of this family.

Step 4. Provide an initial physical capital stock. This covers the value of durable goods which a household buys at the time of marriage and all other transfers which parents may give in order to provide a good start for the couple. This amount is calculated using a formula to be described in subsection 3.3.2.3.

Step 5. Fix the number of children, the family is to have and determine their year of birth. The number of children generally decreases with increasing wealth. The wealth class of the family (see Step 2) and a random component are used as arguments to determine this number.

The following Table 3.1 indicates the ranges and the average for the number of children in each wealth class.

<table>
<thead>
<tr>
<th>Wealth Class</th>
<th>Number of Children</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>poor</td>
<td>2.0 - 3.5</td>
<td>2.75</td>
</tr>
<tr>
<td>medium</td>
<td>1.25 - 2.75</td>
<td>2.00</td>
</tr>
<tr>
<td>rich</td>
<td>0.5 - 2.0</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Table 3.1: Range and mean concerning the number of children within each wealth class.
Arguments for these figures can be found in the population structure of the United States, although this relation is not of such a linear type as assumed here. Forming these data into a linear regression model, however, will provide a clustering similar to that in Table 3.1.

The children are born in any of the five years that follow the year of marriage.

Step 6. Determine a planned ceiling of human capital obtainable for each child. This value is partially class-determined and partially random. The following Table 3.2 presents the range of values used together with the mean. The individual level of human capital is calcu-

<table>
<thead>
<tr>
<th>n</th>
<th>Mean</th>
<th>Class</th>
<th>av.#</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>22,397</td>
<td>-</td>
<td>2.90</td>
</tr>
<tr>
<td>1</td>
<td>22,423</td>
<td>- 5,000</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>22,782</td>
<td>- 10,000</td>
<td>1.98</td>
</tr>
<tr>
<td>3</td>
<td>22,426</td>
<td>- 15,000</td>
<td>2.14</td>
</tr>
<tr>
<td>4</td>
<td>20,980</td>
<td>- 20,000</td>
<td>2.20</td>
</tr>
<tr>
<td>5</td>
<td>19,831</td>
<td>- 25,000</td>
<td>2.12</td>
</tr>
<tr>
<td>6</td>
<td>15,914</td>
<td>- 30,000</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>22,370</td>
<td>+ 40,000</td>
<td>1.92</td>
</tr>
</tbody>
</table>

27. There are basically two sources that prove this assumption. 

a) Mean income for families with "n" children

b) average number of children (av. #) per income class

lated by multiplying the resulting value from this range times $25,000.

\[
\begin{array}{c|cc|c}
\text{Wealth Class} & \text{Ranges of Coefficients} & \text{Mean} \\
\hline
\text{poor} & 0.0 & -1.333 & .666 \\
\text{medium} & 0.333 & -1.666 & 1.0 \\
\text{rich} & 0.666 & -2.0 & 1.333 \\
\end{array}
\]

Table 3.2: Range of variables used for determining the planned ceiling of human capital.

Step 7. Reduce the number of children in each parent household by one.

3.3.2.2 Education of the Children

The education of a child is reduced to the financial transfer from the parent's physical capital account into the child's human capital account.

It will be assumed that the parents decide what amount of money to spend for the education. The planned amount of human capital to be accumulated is partially dependent on the household's wealth class.

There has been a study that investigated the income elasticity of education for special school districts, which yielded the result that "higher socio-economic indices are associated
with increased demand for both public and private education."

The human capital resulting from the amount of money
spent by the parents is a multiple of this amount. This is true
for the following reasons:

- The parents fees cover only a fraction of the total money
  spent for running the (state) university/college/school.
- Well-known private universities require a higher share of
  private financing. But this is compensated by the addi-
  tional revenue generated by a more prestigious degree
  issued by such an institution.

It is, of course, not easy to estimate values for this
multiplier. The reciprocal of the fraction of a university's
total operating costs financed by tuition fees was chosen. It was
assumed that all universities are 50 percent financed through

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The multiplier was, therefore, set at the value two. A
lump sum of $10,000 was added representing the human capital
arising from attending the free schools for general education.
This minimum amount is provided to everybody, whether or not the
parents spend money for college education.

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  Neutrality and the Demand for Education," National Tax Journal
  32 (June 1979), p. 159.

29. This value is too high for most state universities,
as a representative majority of colleges is financed by tuition
  fees up to about 20 percent only.
A special case has to be considered still. Parents whose present wealth is not sufficient to pay for the education of all their children reduce their expenses in equal shares. This leads to an equal sacrifice for all children and avoids situations in which the first-born obtains a higher share and the subsequent children bear increasing burdens of foregone education.

It should be mentioned for completeness that expenditures for education can be afforded by the parents as long as the children concerned remain unmarried. This chance of "filling in the gap later on" vanishes finally, if the child leaves the parents' household for any reason.

3.3.2.3 Children Leave the Household

This chapter deals with the effects upon the parent household at the time such a child leaves.

Basically, two things have to be taken into account:

- The size of the family changes due to one person leaving. Lump sum consumption will decrease.

- A wealth transfer from the predecessor's to the successor's physical wealth account leaves the parents with less wealth. The formula to be used for determining each child's share is:
\[ S[i] = W[i] / (kN - i + 1) \]

with:
\[ S[i] \] the share of the \( i \)th child;
\[ W[i] \] the parents' wealth account \textit{before} the transfer to the \( i \)th child;
\[ N \] the total number of children in the family;
\[ k \] the reciprocal of the fraction to be transferred to all children in total.

It can be proved that this formula makes sure that all \( S[i] \)'s are equal for all children.

This leaves the decision about the size of \( k \). It is impossible that there is a single \( k \) that matches with all families and wealth classes. A value of five, or 20 percent, was arbitrarily fixed.

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30. \textbf{Proof:}

\[ S[i] = W[i] / (kN - i + 1) \] and
\[ S[i+1] = W[i+1] / [(kN - (i+1) + 1) = W[i+1] / (kN - i). \]

\[ = W[i] (kN - i) / (kN - i + 1) \]
\[ S[i+1] = [ W[i] (kN - i) ] / [(kN - i + 1) (kN - 1)] = W[i] / (kN - i + 1) = S[i] \]

31. Poorer families might be willing to transfer a higher share. But the possibilities seem to be limited as "wealth" consists also of assets with a low degree of liquidity. It has to be admitted, however, that every \( k \) is arbitrary.
3.3.2.4 Retirement and Death

The behavior of the old has been a field of extensive studies in recent years. The studies dealing with wealth distribution and behavior of the aged may be categorized into two main groups.

The first group is interested in the consumption behavior and argues that it influences the size distribution of wealth via the volume of bequests, whereas the second group is interested in the decision rules themselves which are connected with the bequeathing process.

Both arguments, or classes of arguments, have to be checked for possible consequences on the model.

The consumption behavior of the retired has come into economists' interest mainly because of a consumption theory known as the "permanent income hypothesis" and related to Modigliani.

Further discussion was done by Friedman and after that,

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many of studies tried to find evidence for that hypothesis in the consumption expenditures of the aged. There has not been a common result, however, as some authors find empirical evidence and others do not.

A consequence of a rigid version of the permanent income hypothesis is that wealth decreases for the aged, ceteris paribus, as labor income has reduced or completely disappeared after retirement. Estimates of data using these underlying assumption would imply people dying with negative assets. The most recent study softens the above findings stating that bequeathing as an economic good has to be taken into consideration and nobody is certain about the date of death. Integrating these two values, King and Dicks-Mireaux pointed out that they could find evidence for wealth declining after retirement, but only after they adjus-


ted for differences in permanent income due to retirement.

Since the permanent income assumptions will not be used within the model for technical reasons, it is assumed that no changes in the general consumption structure occur due to being retired. Further complications can also easily be ruled out, as long as transfer programs addressing to the aged especially, are not included.

The bequeathing behavior has already been discussed in part. The remaining question is when and to whom bequests are given.

It is obvious that every transfer of real capital from the parents to the children is bequeathing, whether it takes place after the parents' death or before. However, it is necessary to consider separate the money transfer that took place at the children's wedding day as it is not taxed by an inheritance tax. If this tax is collected in case of death of the bequestor only (and it is) and if there is no equivalent for comparable situations with transfers inter vivos, it is easy to circumvent this tax. This consideration brought up the inheritance/gift tax com-


bination. The consequence of this has not been integrated in this model for the two main reasons:

1. It cannot be assumed that parental "wedding gifts" are taxed or even taxable.

2. Since a family is assumed to be growing in wealth, the dowries are only a minor fraction of the latter bequests.

As was pointed out by many authors, concentration of wealth depends also of the type of inheritance rules to be followed. Atkinson categorized the concentration causes in a similar way stating that

- the pattern of inheritance,
- family size, and
- marriage rules

are the determinants of concentration of wealth.

The second topic can be skipped, as it was already discussed in subsection 3.3.2.1.

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Reducing all possible forms of wealth transfer to the children into their basic forms, there remain the two antagonisms "primogeniture" and "equal sharing." All other forms imaginable can be found in between these boundary cases.

Pryor showed that primogeniture induces a more unequal development in the long-run than equal sharing, and this holds true also if different fertility rates for different wealth classes are assumed.

Studies have been done comparing the relative wealth positions of the parents with those of the children. In such a kind of experimental environment primogeniture stands for a nearly perfect positive correlation of both wealth figures, meanwhile equal sharing will produce a statistical phenomenon known as "the regression towards the mean" that can be described as "the children of extremely rich (poor) people will also be rich (poor), but not to such a degree as their parents."

This technique has been applied in some studies with divergent results. Adams tried to overcome the problem in using

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41. See Pryor [1973], op.cit., p. 54.

42. This result was discovered by Galton in 1892 while measuring height and weight of parents and children. See Sir F. Galton, *Hereditary Genius: An Enquiry into its Laws and Consequences*, 2nd edition, (London: Watts, 1892)

43. For details in applying this method see C.D. Harbury and D.M.W.N. Hitchens [1979], op.cit., pp. 116-119.

44. Significant indicators are found by Harbury, and Harbury and McMason. See C.D. Harbury, "Inheritance and the
a slightly modified technique. He checked the relation of inheritance income elasticity to income elasticity for education and concluded, "primogeniture is supported, as the first elasticity exceeds the corresponding latter."

The author favors a suggestion made by Menchik who mentioned family size as an influencing factor. If it is assumed that wealthy people are more likely to have one child only, then there is a quasi-primogeniture as the consequence of having only one child.

Selecting from all the pros and cons presented, the following assumptions concerning the inheritance/bequest behavior seem most important:

- All bequests are divided into equal shares after subtracting the inheritance tax to be paid.
- Families with no first degree heirs (children) are treated in the following way:

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44. continued:


46. See Paul L. Menchik [1979], op.cit., p. 360.

47. See statistical report cited in footnote 27 above.
-- All surviving brothers and sisters of both spouses
receive equal shares.

-- Inheritance tax allowances are reduced and inheri-
tance tax rates are increased for such cases of
second degree heirs.

-- If no first and second degree heirs can be found,
an inheritance tax of 100 percent is assumed. This
treatment could also be defined as bequests going
to some charitable organization.

Tax rates and allowances will be discussed in detail
later on.

All the details listed above describe the algorithms
which determine the long-run planning and decision-making proces-

ses of the households.

It was intended to parallel reality as closely as possi-
able while defining these structures. Hopefully, the necessary
simplifications do not change the basic ideas which most people
have concerning the system of intersocietal relations.

3.3.3 Economic Variables and Decisions

This subsection describes the assumptions made in order
to determine the yearly variables such as income, consumption,
taxes, and savings.
Previously discussed economic variables like wealth and human capital, are different from these yearly variables in the following sense:

Wealth or physical capital and human capital are stock variables, whereas income, taxes, consumption, and savings are flow variables. Only stock variables are stored in the information matrix containing the characteristics of households. With these characteristics all the yearly variables can be calculated.

3.3.3.1 Simplifications and Annotations

As can be concluded from the statement above, there is no temporary change in the economic situation of a household that is not predetermined by its characteristic attributes.

This implies a deterministic behavior based on variables, fixed once and for all. These variables, however, are initially chosen in a random manner.

An example may be used to explain this procedure. Labor income is assumed to depend on two factors only: the stock of human capital, and the abilities or skills of the person involved. Neither variable changes any more, once the household is installed. Knowing the size of these variables then, the value of income (and, consequently, of all additional variables) can be determined for each year.
This describes reality correctly, however, only when all economic developments which influence different individuals differently are disregarded.

The following list of economic events which were excluded from the model is not dictated by economic reasons, but by technical circumstances and the intention of keeping the model manageable.

- The economy of the country is always in full-employment. Everybody works at the job for which he is qualified, and receives a wage that corresponds to his innate talents and the education completed.

- There is no inflation. All variables are in real terms. Currency units do not matter, but the range of incomes, taxes, etc. corresponds to the range presently existing in the U.S.

- Capital markets are not regulated. Everybody chooses his own interest/risk combination for investments. All interest rates vary within the range of zero through 12.5 percent.

- Higher interest rates are compensated for by bearing a higher risk. Everybody is assigned a life-long personal attitude towards risk.

- There is only one single interest rate, say an average value, that is applied for all the assets of a given household, but there are, of course, different interest rates for different households.
There is no borrowing. A family cannot spend more than the sum of disposable income and accumulated wealth. On the other hand, there is also no restriction, and no losses, whenever a household changes the degree of liquidity of the assets in its property.

There are no transaction costs and everybody has complete insight. All households with the same risk attitude will receive proportional benefits for similar behaviors.

With these assumptions in mind the following points have to be checked in greater detail. First, income is broken down into labor and interest income, and afterwards the determination of disposable income and consumption is discussed. Savings will be explained as the last topic, as it is the remainder in the income-expenditure process, and as it changes the stock of physical capital.

3.3.2.2 Labor Income

Labor income is based on three components:

- the accumulated human capital,
- the abilities which a person has at birth,
- and the age-income relation, valid for everybody.

These factors, in general, are combined multiplicatively. But there are additional influences that weaken this relation.
a) The Accumulated Human Capital

A person's or household's accumulated human capital is always expressed as a fraction of the mean human capital of the society which is a fixed value during the total simulation period. A significant change in the people's attitude towards education is disregarded. This procedure was chosen to harmonize human capital with an economy in real terms.

An individual's ceiling for potential human capital is partly dependent on the respective wealth class of, and an arbitrary decision by, the parents. This decision does not express rational behavior from the economist's point of view. It is, therefore, expressed by a random variable in the simulation.

In general, the richer the parents are, the higher the human capital. But a child belonging to a "poor" family with the parents deciding to spend an over-proportional share of their financial resources for the child's education can easily have the same human capital as a rich family's descendant, supposing the rich family was reluctant to invest in education.

b) Personal Abilities and Skills

This variable is used to express innate qualifications that are not acquired through education. The question of whether general means of measuring intelligence and abilities (IQ) are
appropriate for economic purposes will not be discussed.

It is supposed that a suitable means of measurement that expresses a person's "abilities in the economic sense" has already been found.

The variable is not defined in the way which Becker did in his studies: it is assumed to be unrelated to the amount of human capital or education accumulated, although most studies show a positive correlation between the two.

This avoids a skewed distribution which would arise if skills were normally distributed and skills and human capital were connected multiplicatively.

c) Extensions and Special Cases

But since skills and education are not independent of each other, care must be taken that it also happens in the model.

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49. Becker found out that people with higher abilities spend more money on education and acquire a higher level of human capital, therefore. See Gary S. Becker [1975], op.cit., p. 166. For a thorough and helpful classification of skills in this sense see Paul J. Taubman, Sources of Inequalities in Earnings, (New York: North-Holland, 1975), pp. 6-11.


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The following assumptions are used to allow for additional returns on human capital:

1. A specific amount of $n$ dollars results from multiplying skills and human capital returns.

2. Additional $n$ dollars will be earned, if either skills or human capital exceed the 80\%-value of the distribution.

3. An amount of $n$ dollars can be added a second time, if either skills or human capital exceed the 95\%-level.

4. Altogether four times $n$ dollars can be reached only by persons whose skills and human capital both exceed this 95\%-level.

With this construction the results found and attributed to various reasons by Gary S. Becker, Jacob Mincer, and Harold F. 51

51. Assumed that both skills and human capital are distributed with neither mean nor spread changing during the simulation period, there is a definite and predetermined value, depending only on the one-tailed 80\%-value of the normal distribution (equal to one) modified with standard deviation 200 and mean 1000 (equals 1200). $160,000 stands as the boundary case for (joint) human capital. This corresponds with the 87.5\%-value of wealth class two and the 62.5\%-value of class three. There is no corresponding value for class one.

52. In detail:

skills: 1,300 or 93.2%
human capital: 170,000 or 95.0\% class two,
70.0\% class three.


d) The Age-Income Relation

A last argument influencing the height of labor income in the model is known in the literature as age-income relation. It deals with the observation that the previously mentioned arguments are unable to completely explain wage differentials. Age-earnings profiles reflect job experience, which is a form of human capital.


The curve starts with an upward slope, reaches a maximum point, and slopes downward afterwards. The specification used in this model is described in Figure 4.1. The upward slope refers to increased training, whereas the downward slope might be caused by skills becoming redundant or reduced physical abilities. A further part does not belong to earnings, but is an old-age or after-retirement income. This relation has been simplified to some degree, assuming that everybody is forced to put some given share of his labor income aside for his own retirement fund. As this is then a proportional share of the labor income earned, the age-earnings curve can easily be extended beyond the point of retirement. The points fixed for the interpolation are arbitrary to some degree.

There are statistical data available, but they are mostly expressed in absolute dollar amounts rather than in multiples of the average which equals one. The curve has been drawn in a way that attempts to include most of the observations of reality.

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60. See, for example, compressed information in Figure 9.11 in Ronald G. Ehrenberg and Robert S. Smith, Modern Labor Economics, (Glenview, Ill.: Scott, Foresman and Company, 1982), p. 246.
Figure 3.1: Age-earnings profile used in the model

e) Minimum Income

The last component that determines labor income is called “minimum income.” It varies neither over time nor with the amount of education which a person has. This variable is assumed to cover everybody’s capacity of doing useful work regardless of education, experience, or innate abilities.

It is possible that the motives that led to the use of such a minimum income might be the same that institutionalized minimum wage in the U.S. However, the U.S. minimum wage and the minimum income component do not hold the same mean and should therefore be kept separate.

The value of this minimum income is fixed at $5,000.
3.3.3.3 Interest Income

A household's second source of income is the interest earned on the physical capital stock.

As it is obvious that there cannot be one unique interest rate in the economy, it has to be decided whether or not the relative wealth position influences a household's interest rate.

It has been frequently argued that fortunes are made only because of capital markets being temporarily out of equilibrium and allowing above-average rates of return, or that the portfolio of the top wealth owners is somewhat different from other households'.

This argument is not emphasized, but different risk-behavior is concentrated on.

As Tobin pointed out, there are basically three types of attitudes towards risk: risk-aversion, risk-neutrality, and risk-love.

-----------------------

It will be assumed for simplicity that everybody's attitude is risk-aversion and that, consequently, higher interest rates have to be paid for assets that are riskier than average.

The assumptions that underlie the so-called Capital Asset Pricing Model, namely complete insight and extremely high reaction speed, are assumed to be valid.

Then there is a portfolio with the following characteristics:
- There is no portfolio that bears less risk than this portfolio while providing the same interest rate.
- There is no portfolio that yields higher interest than this portfolio while bearing identical risk.

This portfolio is normally called market-portfolio.

Within this system everybody can choose his own risk-interest combination. It is assumed that the personal risk behavior has two determinants:
- a random component being uniformly distributed;
- a wealth class component.

----------

This construction incorporates the idea that rich people, at least partially, tend to have a preference for higher interest rates and, on the other hand, to accept a higher risk.

It can be argued that there is no complete insight for everybody in reality and, therefore, entrepreneurs with inside information can have increased returns without bearing increased risk because of someone on the other side of the desk who carries this additional risk without obtaining the additional returns. But this aspect is disregarded.

The resulting range of risk-interest fractions for each wealth class are presented in the following Table 3.3. A value of one refers here to the average interest rate.

<table>
<thead>
<tr>
<th>Class</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>poor</td>
<td>0.0 - 1.3333</td>
<td>0.6667</td>
</tr>
<tr>
<td>medium</td>
<td>0.3333 - 1.6667</td>
<td>1.0</td>
</tr>
<tr>
<td>rich</td>
<td>0.6667 - 2.0</td>
<td>1.3333</td>
</tr>
</tbody>
</table>

*Table 3.3: Distribution of risk parameters*

---

65. This refers partly to the so-called strong version of the efficient capital market hypothesis which expresses the assumption that even insiders are not able to realize excess returns. This hypothesis is not completely accepted. See E.F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance* 25 (May 1970), pp. 383-417.
3.3.3.4 Losses of Wealth

Closely connected with the arguments presented above are the determinants of losses which are assumed to occur in the economy.

This does not refer to speculative losses but to those that are consequences of some unforeseen catastrophes like fires or earthquakes. These events are foisted upon owners of assets randomly. But it is assumed that persons with high risk parameters suffer a greater loss whenever hit by such an event.

This assumption can be defended by arguing that a low interest embodies already the insurance premium paid. Only people preferring higher risk -- and therefore refusing to pay the premium -- will have to pay for the damage themselves.

The first third of all occurring risk parameters (0 - 700) is assumed to be free of losses completely, whereas the rest can lose between 20 percent and 50 percent of its actual wealth. The overall probability of losses is five percent. As both probabilities are independent of each other, this means that in the long run the overall percentage share of losses in the economy is about 1.2 percent. This value will change, however, if the

66. Only two thirds of the people lose at all. Those who lose, lose on average 36.63%, if they are hit by an accidental
3.3.5 Income Taxes

Income taxes will be sketched only in this subsection, because they are handled as the parameters of fiscal policy which are to be used for active redistribution.

At this time only the initial assumptions about the income tax rates are described. These rates are used in the basic form of the model which most closely parallels reality. All hypothetical versions are compared to this basic variant.

Data for determining the slope and the form of the income tax function are taken from Pechman/Okner and Herber, respectively. The type is assumed to be proportional and the rate to be 15 percent. There is an allowance from the taxable base of $6,000 per household, regardless of its size.

-----------------------

66. continued:
loss. The chance of such a loss is 5%. The total is the .3663 times .05 times .6667 = .001221 or 1.221 percent.

67. Justification for a proportional type is in Pechman/Okner [1974], op.cit., p. 62. The type is not exactly valid for the personal income tax, but the assumptions must be changed in order to incorporate all various kinds of "personal income taxes." The allowance refers to various regulations in the system of personal income tax called "personal exemptions". All these can be summed up to roughly $6,000. See Bernard P. Herber, op. cit., p. 145.
3.3.3.6 Consumption and Savings

The consumption function used in the model is of a micro-economic type. Two main components are fixed:

- A lump sum consumption varying with family size and wealth class, and
- income-dependent consumption.

The lump sum consumption refers to the family's basic needs. These occur whether or not the family receives income in the actual period. The amount is consumed whenever the financial resources of the family allow it. That means dissaving by sale of assets will happen when disposable income is lower than lump sum consumption.

If the sum of physical capital and current income is lower than the lump sum amount, then the amount is reduced.

Lump sums are calculated per person living in the household. It is assumed that persons living in a wealthy family have higher "basic needs" which are caused by a different lifestyle of the groups in society. The following Table 3.4 presents the sums used.

66
<table>
<thead>
<tr>
<th>Wealth Class</th>
<th>Lump Sum per Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>poor</td>
<td>$1,000</td>
</tr>
<tr>
<td>medium</td>
<td>$1,500</td>
</tr>
<tr>
<td>rich</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

Table 3.4: Amounts of lump sum consumption per person in different wealth classes.

Income dependent consumption is assumed to vary according to the residual income resulting from subtracting lump sum consumption from disposable income.

The underlying structure has the size shown in Figure 3.2 and refers to the accepted fact that the marginal (and average) propensity to consume declines with increasing income.

![Consumption/Income Relation](image)

Figure 3.2: Marginal propensity to consume as a function of residual income used to determine the income-dependent part of consumption.
3.3.3.7 Adjustment to Changes in Economic Variables

As the description showed, it is wealth class or the relative wealth position that influences numerous economic decisions. It might be discussed now whether a household will change its habits if it finds itself in a different wealth class.

Arguments can be found for either opinion. It was assumed that such adjustment processes should take place. The following reason is cited:

Everybody tries to keep up the appearances if a downstep occurs, whereas an adjustment into a higher class is more likely to be done at once.

In the long-run, however, appearances cannot be maintained indefinitely, if the reduction in financial resources is permanent.

The adjustment process is handled in the following way. Since a new size distribution table is created every tenth year, it is assumed that this table is published by the Statistical Bureau of the country within the next year. People compare their own wealth position with the (new) circumstances and undertake necessary changes in behavior.

This finishes the description of the assumptions which hold true for all simulation runs.
Chapter Four

HYPOTHESES AND RESULTS

This chapter describes the hypotheses to be tested in detail and the methods used to overcome the difficulties which arose.

A presentation of the results will follow together with some suggestions about how to interpret them and what conclusion to draw.

The last part discusses the link between these results and the economics of the real world. It will also outline some further possible applications of the underlying model. It will, in general, argue in favor of extended use of simulation for the analysis of complex economic problems.

4.1 The Hypotheses in this Model

As was already mentioned the purpose of this paper is to discuss the impact of special fiscal policy measures on the size distribution of wealth. This general statement has to be restructured into a form that can be tested in a model.
The author separates the resulting hypotheses into two groups mostly out of the necessity of reducing the computing costs.

In a first step he tries to find out whether the original distribution of inequality among the members of the fictitious society in the model has any influence on the effectiveness of policy measures which will later be examined. If it is found that differing initial distributions all culminate into an identical behavior pattern, then it is unnecessary to repeat the second group of tests for each initial distribution.

The effect of each fiscal policy measure to be discussed is assumed to be independent of the effects of other policy measures. Because of this independence there are fewer distinct combination patterns which need to be tested. Such would not be the case if the measures were assumed to be interdependent.

This assumption is also made in order to reduce the number of simulation runs necessary to obtain a reliable result.

4.1.1 The Influence of the Initial Distribution on the Effectiveness of Fiscal Policy Measures

As discussed in Chapter Two, three initial distributions are assumed to be representative of all possible forms. These distributions were employed along with the basic form of the model to produce the control simulation. The basic form refers to
the absence of any hypothetical taxes or expenditures. The fiscal policy is reduced to a proportional income tax and a proportional inheritance/gift tax. All other forms of fiscal activity are denied consideration using a ceteris paribus condition, thus assuming that their impact in the economic decision units will be constant.

The income tax is of a type called "indirectly progressive" because the average tax rate increases with increasing income or taxable base, although the marginal tax rate stays constant. This result is obtained while applying a proportional marginal tax rate of 15 percent on all income exceeding a basic allowance of $6,000. The percentage share of taxes with respect to the taxable base (income minus allowance) is constant, so this tax is proportional. But taxes paid in relation to income is not constant, therefore indirectly progressive.

The average tax rate of this form is presented later on in Table 4.8 together with the alternative income tax to be implemented in a later simulation.

The tax rate was chosen following the research findings of Pechman/Okner whose incidence assumptions lead to a rate of 14.7 percent in the most progressive variant and 13.8 percent in the least progressive variant, whereas the amount for the allow-

1. Sum of columns "individual income tax" and "payroll tax" of Table 5-6 in Pechman/Okner, op.cit., p. 78.
ance was deduced from Herber.

It should be mentioned that it was more or less a jigsaw puzzle to fix the variables in a way that not only corresponds to real life data, but also harmonizes with all other variables.

Some information about the amount of physical and human capital was taken out of a Government Report. This source stated that in 1973 the average wealth consisting of both physical and human capital was about $75,000 for every man, woman, and child. Of this $39,000 were human capital and $36,000 physical capital. As interest focuses on a household's wealth, the values have to be multiplied by about four. On the other hand a round number was desired. This averaged physical capital to $100,000 and human capital to $120,000. This leaves the relation of human to physical capital nearly unchanged (1.2 versus 1.08), whereas physical wealth is generally too small and human capital too high, if calculated using the household as a base.

The values fixed for the variables are listed in Table 4.1. Variants A, B, and C refer to what was described as uniform, normal, and lognormal initial distributions, respectively.

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2. There is a zero bracket amount of $3,400 and all the deductions published in footnote 5 sum up easily to something like $2,500: See Bernard P. Herber, op. cit., pp. 144-145.

Although the main focus is on the inequality as documented in the development of the Gini-Coefficient, there will also be a documentation of the growth rates of both income and physical wealth reported on household basis.

<table>
<thead>
<tr>
<th>Variable-type</th>
<th>Value in:</th>
<th>Variant A</th>
<th>Variant B</th>
<th>Variant C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Distribution of Wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mean</td>
<td>$ 100,000</td>
<td>$ 100,000</td>
<td>$ 100,000</td>
<td></td>
</tr>
<tr>
<td>- minimum value</td>
<td>$ 80,000</td>
<td>$ 5,000</td>
<td>$ 1,775</td>
<td></td>
</tr>
<tr>
<td>- lowest 5% value</td>
<td>$ 82,000</td>
<td>$ 67,000</td>
<td>$ 22,356</td>
<td></td>
</tr>
<tr>
<td>- lowest 95% value</td>
<td>$ 118,000</td>
<td>$ 133,000</td>
<td>$ 285,084</td>
<td></td>
</tr>
<tr>
<td>- maximum value</td>
<td>$ 120,000</td>
<td>$ 195,000</td>
<td>$ 3,205,254</td>
<td></td>
</tr>
<tr>
<td>Human Capital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- mean</td>
<td>$ 120,000</td>
<td>$ 120,000</td>
<td>$ 120,000</td>
<td></td>
</tr>
<tr>
<td>- minimum</td>
<td>$ 20,000</td>
<td>$ 20,000</td>
<td>$ 20,000</td>
<td></td>
</tr>
<tr>
<td>- maximum</td>
<td>$ 220,000</td>
<td>$ 220,000</td>
<td>$ 220,000</td>
<td></td>
</tr>
<tr>
<td>Income Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- marginal rate</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>- allowance</td>
<td>$ 6,000</td>
<td>$ 6,000</td>
<td>$ 6,000</td>
<td></td>
</tr>
<tr>
<td>Inheritance/Gift-Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- marginal rate</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>- allowance</td>
<td>$ 100,000</td>
<td>$ 100,000</td>
<td>$ 100,000</td>
<td></td>
</tr>
<tr>
<td>Wealth Tax</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>none</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.1: Values for variables used in model runs one through three.

It has to mentioned that the absolute value of growth rates on income does not provide reasonable information as the age structure of the sample in the years one and 101 is significantly different. At the end of the simulation the average age of a sample member is close to 60, whereas is has been about 25 at
the beginning of the simulation. This development was not pre-
planned, but arose due to two main factors:

1. The sample size (50) is too small to provide a sample
whose age structure does not change with time. The
process of artificially aging the sample was not
successful enough to prevent a cyclical development of
the average age of the sample.

2. Furthermore, the sample size also changed cyclically
during the simulation. This provides further evidence
that the situations at the end and the beginning of the
simulation are not directly comparable to each other.

As the percentage of sample member being retired is
remarkably high at the end of the simulation, the average labor
income dropped to a lower level.

This causes some skepticism regarding the results.

This does not mean, however, that the average income of
a, say, 50 year old man is different at the beginning and at the
end of the simulation. It means that the labor income of a 70
year old man is lower than this income of a 30 year old man. This
assumption seems reasonable since this model is in real terms.

4. Since the average wealth per household is significant-
ly higher at the end of the simulation and since labor income is
generally lower because of the retirement of the majority of the
sample members, a greater share of income is earned interest. But
this is already mentioned in the growth rate of wealth.
The results of the three alternatives are presented in Tables 4.2 through 4.4. Table 4.2 presents the Gini-Coefficients and their percentage change, whereas Tables 4.3 and 4.4 focus on the per capita amount of physical wealth and income respectively.

A graphical representation of the results in these Tables is provided in the subsequent Figures 4.1 and 4.2. These graphics emphasize these results especially.

<table>
<thead>
<tr>
<th>Year</th>
<th>Uniform Distrib.</th>
<th>Normal Distrib.</th>
<th>Lognormal Distr.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gini-C.</td>
<td>Av.% Ch.</td>
<td>Gini-C.</td>
</tr>
<tr>
<td>1</td>
<td>0.1491</td>
<td>-,-</td>
<td>0.1875</td>
</tr>
<tr>
<td>11</td>
<td>0.4090</td>
<td>+10.618</td>
<td>0.4559</td>
</tr>
<tr>
<td>21</td>
<td>0.4831</td>
<td>+9.983</td>
<td>0.5280</td>
</tr>
<tr>
<td>31</td>
<td>0.5744</td>
<td>+4.598</td>
<td>0.5353</td>
</tr>
<tr>
<td>41</td>
<td>0.6063</td>
<td>+3.569</td>
<td>0.6293</td>
</tr>
<tr>
<td>51</td>
<td>0.5949</td>
<td>+2.806</td>
<td>0.6548</td>
</tr>
<tr>
<td>61</td>
<td>0.6745</td>
<td>+2.547</td>
<td>0.6803</td>
</tr>
<tr>
<td>71</td>
<td>0.6708</td>
<td>+2.172</td>
<td>0.6748</td>
</tr>
<tr>
<td>81</td>
<td>0.7289</td>
<td>+2.003</td>
<td>0.6694</td>
</tr>
<tr>
<td>91</td>
<td>0.7336</td>
<td>+1.786</td>
<td>0.6660</td>
</tr>
<tr>
<td>101</td>
<td>0.7284</td>
<td>+1.599</td>
<td>0.6627</td>
</tr>
</tbody>
</table>

Table 4.2: Gini-Coefficients and their average percentage change with respect to the base year one for the uniform, the normal, and the lognormal distribution.

5. The other indicators of inequality are listed in the Appendix Two as they do not provide additional information.
<table>
<thead>
<tr>
<th>Year</th>
<th>Uniform Distrib.</th>
<th>Normal Distrib.</th>
<th>Lognormal Distrib.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P/C Wealth</td>
<td>Rate</td>
<td>P/C Wealth</td>
</tr>
<tr>
<td>1</td>
<td>98,537</td>
<td>.-.</td>
<td>103,233</td>
</tr>
<tr>
<td>11</td>
<td>162,394</td>
<td>5.1</td>
<td>174,144</td>
</tr>
<tr>
<td>21</td>
<td>231,992</td>
<td>4.4</td>
<td>254,768</td>
</tr>
<tr>
<td>31</td>
<td>321,139</td>
<td>4.0</td>
<td>333,128</td>
</tr>
<tr>
<td>41</td>
<td>380,183</td>
<td>3.4</td>
<td>442,966</td>
</tr>
<tr>
<td>51</td>
<td>530,176</td>
<td>3.4</td>
<td>658,141</td>
</tr>
<tr>
<td>61</td>
<td>656,593</td>
<td>3.2</td>
<td>867,308</td>
</tr>
<tr>
<td>71</td>
<td>795,966</td>
<td>3.0</td>
<td>1,189,153</td>
</tr>
<tr>
<td>81</td>
<td>1,079,279</td>
<td>3.0</td>
<td>1,392,973</td>
</tr>
<tr>
<td>91</td>
<td>1,387,060</td>
<td>2.5</td>
<td>1,406,545</td>
</tr>
<tr>
<td>101</td>
<td>1,530,175</td>
<td>2.8</td>
<td>1,618,614</td>
</tr>
</tbody>
</table>

Table 4.3: Average wealth per household in year n and its growth rate with respect to the base year one for uniform, normal, and lognormal distribution.

<table>
<thead>
<tr>
<th>Year</th>
<th>Uniform Distrib.</th>
<th>Normal Distrib.</th>
<th>Lognormal Distrib.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P/C Income</td>
<td>Rate</td>
<td>P/C Income</td>
</tr>
<tr>
<td>1</td>
<td>33,118</td>
<td>.-.</td>
<td>34,058</td>
</tr>
<tr>
<td>11</td>
<td>38,435</td>
<td>1.5</td>
<td>40,482</td>
</tr>
<tr>
<td>21</td>
<td>42,131</td>
<td>1.2</td>
<td>44,736</td>
</tr>
<tr>
<td>31</td>
<td>45,608</td>
<td>1.1</td>
<td>48,850</td>
</tr>
<tr>
<td>41</td>
<td>47,613</td>
<td>0.9</td>
<td>53,504</td>
</tr>
<tr>
<td>51</td>
<td>59,165</td>
<td>1.2</td>
<td>71,592</td>
</tr>
<tr>
<td>61</td>
<td>65,935</td>
<td>1.2</td>
<td>86,562</td>
</tr>
<tr>
<td>71</td>
<td>77,664</td>
<td>1.2</td>
<td>102,856</td>
</tr>
<tr>
<td>81</td>
<td>94,168</td>
<td>1.3</td>
<td>112,754</td>
</tr>
<tr>
<td>91</td>
<td>102,208</td>
<td>1.3</td>
<td>114,075</td>
</tr>
<tr>
<td>101</td>
<td>116,816</td>
<td>1.3</td>
<td>120,737</td>
</tr>
</tbody>
</table>

Table 4.4: Average income per household in year n and its growth rate with respect to the base year one for uniform, normal, and lognormal distribution.

Figure 4.1 represents the initial and the final distribution as expressed through the Lorenz-Curves. Each (1) in a curve
stands for the initial distribution (year one), whereas a (2) stands for final distribution in year 101. The solid line refers to the uniform, the dashed to the normal, and the dotted to the lognormal distribution.

Figures 4.2 and 4.3 present the development of the rates of growth for personal wealth and income, respectively. As already used in Figure 4.1 solid lines stand for uniform, dashed lines for normal, and dotted lines for lognormal distributions.

\[ Y = \text{Attributed Wealth in Cumulative \%} \]

\[ X = \text{Households in Cumulative \%} \]

**Figure 4.1:** The Lorenz-Curves of the initial and the final distributions in the simulation runs for uniform, normal, and lognormal distribution.
Figure 4.2: Average growth rates of wealth plotted for uniform, normal, and lognormal distribution.

Figure 4.3: Average growth rates of income plotted for uniform, normal, and lognormal distribution.

A close look at the results and the graphics presented above provides some puzzling results. These results are condensed in the following statements.

1. Regardless of the initial value of the Gini-Coefficient upon completion of the whole simulation this coefficient was located at a value near 0.7.
2. Once this "final" value is reached, there are still some cyclical disturbances around it due to changes in the age structure of the sample.

3. Neither the growth rate of wealth nor the growth rate of income provides evidence for the hypothesis that economic activity as measured by these rates tends to increase with the overall inequality of the initial distribution.

The runs of the initial model back the major findings of empirical studies like the hypothesis of Boulding concerning the 6 long-run stability of inequality.

Furthermore, it emphasizes the fact that a set of internal characteristics of the system such as the distribution of skills and education, determines this long-run value and an arbitrary initial size distribution of wealth does not.

Since the results presented above provide evidence for identical developments, it is possible to limit further hypothesis testing to one initial wealth distribution.

The lognormal distribution was chosen for use in further tests because of the following reasons:

-------------------

6. See Kenneth E. Boulding, op.cit., p. 3.

1. It is closest to the real life situation and thus, prediction can be expected also to be closest to real life.

2. A possible reduction of the coefficient of inequality is easier to determine when the initial value is high. The possible changes in this indicator can then be expected to be more obvious.

4.1.2 The Effectiveness of Fiscal Policy for Redistribution Purposes

Further tests use the information presented above to test the following three fiscal policy measures for their redistributive power.

1. Public expenditures that fill in the gap between the level of education appropriate with regard to innate abilities and the effective expenses of the parents.

2. A system of income taxes and inheritance taxes that are progressive in the original sense.

3. A general wealth tax to be levied not on the return on wealth, but on the stock itself.

The methods were chosen in a way that they are independent of each other and were sorted in an order of increased redistributive power, but also of increasing difficulty of putting into effect.
Thus, everybody can choose his own combination of effectiveness and probability of realizing its implementation.

4.1.2.1 Criteria Used for the Comparison of Variants

As mentioned earlier, the main point of interest is in the development of inequality. Growth rates of both wealth and income were included, since there has to be a criterion for ranking situations, if inequality fails to provide sufficient ranking criteria.

Growth rates are used only to break tie situations. The hypothesis chosen is then the one which provides the highest growth rates.

4.1.2.2 The Tools

Altogether two types of fiscal policy measures will be used in the hypotheses to be tested, public expenditures and taxes.

In this paper there will be no arguing whether or not a government is allowed to levy taxes and, if so, to what extent. All means were chosen only from the point of view of redistributive capacity.
The regions of "allowed" redistribution as defined in Chapter Two were the guideline used when choosing the tools, not a reasoning about the appropriateness of the fiscal policy measures themselves.

4.1.3 The Hypotheses

Altogether five hypotheses will be tested within identical frameworks. Three of them are directly connected to a simulation run and another two refer to differences between these three runs.

Hypothesis 1: The inequality of the size distribution of wealth will be reduced if a system of public education is introduced which provides educational funds with regard to innate skills.

Hypothesis 2: Public education combined with truly progressive income and inheritance/gift-taxes will reduce the inequality of the size distribution of wealth.

Hypothesis 3: Public education and progressive income and inheritance/gift-taxes combined with a general wealth tax will reduce the inequality of the distribution of wealth.

It is assumed that the influence of a fiscal policy measure added to already existing measures is independent of
these measures. Therefore, the difference between the inequality of the size distribution of wealth in two subsequent simulation runs can be attributed to the policy measure added.

This leads to the following two hypotheses:

Hypothesis 4: The difference on inequality of the size distribution of wealth between hypotheses two and one, assumed to be caused by the change of tax structures, is greater than the difference between hypothesis one and the control simulation. This hypothesis expresses the idea that the income and inheritance-taxes are a more effective means of redistribution than the education program.

Hypothesis 5: The difference of inequality between hypotheses three and two is greater than the difference between hypotheses two and one. A general wealth tax is supposed to have the highest redistributive power of all.

4.1.3.1 A System of Public Education Expenditures

One thing has to be made clear. The system does not provide a fixed, given amount of education to everyone. It is still the parents' duty to pay for the education of their children.
In the case in which the parents cannot or do not want to provide sufficient education and in which the child has sufficient innate skills, this education program starts.

The following simplifying assumptions are made to keep the system going:

1. The government can determine the amount of education that a certain person's skill level warrants.

2. The amount of educational funds provided by the parents does not change because of the existence of such a program. This neglect of a "free rider position" is to some degree rigid, but it can be justified, since the amount not spent for education is partly taxed away. Nevertheless it has to be admitted that this assumption is not without problems.

The procedure itself has the following form. At the moment the human capital of a person or household is determined, the accumulated human capital is compared with the hypothetical value demanded by the skills possessed. The following table presents the most important combinations of skills and educational expenses.
There is a proportional relation between the variables in columns one and two of Table 4.5. Column three is calculated while multiplying column two times two and adding $10,000.

<table>
<thead>
<tr>
<th>Skills</th>
<th>Educ. Expenses</th>
<th>Human Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2,500</td>
<td>15,000</td>
</tr>
<tr>
<td>500</td>
<td>12,500</td>
<td>35,000</td>
</tr>
<tr>
<td>750</td>
<td>18,750</td>
<td>47,500</td>
</tr>
<tr>
<td>1000</td>
<td>25,000</td>
<td>60,000</td>
</tr>
<tr>
<td>1250</td>
<td>31,250</td>
<td>72,500</td>
</tr>
<tr>
<td>1500</td>
<td>37,500</td>
<td>85,000</td>
</tr>
<tr>
<td>1900</td>
<td>47,500</td>
<td>105,000</td>
</tr>
</tbody>
</table>

Table 4.5: Amounts of educational funds and human capital guaranteed by the public expenditure hypothesis.

It should be mentioned that the rule of adding the human capital of the spouses in a household is still valid. In this simulation parents are free to exceed the appropriate educational fund amount without being penalized.

8. A value of 1000 in column one represents average skills. The corresponding value of education is the mean of the planned ceiling for the accumulation of human capital which is $25,000. Column one is divided by 10 and multiplied by 25,000 in order to obtain column two. The procedure used to obtain column three is explained in Chapter Two.
4.1.3.2 Progressive Income and Inheritance/Gift Taxes

As a second hypothesis it shall be tested to what degree a truly progressive income and inheritance/gift tax reduces the inequality of the size distribution of wealth if combined with the education program.

As was mentioned above, there is evidence that the income tax can be regarded to be proportional, although the legal character is progressive. In the case of inheritance and gift taxes the progressive character is similarly wiped out.

The tax rates chosen for the income tax is presented in Table 4.6 together with the rates applied in the control simulation. There are mainly three regions with different marginal tax rates which are, however, constant within such a block. The progressive character is documented by the values of the average tax rate.

The tax formula used for hypothesis two has the form:

\[ T = (I-6,000) \times 0.15 + (I-18,000) \times 0.15 + (I-54,000) \times 0.15 \]

In the control simulation income (I) determines the tax (T) in:

\[ T = (I-6,000) \times 0.15 \]

Figure 4.4 shows the curves of both tax rates.

---

<table>
<thead>
<tr>
<th>Income</th>
<th>Hypothesis 2</th>
<th>Control Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marg.%</td>
<td>Tax Amount</td>
</tr>
<tr>
<td>5,000</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>6,000</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>10,000</td>
<td>15.0</td>
<td>600</td>
</tr>
<tr>
<td>15,000</td>
<td>15.0</td>
<td>1,350</td>
</tr>
<tr>
<td>18,000</td>
<td>15.0</td>
<td>1,800</td>
</tr>
<tr>
<td>20,000</td>
<td>30.0</td>
<td>2,400</td>
</tr>
<tr>
<td>25,000</td>
<td>30.0</td>
<td>3,900</td>
</tr>
<tr>
<td>30,000</td>
<td>30.0</td>
<td>5,400</td>
</tr>
<tr>
<td>40,000</td>
<td>30.0</td>
<td>8,400</td>
</tr>
<tr>
<td>50,000</td>
<td>30.0</td>
<td>11,400</td>
</tr>
<tr>
<td>54,000</td>
<td>30.0</td>
<td>12,600</td>
</tr>
<tr>
<td>60,000</td>
<td>45.0</td>
<td>15,300</td>
</tr>
<tr>
<td>80,000</td>
<td>45.0</td>
<td>24,300</td>
</tr>
<tr>
<td>100,000</td>
<td>45.0</td>
<td>33,000</td>
</tr>
<tr>
<td>120,000</td>
<td>45.0</td>
<td>42,300</td>
</tr>
<tr>
<td>150,000</td>
<td>45.0</td>
<td>55,800</td>
</tr>
<tr>
<td>200,000</td>
<td>45.0</td>
<td>78,300</td>
</tr>
</tbody>
</table>

Table 4.6: Income tax rates used in hypothesis two together with the values used in the control simulation.

Figure 4.4: Curves of marginal and average income tax rates used in hypothesis two.
Table 4.7 and Figure 4.5 present in a similar way tax rates for the inheritance/gift tax to be levied simultaneously.

The underlying formula for the inheritance/gift-tax is:

\[ T = (B-100,000) \times 0.05 + (B-300,000) \times 0.05 + (B-900,000) \times 0.10 + \\
+ (B-2,700,000) \times 0.20 + (B-8,100,000) \times 0.40 \]

In the control simulation bequests (B) determine tax (T) in the following way:

\[ T = (B-100,000) \times 0.05 \]

<table>
<thead>
<tr>
<th>Bequest</th>
<th>Hypothesis 2</th>
<th>Control Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marg.%</td>
<td>Tax Amount</td>
</tr>
<tr>
<td>100,000</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>150,000</td>
<td>5.0</td>
<td>2,500</td>
</tr>
<tr>
<td>200,000</td>
<td>5.0</td>
<td>5,000</td>
</tr>
<tr>
<td>300,000</td>
<td>5.0</td>
<td>10,000</td>
</tr>
<tr>
<td>500,000</td>
<td>10.0</td>
<td>30,000</td>
</tr>
<tr>
<td>750,000</td>
<td>10.0</td>
<td>55,000</td>
</tr>
<tr>
<td>900,000</td>
<td>10.0</td>
<td>70,000</td>
</tr>
<tr>
<td>1,250,000</td>
<td>20.0</td>
<td>90,000</td>
</tr>
<tr>
<td>1,500,000</td>
<td>20.0</td>
<td>140,000</td>
</tr>
<tr>
<td>1,800,000</td>
<td>20.0</td>
<td>190,000</td>
</tr>
<tr>
<td>2,000,000</td>
<td>20.0</td>
<td>290,000</td>
</tr>
<tr>
<td>2,500,000</td>
<td>20.0</td>
<td>390,000</td>
</tr>
<tr>
<td>3,000,000</td>
<td>40.0</td>
<td>530,000</td>
</tr>
<tr>
<td>5,000,000</td>
<td>40.0</td>
<td>1,350,000</td>
</tr>
<tr>
<td>10,000,000</td>
<td>80.0</td>
<td>4,110,000</td>
</tr>
<tr>
<td>15,000,000</td>
<td>80.0</td>
<td>8,110,000</td>
</tr>
</tbody>
</table>

Table 4.7: Inheritance tax rates used in hypothesis two together with the values used in the control simulation.
Figure 4.5: Curves of marginal and average inheritance tax rates used in hypothesis two.

4.1.3.3 General Wealth Tax

The general wealth tax in the form to be tested in the third hypothesis has nothing in common with the forms of taxes classified as "wealth taxes" in the U.S. tax law. These estate and property taxes are special wealth taxes, whereas the focus in this study lies on the generality of the tax. That means identical tax rates will be applied on various forms of wealth. An oil painting of Rembrandt satisfies this criterion as well as a savings account, shares, or whatever.

This indicates that many problems will show up whenever such a tax is institutionalized in a country. Such a tax does not exist in the United States. There is very limited discussion
about a wealth tax as a fiscal policy measure. Tait discussed its capacity as a means of replacing income tax and found out that it is inferior to the income tax for several reasons.

Mortimer Lipsky discussed the wealth tax with respect to redistribution but he waived a chance of seriously dealing with the subject, as his emotional way of discussion and unscientific style will not appeal to economists. He mixed the discussion of wealth tax with the warning that revolution will be unavoidable if this last not so drastic means of redistribution is not used to take away money from the rich.

There seems to be some justification for further dealing with this specific tax, as there are some countries in Europe that have a general wealth tax like Germany, the Netherlands, Sweden, and Switzerland.

For the circumstances of this simulation it may be assumed that difficulties in defining the taxable base do not arise. If they arose, however, all the other simulation runs would suffer the same way, since the variable "wealth" which causes these definition problems is used in every run.

The difference between the wealth tax designed for this simulation and all existing forms is that in all existing forms

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11. See Mortimer Lipsky, op.cit., p. 207

the tax rate never exceeds a plausible percentage for the rate of return. From the point of redistribution, however, such a tax does make sense only if there are changes in the taxable base in which net wealth after accumulation of returns and wealth tax paid is lower than before.

The difference of this type of tax from the existing forms of special wealth taxes in the United States can also be described with respect to the redistributive character.

There are some studies that provide evidence that for example the estate tax does not redistribute. Feldstein, for instance, blames among others the deductions from the taxable base that are provided for charitable bequests, stating that charitable bequests are quite sensitive to the deductability of these charitable bequests. His analysis shows that the value of a charitable bequest expressed in terms of circumvented estate taxes exceeds the original market price in numerous cases. 13

Stiglitz argues that these taxes do not redistribute because of non-economic reasons. He identifies the political power resulting from wealth as the main reason for the failure of redistribution.


The technical design and the curves for marginal and average tax rates are presented below in Table 4.8 and Figure 4.6. For reasons of completeness the tax amount is also expressed as a fraction of the earned interest for representative rates of return.

The formula used to calculate the wealth tax (T) is:

\[
T = (W-50,000) \times 0.005 + (W-150,000) \times 0.005 + (W-450,000) \times 0.01 + \\
+ (W-1,350,000) \times 0.02 + (W-4,050,000) \times 0.04
\]

<table>
<thead>
<tr>
<th>Wealth</th>
<th>Marg. Tax Rate</th>
<th>Tax Amount</th>
<th>Tax as a Percentage of Wealth Interest suppose rate is 4.6%</th>
<th>7.6%</th>
<th>12.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>0.5</td>
<td>250</td>
<td>0.25</td>
<td>5.4</td>
<td>3.3</td>
</tr>
<tr>
<td>200,000</td>
<td>1.0</td>
<td>1,250</td>
<td>0.62</td>
<td>13.5</td>
<td>8.2</td>
</tr>
<tr>
<td>300,000</td>
<td>1.0</td>
<td>2,250</td>
<td>0.75</td>
<td>16.3</td>
<td>9.9</td>
</tr>
<tr>
<td>500,000</td>
<td>2.0</td>
<td>4,750</td>
<td>0.95</td>
<td>20.6</td>
<td>12.5</td>
</tr>
<tr>
<td>750,000</td>
<td>2.0</td>
<td>9,750</td>
<td>1.3</td>
<td>28.3</td>
<td>75.2</td>
</tr>
<tr>
<td>1,000,000</td>
<td>2.0</td>
<td>14,750</td>
<td>1.475</td>
<td>32.1</td>
<td>19.5</td>
</tr>
<tr>
<td>1,500,000</td>
<td>4.0</td>
<td>27,750</td>
<td>1.85</td>
<td>40.2</td>
<td>24.4</td>
</tr>
<tr>
<td>2,000,000</td>
<td>4.0</td>
<td>47,750</td>
<td>2.39</td>
<td>51.9</td>
<td>31.55</td>
</tr>
<tr>
<td>5,000,000</td>
<td>8.0</td>
<td>205,750</td>
<td>4.11</td>
<td>89.3</td>
<td>54.26</td>
</tr>
<tr>
<td>10,000,000</td>
<td>8.0</td>
<td>605,750</td>
<td>6.05</td>
<td>131.5</td>
<td>79.88</td>
</tr>
<tr>
<td>15,000,000</td>
<td>8.0</td>
<td>1,005,750</td>
<td>6.7</td>
<td>145.6</td>
<td>88.45</td>
</tr>
</tbody>
</table>

Table 4.8: Average and marginal tax rates of the general wealth tax to be tested in hypothesis three.

Table 4.8 shows that for certain amounts of wealth over $7,000,000 and relatively low interest rates (lower than 4.6 percent) the amount of taxes due can exceed the earned interest.
Figure 4.6: Curves of average and marginal tax rates of the general wealth tax.

Some final technical remarks for the calculation of the wealth tax amount may be added. The wealth tax base is the adjusted physical wealth of a household at the end of a simulation year. It is calculated in the following way:

\[
\text{net wealth year } [n-1] \text{ after taxes} \\
- \text{expenditures for the education} \\
- \text{possible losses of wealth} \\
+ \text{savings} \\
- \text{dissavings} \\
\]

\[
= \text{taxable base of wealth tax} \\
- \text{wealth tax} \\
\]

\[
= \text{net wealth in year } [n]
\]

This procedure of calculating the taxable base includes the widespread form of "making the fisc participate in losses."
4.2 The Simulation -- Some Technical Remarks

The simulation itself was carried out as a GPSS V-program. GPSS V stands for General Purpose Simulation System. Many people may argue that there are numerous computer languages that are more appropriate for this problem than GPSS. But it is always to some degree a personal decision which software to use.

GPSS has the advantage of being a language for discrete simulation; on the other side it bears the disadvantage of not providing the tools specifically needed for this purpose. It would, of course, be possible to develop a system of special subroutines in any higher programming language like APL, FORTRAN or PASCAL. Because of time constraints the author accepted the disadvantages of GPSS because he thinks that they are compensated for as GPSSV is a tested product and user software is not.

All the runs including preliminary ones have been done with the GPSS V-OS Version (IBM Product 5734-XS2) on the NATIONAL ADVANCED SYSTEMS NAS /6130 under OS/MVT release 21.8A and HASP RJE under VM/SP release 1.

The total program used is printed in Appendix One. This program, however, has not been used in this form because this version using CLEAR and RESET-statements and reinitialized variables produces all six hypotheses in one single run.
The author used six single runs in its place. Every run used some two minutes and 30 seconds CPU (central processor unit)-time equivalent to about 500 k-byte seconds. The version documented will, therefore, need about 15 minutes CPU-time and will produce about 510 pages printed output.

The unnecessary printout of source file and assembled program in each run was suppressed using an UNLIST and a NOXREF-statement. This procedure reduced the effective printout to the table of block counts, the distribution tables, the savevalues, and the matrices.

Although the program on the source file as presented in Appendix One is extensively documented, a rough description of the flow will be presented below.

4.2.1 An Outline of the Simulation Program

All the numbers provided in the following description refer to the statement numbers as they are in Appendix One.

Matrix 1 contains all information concerning the sample members. It uses one line per household and in the 15 elements of this row all necessary information is stored. Statements 7

-------------------

through 23 provide further information. Male children and teenagers are also kept in this matrix as non-sample members, whereas their female counterparts are stored in matrix 2. Matrix 3 contains the system of intergenerational cross-reference used for inheritance purpose. A pointer system with a down pointer (next element) and an up pointer (previous element) is used for available space (unused rows in the matrix) and the ranking of the unmarried women with respect to wealth class and age in matrix 2. Matrix 4 contains the first and last lines of these pointers. Matrix 5 is used to store the annual aggregate values of income, consumption, taxes, wealth, and losses.

These matrices are generated and the pointers are installed in statements 262 through 270, subsequently referred to as #262-270.

The original sample is created and written into the rows of matrix 1, one sample member on each row. The procedure is repeated until the total sample size is created (#274-290). The simulation goes through all sample members sequentially, before the next simulation year starts.

A main loop keeps track of all actions that have to be done to each member and each non-member of the sample. This loop contains test statements that determine whether or not a procedure has to be applied to a household. If this procedure is applicable, the main loop will call the respective subroutine, if not it skips to the next test statement. This loop is repeated until the last line in use of both matrices 1 and 2 are reached.
The personal updatings like marriage, birth, and education precede the financial updating because it may cause changes in accounts that have to be taken into consideration by the financial updating. This loop is done in statements 297 through 337.

The next year is then chosen as long as the total simulation is not yet completed (# 341-342).

The other parts of the program are a hierarchical system of subroutines created in a way that avoids double occurrences of statements whenever possible. The first subroutine does all the financial updating with determination of income, taxes, consumption, savings, losses, and wealth balances (# 346-406).

The subroutine EDUCATION has to be broken down into education of males and females, as the corresponding variables are stored in different columns of matrix 1 and 2. There is a male education subroutine and a female education subroutine, both calling a subroutine in which operations were done that are identical to both (# 410-435).

Similarly, institutionalizing a single-person household, separated for male and female for reasons of data organization, calls part of the MARRIAGE subroutine that is used for marrying couples also (# 439-462).

Marriage itself consists of two main parts, finding the partner (# 467-488) and updating various data due to that marriage (# 491-559). Subroutines called by this MARRIAGE procedure
are the "birth of children" KIDS (# 563-611) and the "no-children" case NOKIDS (# 615-634). The second is necessary because of keeping cross-reference for the second degree heirs. The last subroutine DIE deals with death and bequeathing (# 638-690).

4.2.2 Characteristics of the Model

In this simulation program two main programming techniques are used for enabling the reader to "read" the program as easily as the general structure of GPSS allows.

- **named variables** instead of numbered variables. For all the savevalues that are designed to contain the parameters of the hypotheses named variables are chosen.
- **named locations** were chosen whenever possible.

In addition to that the program is documented extensively. Documentation is placed either in valid GPSS-statements starting from column 46 or in comment lines that are identified by an asterisk in column 1.

The CLEAR and START statements that go along with the various runs emphasize how the model variants for the different hypotheses have been defined while only redefining variables. If paragraphs or lines of the program are not used in a specific hypothesis, a flag variable is initialized to zero thus inducing a test statement to skip the corresponding lines, whereas in other versions the flag is set to one to have the lines executed.
This program is general enough to be used for further research, and nearly all the changes necessary to test further hypotheses would be located in the initialization part (#692-739).

4.3 The Results

In this section there will be a representation of the results, which will be shown in two parts.

The first group of data refers to the inequality and its change, whereas in a second group all the secondary indicators for ranking hypotheses will be documented. After that, the author provides some personal opinion in interpreting the results.

4.3.1 The Hypotheses and the Development of Inequality

In the following tables and graphics the development of the measures of inequality will be presented in absolute terms. For the relative point of view the change of the variables in different variants with respect to the control simulation will also be presented.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>Hypothes.1</th>
<th>Hypothes.2</th>
<th>Hypothes.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 1:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini</td>
<td>0.46313</td>
<td>0.44919</td>
<td>0.45856</td>
<td>0.45513</td>
</tr>
<tr>
<td>Median/Median</td>
<td>1.517</td>
<td>1.508</td>
<td>1.484</td>
<td>1.480</td>
</tr>
<tr>
<td>CRV</td>
<td>105.466</td>
<td>103.429</td>
<td>104.147</td>
<td>100.775</td>
</tr>
<tr>
<td><strong>Year 51:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini</td>
<td>0.64615</td>
<td>0.60180</td>
<td>0.49648</td>
<td>0.44071</td>
</tr>
<tr>
<td>Median/Median</td>
<td>2.687</td>
<td>2.441</td>
<td>1.426</td>
<td>1.267</td>
</tr>
<tr>
<td>CRV</td>
<td>151.592</td>
<td>130.639</td>
<td>97.093</td>
<td>82.860</td>
</tr>
<tr>
<td><strong>Year 101:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini</td>
<td>0.74969</td>
<td>0.72407</td>
<td>0.55876</td>
<td>0.47129</td>
</tr>
<tr>
<td>Median/Median</td>
<td>6.908</td>
<td>5.301</td>
<td>1.900</td>
<td>1.253</td>
</tr>
<tr>
<td>CRV</td>
<td>231.244</td>
<td>239.857</td>
<td>114.360</td>
<td>91.128</td>
</tr>
</tbody>
</table>

Table 4.9: Gini-Coefficients, the mean/median relation, and the coefficient of relative variation (CRV) for hypotheses one through three and the control simulation.

Some table variables need explanation:

The **mean/median relation** is the table mean expressed as a fraction of the median. This fraction is not standardized, but nevertheless, the following statements can be made.

- The closer the fraction to one, the more symmetric is the distribution.
- Values greater than one indicate a positively skewed distribution, where the majority of elements is to the left of the mean.
- A negatively skewed distribution with the majority to the elements to the right of the mean in identified by values smaller than one.
The coefficient of relative variation is the standard deviation of the table expressed as a percentage of the table mean. The smaller this coefficient the smaller the variation. "Remarkable" variations are normally those with values higher than 100 percent.

A comparison of these indicators with the Gini-Coefficient shows that not all indicators bring up the same result. The development from year one to year 51 in hypothesis two is characterized by increased inequality looking at the Gini-Coefficient, whereas mean/median relation and coefficient of relative variation indicate that the second distribution is less skewed and has less variation. These results do not match.

Some explanation may be provided:
GPSS allows tables with a uniform class width only. This class width and the number of classes have to be supported a priori. This leads sometimes to lumps in the table. Situations in which 35 percent of the elements are located in one class (out of 50) the table does no longer support reliable evaluation of the Gini-Coefficient.

As GPSS itself provides the values of both mean and standard deviation and as the modal value can easily be determined, one should rely on these indicators more than on the Gini-Coefficient in cases of doubt. A further source of divergence between Gini-Coefficient and both mean/modal and CRV originates in the adjustment process of the tables as explained in detail in Appendix Three.
The Gini-Coefficient, however, cannot be blamed for this result, as it is the arrangement of data provided by the system that causes the problem.

The first remarkable result out of Table 4.9 is that no hypothesis was able to reduce the overall inequality. The most redistributive version three provided only means for keeping the size distribution of wealth more or less constant.

It can be argued that this result is caused by system characteristics that are too rigid. The impact of inappropriate assumptions can be ruled out by focusing on the average change of inequality measures between years one and 51 or one and 101 rather than looking at the Gini-Coefficients at these years themselves. Then the wrong assumptions no longer play a role. This kind of information is provided in Table 4.10. In this table both absolute and relative changes are presented.

With all hypotheses tested there is a redistributive effect towards reducing inequality of the size distribution of wealth as was a priori assumed.

Concentrating on the differences between the simulation runs the result is that whatever measure of inequality is used, the biggest redistributitional effect seems to be with the progressive income and inheritance tax. In second place is the wealth tax, whereas the education program does not seem to have significant influence.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Hypoth. 1</th>
<th>Hypoth. 2</th>
<th>Hypoth. 3</th>
<th>Hypoth. 4</th>
<th>Hypoth. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>year 51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini</td>
<td>-0.044</td>
<td>-0.149</td>
<td>-0.205</td>
<td>-0.105</td>
<td>-0.055</td>
</tr>
<tr>
<td></td>
<td>-6.9%</td>
<td>-23.2%</td>
<td>-31.8%</td>
<td>-16.3%</td>
<td>-8.6%</td>
</tr>
<tr>
<td>m/m</td>
<td>-0.245</td>
<td>-1.261</td>
<td>-1.420</td>
<td>-1.016</td>
<td>-0.159</td>
</tr>
<tr>
<td></td>
<td>-9.1%</td>
<td>-46.9%</td>
<td>-52.8%</td>
<td>-37.8%</td>
<td>-5.9%</td>
</tr>
<tr>
<td>CRV</td>
<td>-20.953</td>
<td>-54.499</td>
<td>-68.732</td>
<td>-33.546</td>
<td>-47.779</td>
</tr>
<tr>
<td></td>
<td>-13.8%</td>
<td>-35.9%</td>
<td>-45.3%</td>
<td>-22.1%</td>
<td>-31.5%</td>
</tr>
<tr>
<td></td>
<td>year 101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gini</td>
<td>-0.025</td>
<td>-0.191</td>
<td>-0.278</td>
<td>-0.165</td>
<td>-0.087</td>
</tr>
<tr>
<td></td>
<td>-3.4%</td>
<td>-25.5%</td>
<td>-37.1%</td>
<td>-22.0%</td>
<td>-11.7%</td>
</tr>
<tr>
<td>m/m</td>
<td>-1.607</td>
<td>-5.008</td>
<td>5.655</td>
<td>-3.401</td>
<td>-0.647</td>
</tr>
<tr>
<td></td>
<td>-23.3%</td>
<td>-72.5%</td>
<td>-81.9%</td>
<td>-49.2%</td>
<td>-9.4%</td>
</tr>
<tr>
<td>CRV</td>
<td>8.613</td>
<td>-116.884</td>
<td>-140.116</td>
<td>-125.497</td>
<td>-23.232</td>
</tr>
<tr>
<td></td>
<td>+3.7%</td>
<td>-50.5%</td>
<td>-60.6%</td>
<td>-54.3%</td>
<td>-10.0%</td>
</tr>
</tbody>
</table>

Table 4.10: Changes in the measures of inequality with respect to year one.

Breaking down the over-all development into changes in skewness and variation there is some evidence for increased variation due to the education program.

The joint effect of income and inheritance taxes on both skewness and variation is remarkable. The effect on variation is slightly stronger. Wealth tax reduces variation and kurtosis in the same degree.

The following figures contain the Lorenz-Curves of the inequality at the beginning of the simulation and after each tested hypothesis.
Figure 4.7: Lorenz-Curves for the hypotheses tested

The graphics used are:

- a solid line indicates the initial distribution which is the same for all hypotheses;
- long dashes --- stand for hypothesis one;
- short dashes ---- stand for hypothesis two, and
- dots ...... stand for hypothesis three.
4.3.2 The Development of the Economic Growth

Further information may be obtained from looking at the development of the growth rates of income and wealth.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hypoth.1</th>
<th>Hypoth.2</th>
<th>Hypoth.3</th>
<th>Hypoth.4</th>
<th>Hypoth.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51 vs 1</td>
<td>+1.58%</td>
<td>+0.33%</td>
<td>+0.17%</td>
<td>-1.25%</td>
<td>-0.16%</td>
</tr>
<tr>
<td>101 vs 1</td>
<td>+1.64%</td>
<td>+0.35%</td>
<td>+0.08%</td>
<td>-1.29%</td>
<td>-0.27%</td>
</tr>
<tr>
<td>wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51 vs 1</td>
<td>+3.65%</td>
<td>+1.74%</td>
<td>+1.39%</td>
<td>-1.91%</td>
<td>-0.35%</td>
</tr>
<tr>
<td>101 vs 1</td>
<td>+2.98%</td>
<td>+1.44%</td>
<td>+0.90%</td>
<td>-1.54%</td>
<td>-0.54%</td>
</tr>
</tbody>
</table>

Table 4.11: Average growth rates of income and wealth for the first 50 and 100 years.

The abbreviation "51 vs 1" refers to the average yearly rate of growth in the years one and 51, whereas "101 vs 1" stands for the years one and 101, respectively.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Hypoth.1</th>
<th>Hypoth.2</th>
<th>Hypoth.3</th>
<th>Hypoth.4</th>
<th>Hypoth.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51 vs 1</td>
<td>+0.28%</td>
<td>-0.97%</td>
<td>-1.13%</td>
<td>-1.25%</td>
<td>-0.16%</td>
</tr>
<tr>
<td>101 vs 1</td>
<td>+0.64%</td>
<td>-0.65%</td>
<td>-0.92%</td>
<td>-1.29%</td>
<td>-0.27%</td>
</tr>
<tr>
<td>wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51 vs 1</td>
<td>+0.43%</td>
<td>-1.46%</td>
<td>-1.81%</td>
<td>-1.89%</td>
<td>-0.35%</td>
</tr>
<tr>
<td>101 vs 1</td>
<td>+0.73%</td>
<td>-0.76%</td>
<td>-1.30%</td>
<td>-1.91%</td>
<td>-0.54%</td>
</tr>
</tbody>
</table>

Table 4.12: Average growth rates of income and wealth as compared to the control simulation.

The educational program increased the rate of growth of both personal wealth and income to close to 0.7% in the long run, while all forms of taxes obviously reduced the average amount of wealth and income kept by households. Remarkable in this context seems that contrary to hypothesis five the highest reduction effect is caused by the income/inheritance tax and not by the wealth tax.

4.4 Some Interpretation and Comment

Looking back to the results that came out of the simulation it has to be admitted that despite all a priori reasoning there were still some astonishing things left.
The following statements may epitomize the main points:

1. The results provided by the general model correspond with the major empirical findings in this field. This is, of course, no proof for the appropriateness of the assumptions which the model is based on, but it can be stated that there is evidence for a valid modeling procedure.

2. The main criteria determining the long run inequality of an economy are the human capital stock and the human behavior within the society as far as it is relevant for economic decisions. Whenever these variables are fixed and are not subject to change, the distribution of physical capital seems to tend to a steady state value.

3. Public education in the form used in the model increases the average amount of physical capital of a household. A countereffect, however, increases also the variation of the distribution. It is hard to say whether or not such a situation is preferable from the point of view of redistribution.

4. The highest redistributive power is in a really progressive income and inheritance/gift tax. The change in inequality is significantly greater with these taxes than with the general wealth tax. This is even more remarkable, as the wealth tax rates were extremely high.

The outcome of point four is that a real progressive income and inheritance tax has a higher redistributive efficiency than a general wealth tax. If it is taken into account that the
difficulties with institutionalizing a new tax are greater than with changing the structure of a given one, the idea of not introducing a wealth tax can be justified.

If it is, however, no longer assumed that the policy measures are independent of each other, this last statement has to be revised. It could then be argued that the big redistributational effect is already performed by the income and inheritance/gift-tax and nothing is left for the wealth tax. This discussion can easily be ended by having a further simulation run with the policy measures performing in reversed order.

4.5 Conclusion

It has been mentioned more than once throughout this paper that the simulation deals with a fictitious economy. This final section tries to give an answer to the question whether a real economy could be simulated and, if yes, which changes would have to be made in the model.

The problem of defining wealth was already mentioned. Although it has nothing to do with the step from fictitious to real economy, it will probably cause the most problems.

Further changes in the model would have to be made to allow for changes in the behavior of the households that are caused by changes in the fiscal policy. This is really a field of research where the qualities of micro-simulation can be shown.
APPENDICES
Appendix One:

Source File of the Simulation Program

On the subsequent pages the source file of the simulation program is listed. It is a GPSS-V program and the cross-reference tables are included. The listing of the assembled program is not part of this Appendix One.
* MATRIX MX3 (LINES, 8) IS CROSS-REFERENCE MATRIX
  * CC  CONTENT
  * 1 BEQUESTOR'S LINE
  * 2 NUMBER OF HEIRS
  * 3-8 HEIRS' LINES
  * MATRIX MX4 (4,6) IS POINTER MATRIX
  * CC  CONTENT
  * 1;1 AVAIL. SPACE MATRIX 1
  * 1;2 " 2
  * 1;3 " 3
  * 3;1 FIRST ELEMENT OF WEALTH CLASS 1
  * 3;N FIRST ELEMENT OF WEALTH CLASS N
  * 4;1 LAST ELEMENT OF WEALTH CLASS 1
  * 4;1 LAST ELEMENT OF WEALTH CLASS N
  * MATRIX MX5 (7, RUNTIME) STORAGE MATRIX FOR ANNUAL VALUES
  * 1 WEALTH (BALANCED)
  * 2 LABOR INCOME
  * 3 INTEREST INCOME
  * 4 TAXES PAID
  * 5 CONSUMPTION
  * 6 LOSSES
  * 7 SAMPLE SIZE
  * SAVEVALUES
  * FULLWORD 1 LENGTH OF MATRIX 1
  * 2 LENGTH OF MATRIX 2
  * 3 LENGTH OF MATRIX 3
  * 4 STANDARD DEVIATION OF WEALTH DISTRIBUTION
  * 5 MEAN OF WEALTH DISTRIBUTION
  * 6 MEAN OF HUMAN CAPITAL
  * 7 STANDARD DEVIATION OF SKILL DISTRIBUTION
  * 8 MEAN OF SKILL DISTRIBUTION
  * 9 TAX-ALLOWANCE INHERITANCE TAX
  * 10 TAX-ALLOWANCE INCOME TAX
11-17 STORAGE VARIABLES FOR INCOME DATA

18 TAX-ALLOWANCE WEALTH TAX

HALFWORD

MAGE MAXIMUM AGE IN PRE-SIMULATION

SIZE LAST LINE IN USE IN MATRIX 1

SZ1 LAST LINE IN USE IN MATRIX 2

RUN SIMULATION RUN TIME IN YEARS

MIN MINIMUM LABOR INCOME

BYTESIZE

VERS VERSION CODE FOR INITIAL DISTRIBUTION

CLASS WEALTH CLASSES IN USE

WAT WEALTH TAX FLAG (1: WEALTH TAX LEVIED-- 0:NOT)

PRO PROGRESSIVE TAX RATES FLAG (1: YES-- 0: NO)

EDPUB PUBLIC EDUCATION FLAG (1: YES-- 0: NO)

FLOATING

INT INTEREST RATE WEALTH (MAXIMUM RISK)

ZIN INTEREST RATE HUMAN CAPITAL (AVERAGE)

TAX MINIMUM MARGINAL RATE INCOME TAX

TAM MAXIMUM MARGINAL RATE INCOME TAX

IHT MINIMUM MARGINAL RATE INHERITANCE TAX

IHIM MAXIMUM MARGINAL RATE INHERITANCE TAX

WAT MINIMUM MARGINAL RATE WEALTH TAX

WTM MAXIMUM MARGINAL RATE WEALTH TAX

DEFINITIONS

MATRICES

1 MATRIX MX,200,15

2 MATRIX MX,100,8

3 MATRIX MX,200,8

4 MATRIX MX,4,6

5 MATRIX MX,7,102
* TABLES

1. TABLE PF11,20000,20000,50 TABLE FOR WEALTH TABUL.
2. TABLE PF11,20000,20000,50 TABLE FOR WEALTH TABUL.
3. TABLE PF11,20000,20000,50 TABLE FOR WEALTH TABUL.
4. TABLE PF11,50000,50000,50 TABLE FOR WEALTH TABUL.
5. TABLE PF11,50000,50000,50 TABLE FOR WEALTH TABUL.
6. TABLE PF11,50000,50000,50 TABLE FOR WEALTH TABUL.
7. TABLE PF11,100000,100000,50 TABLE FOR WEALTH TABUL.
8. TABLE PF11,100000,100000,50 TABLE FOR WEALTH TABUL.
9. TABLE PF11,100000,100000,50 TABLE FOR WEALTH TABUL.
10. TABLE PF11,100000,100000,50 TABLE FOR WEALTH TABUL.
11. TABLE PF11,100000,100000,50 TABLE FOR WEALTH TABUL.

* FUNCTIONS

1. FUNCTION RN1,C2 STOCK,EQUAL DISTRIBUTION
   0,-1/1,1

2. FUNCTION RN1,C25 STANDARD NORMAL DISTRIBUTION
   0,-5/0.0003,-4/0.00135,-3/0.00621,-2/0.02275,-2/0.06681,-1.5
   0.11507,-1.2/0.15866,-1/0.21186,-0.5/0.27425,-0.3/0.3458,-0.2/0.42074,-0.1
   0.15/0.57926,0.2/0.65542,0.3/0.72575,0.4/0.78814,0.5/0.8134,0.6/0.88493,0.7
   0.8/0.93319,1.5/0.97725,2/0.99379,2.5/0.99865,3/0.99997,4/1.5

3. FUNCTION RN1,C25 LOGNORMAL DISTRIBUTION
   0.02352/-0.0003,0.04979/-0.00135,0.10540/-0.00621,0.15335/-0.02275,0.22313
   0.06681,0.32465,0.11507,0.40656,0.15866,0.47237,0.21186,0.54881
   0.27425,0.3743,0.34458,0.74082,0.42074,0.86071,0.51,0.57926,0.61683
   0.65542,1.34986,0.72575,1.56831,0.78814,1.82212,0.8134,2.117
   0.88493,2.45960,0.93319,3.08022,0.97725,4.48169,0.99379,6.52082
   0.99865,9,4.8773,9.9997,20.08553,1.42,5.102

4. FUNCTION RN1,C25 INGENUITY PARAMETER
   0.05/0.0003,-4/0.00135,-3/0.00621,-2.5/0.02275,-2/0.06681,-1.5
   0.11507,-1.2/0.15866,-1/0.21186,-0.8/0.27425,-0.6/0.3458,-0.4/0.42074,-0.2
   0.5/0.57926,0.2/0.65542,0.4/0.72575,0.6/0.78814,0.8/0.8134,1/0.88493,1.2
   0.93319,1.5/0.97725,2/0.99379,2.5/0.99865,3/0.99997,4/1.5
FUNCTION RN1,C2  AGING RANDOM YEARS
0,1/1,50

FUNCTION RN1,C2  MARRIAGE AGE
0,19/1,21

FUNCTION RN1,C2  AGE OF DEATH
0,56/1,75

FUNCTION PF2,C23  AGE-INCOME PROFILE
15,.5/20,.75/25,.9/28,1/30,1.05/35,1.175/40,1.25/43,1.28
45,1.3/47,1.275/50,1.2/53,1.1/55,1/58,.85/60,.7/62,.5
35,.4/64,.375/65,.35/68,.275/70,.25/75,.2/100,.2

FUNCTION PF8,C11  STOCHASTIC FOR WEALTH LOSSES
0,.184/250,.208/500,.236/750,.268/1000,.303/1250,.344

FUNCTION RN1,D2  PROBABILITY OF LOSSES
.95,0/1,1

FUNCTION PF10,E7  LOCATIONS
1,PF11/2,PF3/3,PF4/4,PF6/5,PF7/6,PF9/7,1

FUNCTION PF14,L7  COLUMN CHANGE (MH2>MH1)
2,3/7,8/10/11,14

FUNCTION V32,C4  WEALTH CLASS DETERMINATION
-4000,.001/-1,.001/1,.999/4000,.999

FUNCTION RN1,D2  SEX DETERMINATION
.5,0/1,1000

FUNCTION V41,D12  LOCATIONS FOR REORDERING
1,3/2,7/3,8/4,10/5,11/6,14/1001,1/1002,3/1003,4/1004,5
1005,6/1006,7

*
16 FUNCTION V41,D12
1,3/2,7/3,8/4,9/5,11/6,1/1001,3/1002,7/1003,8/1004,9
1005,11/1006,1
* 
17 FUNCTION RN1,C2
0,1/1,4
* 
18 FUNCTION PF9,C4
0,1/5000,1/25000,.5/100000000,.5
* 
* VARIABLE STATEMENTS
* 
1 BVARIABLE (MX1(PF1,1)*E'0)*(MX1(PF1,5)*E'0)*(MX1(PF1,6)*E'0) 192
2 BVARIABLE (MX2(PF1,1)*E'0)*(MX2(PF1,5)*E'0)*(MX2(PF1,6)*E'0) 193
3 BVARIABLE (MX4(PF13)*E'0)+(MX4(PF13)*E'0) 194
4 BVARIABLE (PH1*LE*XR*HDR)+(MX1(PF1,12)*E'0) 195
5 BVARIABLE (PF15*E*PF1)+(PF16*E*PF1) 196
6 BVARIABLE BV7+BV8 197
7 BVARIABLE (PF15*E*MX1(PF1,14))+(PF15*E*MX1(PF1,15)) 198
8 BVARIABLE (PF16*E*MX1(PF1,14))+(PF16*E*MX1(PF1,15)) 199
9 BVARIABLE (1200*E*MX1(PF1,4))+(16000*E*MX1(PF1,4)) 200
10 BVARIABLE (1300*E*MX1(PF1,4))+(17000*E*MX1(PF1,4)) 201
11 BVARIABLE (1300*E*MX1(PF1,4))+(17000*E*MX1(PF1,4)) 202
12 BVARIABLE BV13+MX1(PF1,1)*E'0) 203
13 BVARIABLE (MX1(PF1,13)*E'0)*(MX1(PF1,1)*E'1) 204
* 
1 VARIABLE PF1*1 205
2 FVARIABLE XF5+XF4*FN*XB*VERS 206
3 FVARIABLE (RN1/1000+FN13)* XF6 207
4 FVARIABLE FN4*XF7+XF8 208
5 FVARIABLE (RN1/1000+FN13)*1000 209
6 VARIABLE FN5 210
7 VARIABLE PF6+12 211
8 VARIABLE PF6*FN6 212
9 FVARIABLE FN13*15+PF6*FN7 213
,10 FVARIABLE PF9*FN17 214
11 FVARIABLE FN13*XB*CLASS+1 215
12 FVARIABLE (RN1+RN1)/1330+2.75-0.75*PF11 NUMBER OF CHILDREN 216
TABLE YEAR
TABLE NUMBER
LABOR INCOME
RETURN ON HUMAN CAPITAL
WEALTH INCOME
TOTAL INCOME
DISPOSABLE INCOME
PERSON'S AGE
CONSUMPTION
LOSSES OF WEALTH SPECULATION
NET WEALTH INCREASE
STORAGE COLUMN IN MX1
RENAMER SAVEVALUES
TIME RECALCULATION
YEARLY HUM. CAP COST
YEARLY HUM CAP AM. PER KID
ADJUSTED VALUE FOR HUM. CAP.
FINANCIAL HUM. CAPITAL
WEALTH RELATIONSHIP
WEALTH TRANSFER FOR MARRIAGE
PARENTS' AVERAGE WEALTH
STARTING WEALTH OF COUPLE
PERCENTAGE
PERCENTAGE
LUMP CONNS
MATRIX CHANGE
MATRIX #
INPUT FOR REORDER FUNCTION
PUBLIC SHARE OF EDUCATION
PUBLIC EDUCATION
EACH HEIR'S SHARE
INCOME DEP. CONSUMPTION
TIME RELATIONSHIP
COLUMN CHECK IN X-REF
POSSIBLE HEIRS
WEALTH AFTER WEALTH-TAX
51 VARIABLE MX1(PF1, 6)+45       AGE FOR WEALTH ADJUSTM. 256
52 FVARIABLE (PF31-PF30)*PL1      PART OF EACH TAX 257
53 VARIABLE PF30*3                NEW TAX ALLOWANCE 258

* CREATE MATRICES WITH POINTERS FOR AVAILABLE SPACE 259

* 1 GENERATE,,,1,,2PH,32PF,2PL,2PB TRANSACTION 260
2 ASSIGN 1-2,1,PB LINE COUNTER AND MATRIX # 261
3 MSAVEVALUE PF2,PF1,4,V1,MX POINTER AVAILABLE SPACE MAT #1 262
4 ASSIGN 1+,1,PB INCREMENT LINE COUNTER 263
5 TEST G PF1,XF*PF2,*,=2 1ST MATRIX READY? 264
6 ASSIGN 2+,1,PB NEXT MATRIX 265
7 ASSIGN 1,1,PB INCREMENT LINE COUNTER 266
8 TEST G PF2,3,*,=5 3RD MATRIX READY? 267
9 MSAVEVALUE 4,1,1-3,1,MX INPOINTERS FOR MAT #1-3 268

* CREATE ORIGINAL SAMPLE (50 HOUSEHOLDS) 269

10 ASSIGN 1,1,PB CREATE SAMPLE 270
11 MSAVEVALUE 4,1,1,MX1(PF1,4),MX UPDATE AVAILABLE SPACE 271
12 ASSIGN 1,2,PB ROW COUNTER 272
13 ASSIGN PB1,V*PB1,PB DEFINE VARIABLE #PB1 273
14 MSAVEVALUE 1,PB1,PB1,PB*PB1,MX STORE VARIABLE IN PB1 274
15 ASSIGN 1+,1,PB INCREMENT COLUMN COUNTER 275
16 TEST G PB1,13,*,=3 LAST RELEVANT COLUMN DONE? 276
17 MSAVEVALUE 1+,PF1,3,MX1(PF1,3),MX UPDATE HUMAN CAPITAL 277
18 TEST E X85EDPUB,1,***4 PUBLIC EDUCATION? 278
19 ASSIGN 1,2,PB SET 2-PERSON FLAG 279
20 TEST L MX1(PF1,3),V44,***2 PUBL. ED. NECESSARY? 280
21 MSAVEVALUE 1,PF1,3,V44,MX DO PUBL. EDUCATION 281
22 MSAVEVALUE 1,PF1,3,V43,MX UPDATE HUMAN CAPITAL 282
23 TEST G PF6,XH$MAGE,*,=2 ACTUAL AGE>MAX YEAR IN USE? 283
24 SAVEVALUE MAGE,PF6,XH RESET MAX YEAR 284
25 ASSIGN 1+,1,PB INCREMENT LINE COUNTER 285
26 TEST G PF1,XH$SIZE,LOS+1 SAMPLE COMPLETE? 286

27 MSAVEVALUE 1,1-XH$SIZE,1,1,MX MAKE SAMPLE ACTIVE 287
28 SAVEVALUE RUN+,XH$MAGE,XH INCR. # OF RUNS WITH MAX AGE 288
* * PRELIMINARY SIMULATION FOR AGING AND START OF MAIN SIMULATION * *
29
ASSIGN  1,1,PH  INITIALIZE YEAR COUNTER 294
30 CON  ASSIGN  1,1,PF  INITIALIZE LINE COUNTER 295
31 TEST LE  PFI, XH$SI121, **7  SKIP IF MATRIX DONE 296
32 TEST NE  BV1,1, **6  SKIP FOR EMPTY LINE 297
33 TEST LE  MX2(PFI,1), PH1, **3  EDUCATION DUE (FEMALE)? 298
34 TEST NE  MX2(PFI,1), MX2(PFI,2), **2  EDUCATION COMPLETE? 299
35 TRANSFER  SBR, EDUF, 5PF  EDUCATION 300
36 TEST L  MX2(PFI,4), V27, **2  UPDATE NECESSARY? 301
37 TRANSFER  SBR, UPDF, 5PF  UPDATE 302
38 TEST NE  BV1,1, REP  SKIP EMPTY LINE 303
39 TEST E  MX1(PFI,1), 0, **4  SKIP FOR ALREADY SAMPLED 304
40 TEST LE  MX1(PFI,7), PH1, **3  EDUCATION PROCESS STARTS? 305
41 TEST NE  MX1(PFI,3), MX1(PFI,4), **2  EDUCATION COMPLETE? 306
42 TRANSFER  SBR, EDUM, 5PF  SUBROUTINE EDUCATION 307
43 TEST E  BV12,1, LAT  SKIP FOR ALREADY SAMPLED 308
44 TEST E  MX1(PFI,8), PH1, **2  MARRIAGE DUE? 309
45 TRANSFER  SBR, MAR, 5PF  SUBROUTINE MARRIAGE 310
46 TEST E  MX1(PFI,1), 0, **3  SKIP IF ALREADY SAMPLED 311
47 TEST L  MX1(PFI,8), V27, **2  UPDATE NECESSARY? 312
48 TRANSFER  SBR, UPDM, 5PF  UPDATE MALE 313
49 LAT  TEST E  MX1(PFI,101), PH1, **2  DEATH DUE? 314
50 TRANSFER  SBR, DIE, 17PF  315
* * UPDATE NEXT SAMPLE MEMBER * *
51 REP  ASSIGN  1+,1,PF  INCREMENT LINE COUNTER 316
52 TEST G  PFI, XH SIZE, CCN+1  LAST SAMPLE MEMBER? 317
53 TEST GE  PH1, XH$IMAGE, ZUK  AV. RECORDS FOR AGING YEARS 318
54 TEST NE  BV1,1, **3  SKIP FOR EMPTY LINE 319
55 TEST NE  MX1(PFI,1), 0, **2  SKIP FOR YOUNGSTER 320
56 TRANSFER  SBR, REC, 5PF  RECORDING 321
57 LOOP  1PF, **-3  "  322
58 ASSIGN  5,7,PF  DUMMY VARIABLE 323
59 MSAVEVALUE  5, PF5, V24, XF+V25, MX  KEEP YEARLY VARIABLES 324
60 LOOP  5PF, **-1  DO ALL 5 VARIABLES 325
61   TEST E   V13,0,**3
62   SAVEVALUE 5,TB*V14, XF
63   SAVEVALUE 4,TD*V14, XF
64   SAVEVALUE 11-17,0,XF
65   ADVANCE 1
66   ZUK   ASSIGN 1+,1,PH

* NEW SIMULATION YEAR
*
67   TEST G   PH1,XH$RUN,CON
68   TERMINATE 1

* SUBROUTINE: RECORD MONEY VALUES FOR HOUSEHOLDS
*
69   REC   ASSIGN 2,V20,PF
70   ASSIGN 20,V16,PF
71   TEST E   BV9,1,**6
72   ASSIGN 20+,V16,PF
73   TEST E   BV10,1,**4
74   ASSIGN 20+,V16,PF
75   TEST E   BV11,1,**2
76   ASSIGN 20+,V16,PF
77   ASSIGN 8, MX1(PF1,5), PF
78   ASSIGN 3, V15, PF
79   TEST E   V13,1,**4
80   TEST G   PH1,V51,**3
81   ASSIGN 2, MX1(PF1,2), PF
82   MSAVEVALUE 1,PF1,11,V11, MX
83   ASSIGN 4,V17,PF
84   ASSIGN 6,0, PF
85   ASSIGN 30, XF10,PF
86   ASSIGN 1,XL$TAX, PL
87   ASSIGN 31, V18, PF
88   TEST G   PF31,PF30,**6
89   ASSIGN 6*,V52,PF
90   ASSIGN 30,V53,PF
91   ASSIGN 1+,XL$TAX, PL
92   TEST LE   PL1,XL$TAM,**2

UPD. VALUE "AVERAGE WEALTH"
" 'STD DEV WEALTH'
CLEAR VARIABLES
NEW YEAR IN REAL SIMUL.
INCREMENT YEAR COUNTER
RUNS ALL DONE?
STOP
PERSON'S AGE
1ST RETURN PART
FURTHER RETURNS?
2ND RETURN PART
FURTHER RETURNS?
3RD RETURN PART
FURTHER RETURNS?
4TH RETURN PART
RISK VARIABLE
LABOR INCOME
WEALTH-CLASS UPDATE NEG.?
UPDATE RELEVANT FOR HOUSEH.
WEALTH
DO UPDATE
INTEREST INCOME
RESET TAXES
ALLOWANCE
RATE
INCOME
INCOME TAXABLE?
TAX AMOUNT
NEW ALLOWANCE
NEW RATE
ALL THROUGH?
93  TEST E  XB$RO,0,*,5
94  ASSIGN  2,0,PB
95  TEST L  MX1(PF1,9),PH1,*,2
96  ASSIGN  2,1,PB
97  ASSIGN  7,V38,PF
98  ASSIGN  9,V21,PF
99  TEST L  PF9,0,*,2
100 ASSIGN  7,V19,PF
101 ASSIGN  9,0,PF
102 ASSIGN  7+,V46,PF
103 ASSIGN  9,0,PF
104 TEST G  PF8700,*,2
105 ASSIGN  9,V22,PF
106 ASSIGN  11,MX1(PF1,2),PF
107 ASSIGN  11-,PF9,PF
108 ASSIGN  11+,V23,PF
109 TEST LE  PF11,0,*,2
110 ASSIGN  11,0,PF
111 TEST E  XB$AT1,1,*,12
112 ASSIGN  30,XF18,PF
113 ASSIGN  1,XL$WT1,PL
114 ASSIGN  31,PF11,PF
115 ASSIGN  11,0,PF
116 TEST G  PF31,PF30,*,5
117 ASSIGN  11+,V52,PF
118 ASSIGN  30,V53,PF
119 ASSIGN  1+,PL1,PL
120 TEST G  PL1,XL$WMT,*,4
121 ASSIGN  6+,PF11,PF
122 ASSIGN  11,V50,PF
123 ASSIGN  1,PF12,PF11,MX
124 TEST E  V13,0,*,2
125 TABULATE V14
126 ASSIGN  10,7,PF
127 SAVEVALUE V26+,FN11,XF
128 LOOP  1UPF,*,1
129 TRANSFER PF,5,1

PROGRESSIVE RATES?
SET 2 SPOUSES
BOTH SPOUSES ALIVE?
SET 1 SPOUSE
LUMP SUM CONSUMPTION
NOT USED INCOME
ENOUGH INCOME?
RESET CONSUMPTION
RESET NOT UNUSED INCOME
INC. DEPENDENT CONS.
RESET NOT UNUSED INCOME
NO LOSSES WITH SECURE ASSETS
LOSSES DUE?
WEALTH (T-1)
ADJUST FOR LOSSES
ADJUST FOR YEARLY CHANGES
WEALTH NEGATIVE?
IF SU, RESET TO ZERO
WEALTH TAX LEVIED?
ALLOWANCE
RATE
WEALTH
SET TAXES ZERO
WEALTH TAXABLE?
TAX AMOUNT
NEW ALLOWANCE
NEW RATE
ALL THROUGH?
SUM UP TAXES
AFTER TAX WEALTH
UPDATE WEALTH (T)
TABLE DUE? (EACH 2OTH YEAR)
DO TABLE
DUMMY
STORE VARIABLES
RUN AROUND
* SUBROUTINE: EDUCATION OF FEMALES

130 EDF  ASSIGN  12, MX2(PF1,1), PF  PLANNED H.C.
131 ASSIGN  13, MX2(PF1,7), PF  LINE OF FATHER (PREDECESSOR)
132 ASSIGN  15, MX2(PF1,2), PF  ACCUMULATED H.C.
133 TRANSFER SBR, EDF, 16PF  GOSUB EDUCATION GENERAL
134 MSAVEVALUE 2++, PF1, 2, PF14, MX  UPDATE ACCUMULATED HC
135 TRANSFER PF, 5, 1  RETURN

* SUBROUTINE: EDUCATION MALES

136 EDUM ASSIGN  12, MX1(PF1,3), PF  PLANNED H.C
137 ASSIGN  13, MX1(PF1,14), PF  PREDECESSOR
138 ASSIGN  15, MX1(PF1,4), PF  ACCUMULATED H.C
139 TRANSFER SBR, EDUM, 16PF  UPDATE ACC. HC
140 MSAVEVALUE 1++, PF1, 4, PF14, MX  RETURN
141 TRANSFER PF, 5, 1

* SUBROUTINE: EDUCATION COMMON

142 EDU TEST G MX1(PF13,2), V28, **6  WEALTH LARGE ENOUGH?
143 ASSIGN  14, V29, PF  HC VALUE
144 TEST L V30, PF14, **2  OVER-PAID?
145 ASSIGN  14, V30, PF  RESET HC VALUE
146 MSAVEVALUE 1++, PF13, 2, PF14, MX  UPDATE FATHER'S WEALTH
147 TRANSFER PF, 16, 1  RETURN
148 ASSIGN  14, V31, PF  SET AFFORDABLE HC
149 TRANSFER , **-3

* SUBROUTINE: CREATE ONE HEAD FAMILY -- MOTHER

150 UPDF ASSIGN  3, PF1, PF  RESET LINE COUNTER
151 ASSIGN  1, MX41(1,1), PF  AVAILABLE LINE
152 MSAVEVALUE 4, 1, 1, MX1(PF1,4), MX  UPDATE POINTER
153 ASSIGN  14, 7, PF  DUMMY
154 MSAVEVALUE 1, PF1, FN12, MX2(PF3, PF14), MX  REWRITE DATA
155 LOOP  14PF, **-1
MSAVEVALUE 1,PF1,3,0,MX
MSAVEVALUE 1,PF15,14,MX
ASSIGN 6,MX1(PF1),PF
ASSIGN 6-12,PF
MSAVEVALUE 1,PF1,6,PF6,MX
TRANSFER SBR,MAR1,16PF
MSAVEVALUE 1,PF1,14,0,MX
MSAVEVALUE 1,PF1,9,1,MX
ASSIGN 1,PF3,PF
TRANSFER PF,5,1

* SUBROUTINE: CREATE ONE HEAD FAMILY -- FATHER *

UPDM ASSIGN 7-8,MX1(PF1),PF
MSAVEVALUE 1,PF1,3,MX1(PF1),MX
TRANSFER SBR,MAR0,16PF
MSAVEVALUE 1,PF1,9,1,MX
TRANSFER PF,5,1

* SUBROUTINE: SPECIAL "MARRIAGE" FOR PRE-SIMULATION *
TRANSFER SBR,MAR1,16PF
TRANSFER PF,5,1

* SUBROUTINE: MARRIAGE -- FIND GIRL FOR MARRYING *

MAR TEST E MX1(PF1),0,*,2
ASSIGN 2-4,MX1(PF1),11,PF
ASSIGN 3,MX4,PF2,PF
TEST NE PF3,0,SEC
TEST LE MX2(PF3),1,4,SEC
TEST NE MX1(PF1),MX2(PF3),*,3
TRANSFER SBR,MAR1,16PF
TRANSFER PF,5,1
ASSIGN 3,MX2(PF3),8,PF
TEST E PF3,0,SEC
TEST E PF2,PF4,THI
SEC TEST E PF2,XB#CLASS,THI
185   ASSIGN 2+,1,PF                         GO NEXT CLASS 483
186   TRANSFER ,MAR+2                      484
187   THI TEST G PF2,2,MAR+7              ANY LOWER CLASS? 485
188   ASSIGN 2,PF4,PF                     GO LOWER CLASS 486
189   ASSIGN 2-,1,PF                       " 487
190   TRANSFER ,MAR+2                      488
*      MARRIAGE RELATED UPDATING          489
*      490
191   MARI ASSIGN 7,MX2(PF3,6),PF         WEALTH CLASS 492
192   ASSIGN 14,MX4(3,PF7),PF             1ST GIRL OF TYPE 493
193   TEST NE PF14,PF3,**7                OUR GIRL? 494
194   ASSIGN 15,PF14,PF                   RESET 495
195   ASSIGN 14,MX2(PF15,8),PF            NEXT GIRL 496
196   ASSIGN 15,PF14,PF                   OUR GIRL? 497
197   TRANSFER ,**-3                      ELSE REPEAT 498
198   MSAVEVALUE 2,PF15,8,MX2(PF14,8),MX  UPD. POINTER 499
199   TRANSFER ,MARH                      SKIP NEXT LINE 500
200   MSAVEVALUE 4,3,MX2(PF3,6),MX2(PF3,8),MX UPD. POINTER 501
201   MARH ASSIGN 7,MX1(PF1,14),PF        HIS FATHER'S LINE 502
202   ASSIGN 8,MX2(PF3,7),PF              HER FATHER'S LINE 503
203   MSAVEVALUE 1+,PF1,3,MX2(PF3,2),MX    ADD HUM. CAPITAL 504
204   TEST G MX2(PF3,5),MX1(PF1,10),**4    MAXIMIZE DEATH AGE 505
205   MSAVEVALUE 1,PF1,9,MX1(PF1,10),MX    1ST DYING SPOUSE 506
206   MSAVEVALUE 1,PF1,10,MX2(PF3,5),MX   LAST DYING SPOUSE 507
207   TRANSFER ,**2                       508
208   MSAVEVALUE 1,PF1,9,MX2(PF3,5),MX    1ST DYING SPOUSE 509
209   MSAVEVALUE 1,PF1,15,PF8,MX         UPD. HER SOURCE LINE 510
210   MARO ASSIGN 9,MX1(PF7,2),PF         HIS FATHER'S WEALTH 511
211   ASSIGN 10,MX1(PF8,2),PF             HER FATHER'S WEALTH 512
212   ASSIGN 1,1,PB                       FLAG FOR 1-PERSON FAMILY 513
213   TEST NE PF7,PF8,**4                 SINGLE FAMILY? 514
214   ASSIGN 1,2,PB                       FLAF FOR 2-PERSON FAMILY 515
215   MSAVEVALUE 1-,PF7,12,1,MX           DECREASE HOUSEHOLD'S SIZE 516
216   MSAVEVALUE 1-,PF8,12,1,MX           " 517
217   ASSIGN 2,V34,PF                     AVERAGE WEALTH 518
218   ASSIGN 11,V11,PF                    WEALTH CLASS 519
219   MSAVEVALUE 1,PF1,11,PF11,MX         STORE WEALTH CLASS 520
MSAVEVALUE 1,PF1,5,V5,MX
ASSIGN 27,MX1(PF7,13),PF
ASSIGN 28,MX1(PF8,13),PF
MSAVEVALUE 1,PF1,2,V35,MX
MSAVEVALUE 1,PF1,4,V4,MX
MSAVEVALUE 1-,PF7,2,V36,MX
MSAVEVALUE 1-,PF8,2,V37,MX
TEST NE MX1(PF1,15),0,*,+5
MSAVEVALUE 1,PF1,12,V12,MX
MSAVEVALUE 2,PF3,1-8,0,MX
MSAVEVALUE 2,PF3,4,MX4(1,2),MX
MSAVEVALUE 4,1,2,PF3,MX
TEST E BV4,1,*,+2
MSAVEVALUE 1,PF1,12,1,MX
ASSIGN 4,MX4(1,3),PF
MSAVEVALUE 4,1,3,MX3(PF4,4),MX
MSAVEVALUE 3,PF4,1-8,0,MX
MSAVEVALUE 3,PF4,1,PF1,MX
MSAVEVALUE 1,PF1,13,PF4,MX
TEST NE MX1(PF1,12),0,*,+2
TRANSFER SBR,KID,30PF
TRANSFER SBR,NOK,30PF
TEST E MX1(PF1,11),0,*,+6
MSAVEVALUE 1,PF1,1,1,MX
TEST E XB$EDPUB,1,*,+3
TEST L MX1(PF1,31),V44,*,+2
MSAVEVALUE 1,PF1,3,V44,MX
MSAVEVALUE 1,PF1,3,V43,MX
TEST NE MX1(PF1,15),0,*,+10
ASSIGN 0,MX1(PF1,15),PF
ASSIGN 15,MX1(PF8,13),PF
ASSIGN 17,3,PF
TEST NE MX3(PF15,PF17),0,*,+6
TEST E MX3(PF15,PF17),V39,*,+3
MSAVEVALUE 3,PF15,PF17,PF1,MX
TRANSFER *,*,+3
ASSIGN 17+,1,PF
TRANSFER ,*,+5
STORE RISK-Para
HIS FATHER'S X-REF LINE
HER FATHER'S X-REF LINE
WEALTH
INGENUITY
UPD. HIS FATHER'S WEALTH
UPD. HER FATHER'S WEALTH
SINGLE MAN?
# OF KIDS
CLEAR HER LINE
UPD. POINTER AV. SPACE
" NO KID IN PRELIM?
RESET # OF KIDS
AV SPACE X-REF
UPD. AV. SPACE
CLEAR LINE IN X-REF
STORE SOURCE IN X-REF
STORE X-REF# DOWNSTREAM
KIDS?
GOSUB KIDS
GOSUB NOKIDS
SKIP FOR PRE-SIMULATION
MAKE ACTIVE SAMPLE
PUBL EDUCATION?
PUBL. ED. NECESS.? SET PUBL. ED.
ADD PUBL. SHARE TO H.C.
SINGLE MAN?
PREC. LINE
X-REF LINE OF FATHER
DUMMY
LINE IN X-REF THROUGH
RELEVANT LINE?
RESET LINE IN HERITAGE
END
INCREASE DUMMY
GOBACK
TRANSFER PF,16,1

* SUBROUTINE: CREATING CHILDREN

* KID ASSIGN 7,MX1(PF1,12),PF # OF KIDS
259 260
MSAVEVALUE 3,PF4,2,PFF7,PF STORE # OF KIDS
261
ASSIGN 8,3,PF DUMMY
262
ZIE ASSIGN 9-11,FN14,PF ATTACH SEX
263
ASSIGN 10,MX4(1,V40),PF AV. SPACE
264
MSAVEVALUE 4,1,V40,MX*V40(PF10,4),MX UPD. AV. SPACE
265
ASSIGN 11+,PF10,PF FIND LINE
266
ASSIGN 6,PH1,PF ENTER AGE
267
ASSIGN 6+,FN17,PF SPREAD KIDS' BIRTHYEAR
268
MSAVEVALUE V40,PF10,4,0,MX CLEAR LINE
269
MSAVEVALUE V40,PF10,6,P6,PF,MAX STORE ENTER YEAR
270
MSAVEVALUE 3,PF4,PF8,P11,MX STORE VALUE IN X-REF
271
ASSIGN 1-1,,PF RESET LINE# 571
272
ASSIGN 12,6,PF DUMMY
273
MSAVEVALUE V40,PF10,FN15,V*FN16,MX CREATE VALUES FOR THE KIDS
274
LOOP 12PF,**-1 CIRCLE AROUND 578
275
ASSIGN 1+1,PF RESET PF1 579

* ORDER WOMEN IN THEIR MATRIX

* TEST G PF11,1000,EMIL-3 SKIP FOR MALE KIDS
276
TEST G PF10,XH*SIZ1,*,*,2 NEW LAST LINE IN MATRIX?
277
SAVEVALUE SIZ1,PF10,XH RESET "LAST LINE"
278
ASSIGN 13,MX2(PF10,61),PF WEALTH CLASS
279
ASSIGN 14,MX4(4,P13),PF LAST GIRL
280
TEST NE BV3,1,EMIL FIRST ENTRY?
281
TEST GE MX2(PF10,4),MX2(PF14,4),VCRN UPDATE POINTER
282
MSAVEVALUE 2,PF14,8,PF10,MX ""
283
MSAVEVALUE 4,4,PF13,PF10,MX
284
TRANSFER ,EMIL+1
285
VORN ASSIGN 14,MX4(3,P13),PF ORDER TO COMPARE
286
TEST LE MX2(PF10,4),MX2(PF14,4),*,7 IN PLACE?
287
MSAVEVALUE 2,PF10,8,PF14,MX DOWN POINTER
288
TEST E MX4(3,PF13),PF14,**3 FIRST OF ROW?
MSAVEVALUE 4,3,PF13,PF10,MX
TRANSFER ,*+2
MSAVEVALUE 2,PF15,8,PF10,MX
TRANSFER ,EMIL+1
ASSIGN 15,PF14,PF
ASSIGN 14,MX21(PF15,8),PF
TRANSFER ,VORN+1
TEST G PF10,XH+$SIZE,++4
SAVEVALUE SIZE,PF10,XH
TRANSFER ,*+2
EMIL MSAVEVALUE 4,3-4,PF13,PF10,MX
ASSIGN 8+,1,PF
ASSIGN 7-,1,PF
TEST LE PF7,0,ZIE
TRANSFER PF,30,2
* *
SUBROUTINE: INHERITANCE RULES FOR NO-CHILDREN SITUATION
  *
  *
  NOK ASSIGN 7,3,PF
  ASSIGN 8,MX1(PF1,15),PF
  TEST NE PF8,0,ZWI
  ASSIGN 11,MX1(PF8,13),PF
  TEST G MX31(PF11,2),1,ZWI
  ASSIGN 9,MX31(PF11,2),PF
  ASSIGN 10+,3,PF
  TEST LE PF10,V42,++7
  TEST L MX31(PF11,PF10),1000,++4
  TEST NE MX31(PF11,PF10),PF1,++3
MSAVEVALUE 3,PF4,PF7,MX31(PF11,PF10),MX
TRANSFER
ASSIGN 7+,1,PF
ASSIGN 10+,1,PF
TRANSFER ,*+6
ZWI TEST NE MX1(PF1,14),PF8,ENDE
TEST NE MX1(PF1,14),0,ENDE
ASSIGN 8,MX1(PF1,14),PF
TRANSFER ,NOK+3
ENDE MSAVEVALUE 3,PF4,2,4V8,MX
TRANSFER PF,30,1
* SUBROUTINE: DEATH AND BEQUEST *

325 DIE ASSIGN 2-16,0,PF
326 ASSIGN 20-32,0,PF
327 ASSIGN 12,MX1(PF1,13),PF
328 ASSIGN 13,3,PF
329 TEST NE MX3(PF12,2),0,RID
330 ASSIGN 14,20,PF
331 ASSIGN PF13,MX3(PF12,PF13),PF
332 TEST LE PF*PF13,1000,WEI
333 ASSIGN 15,MX1(PF*PF13,14),PF
334 ASSIGN 16,MX1(PF*PF13,15),PF
335 TEST E BV5,1,SIS
336 ASSIGN 1,1,PB
337 ASSIGN 14,PB,PF
338 ASSIGN 14,1,PF
339 ASSIGN 13,1,PF
340 TEST G PF13,49,DIE+6
341 ASSIGN 14,1,PF
342 TEST G PF14,19,RID+1
343 ASSIGN 31,MX1(PF1,2),PF
344 ASSIGN 30,XF9,PF
345 ASSIGN 1,XL$1HT,PL
346 ASSIGN 30,0,PF
347 TEST G PF31,PF30,**6
348 ASSIGN 32+5,V52,PF
349 ASSIGN 30,V53,PF
350 ASSIGN 1,+PL1,PL
351 TEST LE PL1,XL$1HM,**2
352 TEST E XB$PRO,0,**5
353 TEST E PB1,2,**4
354 ASSIGN 32,PF32,PF
355 TEST L PF31,PF32,**2
356 ASSIGN 32,PF31,PF
357 ASSIGN 11,V45,PF
358 MSAVEVALUE 1,PF*PF14,2,PFI1,MX
359 ASSIGN 14-,1,PF
360 TEST L PF14,20,*,2-2 DO ALL
361 * SAVEVALUE 14*,PF32,XF
362 CLE MSAVEVALUE 1,PFL,1-15,0,MX
363 MSAVEVALUE 1,PFL,4,MX(1,1),MX
364 MSAVEVALUE 4,1,1,PFL,MX
365 MSAVEVALUE 3,PFL,1-8,0
366 MSAVEVALUE 3,PFL,4,MX(1,3),MX
367 MSAVEVALUE 4,1,3,PFL,MX
368 TRANSFER PF,17,1
369 * SIS TEST E BV6,1,RID
370 ASSIGN 1,2,PB
371 TRANSFER ,WEI-2
372 RID TEST E PF13,3,WEI
373 SAVEVALUE 14*,MX1(PFL,2),XF
374 TRANSFER ,CLE
375 * INITIAL XF1,200/XF2,100/XF3,200/XF4,20000/XF5,10000
376 INITIAL XF6,25000/XF7,200/XF8,1000/XF9,100000
377 INITIAL XF10,6000/XF11-XF17,0/XF18,50000/XL$WTA,,005
378 INITIAL XH$HAGE,0/XH$SIZE,50/XH$SL1,0/XH$RUN,100
379 INITIAL XB$WAT,0/XB$EDPUB,0/XL$WTM,,05/XB$PRO,0
380 INITIAL XL$TAX,,15/XL$TAM,,45/XL$INT,,05/XL$INT,08
381 INITIAL XL$INT,,25/XL$ZIN,,10
382 INITIAL XB$CLASS,3/XB$VERS,1/XH$MIN,5000
383 * START 1
384 * CLEAR INITIAL XF1,200/XF2,100/XF3,200/XF4,20000/XF5,100000
385 INITIAL XB$WAT,0/XB$EDPUB,0/XL$WTM,,08/XB$PRO,0
386 INITIAL XB$CLASS,3/XB$VERS,2/XH$MIN,5000
387 * START 1
388
389
CLEAR 75485*FN*XB$VERS
INITIAL XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000
INITIAL XB$WAT,0/XB$EDPUB,0/XL$WTM,.08/XB$PRO,0
INITIAL XB$CLASS,3/XB$VERS,3/XH$MIN,5000

* START 1

CLEAR
INITIAL XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000
INITIAL XB$WAT,0/XB$EDPUB,1/XL$WTM,.08/XB$PRO,0
INITIAL XB$CLASS,3/XB$VERS,3/XH$MIN,5000

* START 1

* CLEAR
INITIAL XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000
INITIAL XB$WAT,0/XB$EDPUB,1/XL$WTM,.08/XB$PRO,1
INITIAL XB$CLASS,3/XB$VERS,3/XH$MIN,5000

* START 1

* CLEAR
INITIAL XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000
INITIAL XB$WAT,1/XB$EDPUB,1/XL$WTM,.08/XB$PRO,1
INITIAL XB$CLASS,3/XB$VERS,3/XH$MIN,5000

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CROSS-REFERENCE
HALFWORD SAVEVALUES

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**** ASSEMBLY TIME = .04 MINUTES ****
Appendix Two:

Development of Inequality Due to Different Initial Distributions

a) "uniform distribution"

<table>
<thead>
<tr>
<th>Year</th>
<th>Gini-Coefficient</th>
<th>Mean/Median Rel.</th>
<th>CRV</th>
</tr>
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<td>0.000</td>
<td>1.003</td>
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<tr>
<td>11</td>
<td>0.4090</td>
<td>+10.618</td>
<td>1.203</td>
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<tr>
<td>21</td>
<td>0.4831</td>
<td>+9.983</td>
<td>1.550</td>
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<tr>
<td>31</td>
<td>0.5744</td>
<td>+4.598</td>
<td>2.129</td>
</tr>
<tr>
<td>41</td>
<td>0.6063</td>
<td>+3.569</td>
<td>2.162</td>
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<tr>
<td>51</td>
<td>0.5949</td>
<td>+2.806</td>
<td>1.857</td>
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<tr>
<td>61</td>
<td>0.6745</td>
<td>+2.547</td>
<td>4.336</td>
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<tr>
<td>71</td>
<td>0.6708</td>
<td>+2.172</td>
<td>3.666</td>
</tr>
<tr>
<td>81</td>
<td>0.7289</td>
<td>+2.003</td>
<td>8.498</td>
</tr>
<tr>
<td>91</td>
<td>0.7336</td>
<td>+1.786</td>
<td>8.013</td>
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<tr>
<td>101</td>
<td>0.7284</td>
<td>+1.599</td>
<td>17.748</td>
</tr>
</tbody>
</table>

Table A.1: Inequality measures for the initial uniform distribution.
b) normal distribution

<table>
<thead>
<tr>
<th>Year</th>
<th>Gini-Coefficient</th>
<th>Mean/Median Rel.</th>
<th>CVR</th>
</tr>
</thead>
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<td>Av.% Ch.</td>
<td>Absol.</td>
</tr>
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<td>-.-</td>
<td>1.019</td>
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<td>+9.292</td>
<td>1.583</td>
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<td>21</td>
<td>0.5280</td>
<td>+5.313</td>
<td>1.779</td>
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<tr>
<td>31</td>
<td>0.5353</td>
<td>+3.558</td>
<td>2.379</td>
</tr>
<tr>
<td>41</td>
<td>0.6293</td>
<td>+3.073</td>
<td>2.692</td>
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<tr>
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<td>0.6548</td>
<td>+2.533</td>
<td>2.742</td>
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<tr>
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<td>0.6803</td>
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<td>3.881</td>
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<td>0.6748</td>
<td>+1.846</td>
<td>3.716</td>
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<td>0.6694</td>
<td>+1.604</td>
<td>4.601</td>
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<tr>
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<td>0.6660</td>
<td>+1.418</td>
<td>5.410</td>
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<td>101</td>
<td>0.6627</td>
<td>+1.270</td>
<td>5.423</td>
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</table>

Table A.2: Inequality measures for the initial normal distribution.

c) lognormal distribution

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<th>Mean/Median Rel.</th>
<th>CRV</th>
</tr>
</thead>
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<td>Av.% Ch.</td>
<td>Absol.</td>
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<td>-.-</td>
<td>1.517</td>
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<td>0.5619</td>
<td>+0.972</td>
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<tr>
<td>31</td>
<td>0.5767</td>
<td>+0.734</td>
<td>2.687</td>
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<tr>
<td>41</td>
<td>0.5918</td>
<td>+0.615</td>
<td>2.782</td>
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<td>51</td>
<td>0.6461</td>
<td>+0.668</td>
<td>2.687</td>
</tr>
<tr>
<td>61</td>
<td>0.6729</td>
<td>+0.625</td>
<td>3.691</td>
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<td>71</td>
<td>0.6922</td>
<td>+0.576</td>
<td>3.636</td>
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<td>+0.538</td>
<td>5.390</td>
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<td>0.7306</td>
<td>+0.508</td>
<td>4.225</td>
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<tr>
<td>101</td>
<td>0.7497</td>
<td>+0.483</td>
<td>6.908</td>
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</tbody>
</table>

Table A.3: Inequality measures for the initial lognormal distribution
Appendix Three

How to Obtain the Inequality Measures out of a Table Produced by GPSS

GPSS offers the option to tabulate variables into tables predetermined by three parameters.

- the upper limit of the first class
- the class width
- the number of classes.

These operations are not very flexible concerning the problem of that paper. As there is no possibility to predict the development of simulation variables but in very broad limits, the problem arose how to get a fixed number of equidistant classes.

The problem was solved by defining relatively narrow class widths and a large number of classes with a subsequent manual reorganization of the table.

As GPSS tables do not provide values for the class means, a method has to be found that allows approximations for those means. The method used assumes the values to be equally distributed within the classes so that they can be approximated by the
class mean. The sum of this approximation over all classes is compared with the effective sum of arguments and the difference is equally divided by the number of arguments. This adjusts all means in the same way.

It can be shown that this approximation leaves the Gini-Coefficient at the lowest level of all alternatives. The following example may explain how the method was used.

A GPSS program may have produced the following table:

<table>
<thead>
<tr>
<th>ENTRIES IN TABLE</th>
<th>MEAN</th>
<th>STANDARD DEV</th>
<th>SUM OF ARGUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>22,081</td>
<td>118,109.7</td>
<td>1,341,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UPPER LIMIT</th>
<th>OBSERVED FREQUENCY</th>
<th>PER CENT OF TOTAL</th>
<th>CUMULATIVE PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000</td>
<td>20</td>
<td>33.33</td>
<td>33.3</td>
</tr>
<tr>
<td>20,000</td>
<td>9</td>
<td>15.00</td>
<td>48.3</td>
</tr>
<tr>
<td>30,000</td>
<td>12</td>
<td>20.00</td>
<td>68.3</td>
</tr>
<tr>
<td>OVERFLOW</td>
<td>19</td>
<td>31.67</td>
<td>100.0</td>
</tr>
</tbody>
</table>

| AVERAGE VALUE OF OVERFLOW | 42,000           |

The corrected sum of arguments is

- 19 times average value of overflow

\[ 1,341,500 - 789,000 = 543,500 \]

The hypothetical sum of arguments, supposed equally distributed in classes:

- 20 times 5,000 = 100,000
- 9 times 15,000 = 135,000
- 12 times 25,000 = 300,000

unexplained per argument (divided by 60)

\[ 8,500 \]

\[ 207.3 \]
Reorganized table adjusted with 207.3

<table>
<thead>
<tr>
<th>OBSERVED FREQUENCY</th>
<th>PERCENT OF TOTAL FREQUENCY</th>
<th>PERCENT OF TOTAL PERCENTAGE</th>
<th>CUMULATIVE CLASS MEAN</th>
<th>PERCENT OF TOTAL PERCENTAGE</th>
<th>CUMULATIVE OF TOTAL PERCENTAGE</th>
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<td>33.3</td>
<td>5,207.3</td>
<td>7.76</td>
<td>7.8</td>
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<tr>
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<td>10.20</td>
<td>18.0</td>
</tr>
<tr>
<td>12</td>
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<td>68.3</td>
<td>25,207.3</td>
<td>22.55</td>
<td>40.5</td>
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<td>42,000</td>
<td>59.49</td>
<td>100.0</td>
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</table>

Assumed three classes should be retained, the final result is:

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<th>PERCENT OF TOTAL PERCENTAGE</th>
<th>CUMULATIVE CLASS MEAN</th>
<th>PERCENT OF TOTAL PERCENTAGE</th>
<th>CUMULATIVE OF TOTAL PERCENTAGE</th>
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</thead>
<tbody>
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<td>33.3</td>
<td>5,207.3</td>
<td>7.76</td>
<td>7.8</td>
</tr>
<tr>
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<td>20,081</td>
<td>100.00</td>
<td>---</td>
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</tbody>
</table>

Out of this information the Gini-Coefficient is calculated.
BIBLIOGRAPHY


METHODS OF INFLUENCING THE DISTRIBUTION OF WEALTH:
A SIMULATION STUDY

by

GUNTER KLAUS BRUECKNER

Diplom-Oekonom, Justus Liebig-Universität Giessen, 1979

-------------------------

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1983
ABSTRACT

This paper deals with the redistribution of personal wealth. The first part tries to answer the question whether or not redistribution can be justified by economic reasons.

Answering this question requires the use of normative economics. The value judgements used seem to be approved in most countries. Thus, redistribution will be considered justified if these goals are met.

In a second part a microsimulation model was used to select the fiscal policy measure that redistributes most effectively. The behavior of 50 households is modelled and it is assumed that the initial and subsequent generations act according to predetermined rules. The main economic determinants of this model are the amount of human capital and the family's ranking in society.

A first group of hypotheses was set up to determine whether the size of the initial distribution of wealth influences the development of the economic system. The inequality of the resulting size distribution of wealth and the rate of growth of both income and wealth were used as criteria for this determination.
The results of the simulation provide evidence that the influence of the initial distribution corresponding to all criteria was neglectable.

The same sample structure was then used to test three fiscal policy measures for their redistributive effectiveness.

- A skill-oriented public education funding.
- A change of the existing income and inheritance tax system into a significantly more progressive system.
- The introduction of a general wealth tax.

The study showed that the most effective redistribution measure was the alteration of the income and inheritance tax. A reduced kurtosis and variation around the mean resulted from the implementation of this hypothesis.

The simulation results can also be used to argue that public expenditures on education do not redistribute to a noticeable degree if applied over all classes. Finally, the results seem to provide evidence that a general wealth tax does not perform the redistributive miracles that it is sometimes believed to perform.