METHODS OF INFLUENCING THE DISTRIBUTION OF WEALTH: A SIMULATION STUDY

by

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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 borowing 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.[1]

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,[2] the Gini-Coefficient[3] together with the Lorenz-Curve[4] will be used

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1. This term together with extensive analysis was introduced by Gary S. Becker and strengthened, also empirically, by Jacob Mincer. See Gary S. Becker, _Human Capital_, (New York: Columbia University Press, 1975) and Jacob Mincer, "The Distribution of Labor Income: A Survey with Special Referance to the Human Capital Approach," _Journal of Economic Literature_ 8 (March 1970), pp. 1-26.

2. Atkinson points out that the Gini-Coefficient, among others, does not rank distributions unanimously, if these are described by intersecting Lorenz-Curves. See A.B. Atkinson, "On the Measurement of Inequality," _Journal of Economic Theory_ 2 (June 1970), p. 255.

3. See C. Gini, _Variabilita e Mutabilita_. Studi Economico-Giuridici della R. Universita de Caglari 3 (1912), p. 80.

4. See M.O. Lorenz, "Methods of Measuring the Concentration of Wealth," _Publications of the American Statistical Association_ 70 (June 1905), p. 205.

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.

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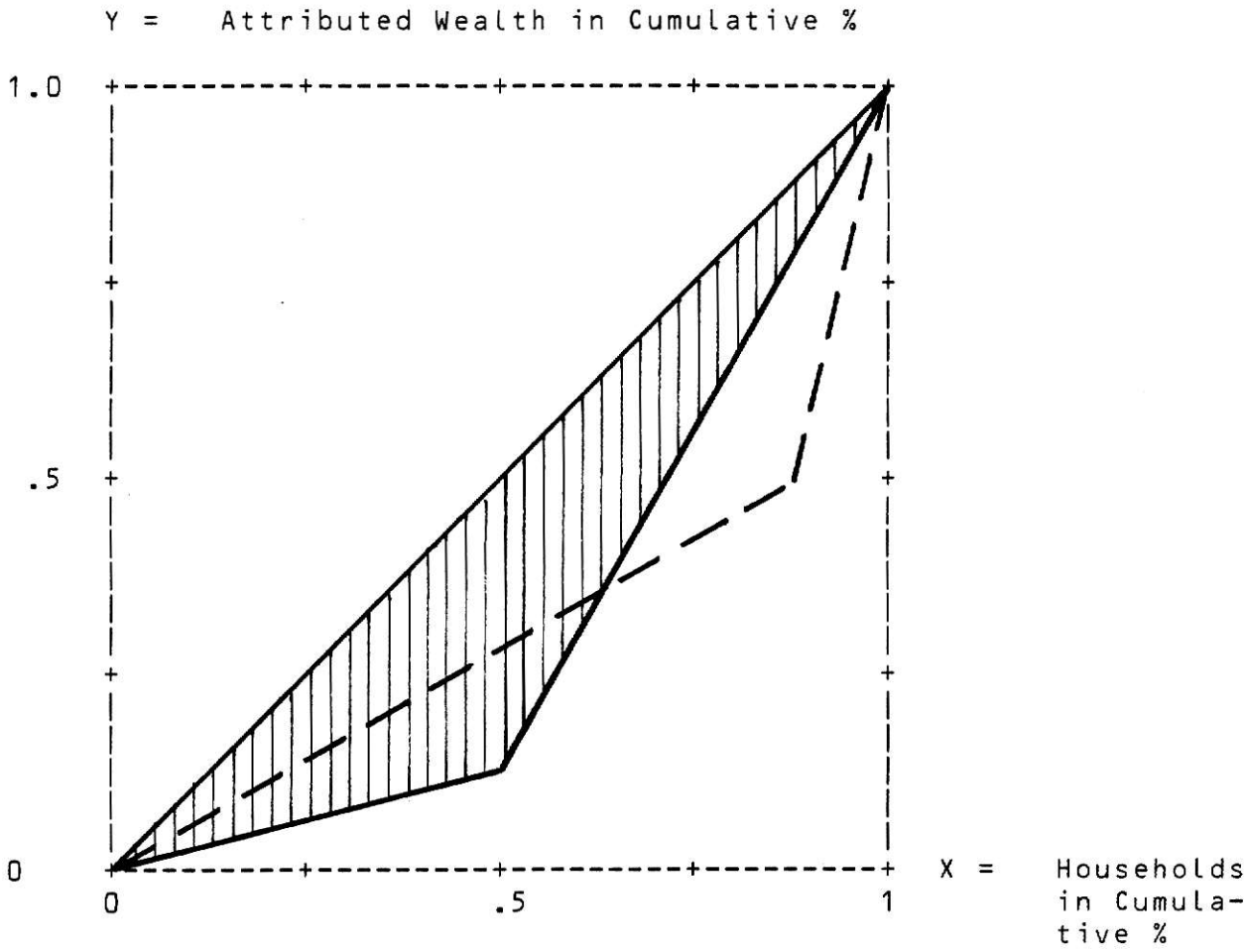

Figure 1.1: Two different Lorenz-Curves representing identical values of Gini-Coefficients.

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.

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1.2 Methodology Used

A microsimulation model[5] 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

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5. The first model of that type was used in G. Orcutt, et al., Microanalysis of Socio-economic Systems: A Simulation Study, (New York: Harper & Brothers, 1961).

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.[6]

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.

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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.

Economic utilitarianism[1] 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[3] as well as in Rawls'[4] 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 explicitely named human rights.[5]

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1. Norman Bowie breaks down utilitarianism into the "philosophical" and "economic" components. See Norman E. Bowie, Towards a Theory of Distributive Justice, (Amherst: The University of Massachusetts Press, 1971), pp. 12-49.

2. See I.M.D. Little, A Critique of Welfare Economics, (Oxford: Claredon Press, 1957), p. 8.

3. See, for example, Jeremy Bentham, Constitutional Code, Works, volume 9, edited by John Bowring, (New York: Russell and Russell, 1962).

4. Rawls focuses on the less priviledged groups; see John Rawls, A Theory of Justice, (Cambridge: Harvard University Press, 1971), p. 83.

5. See Jean-Jacques Rousseau, "Discourse on the Origin of Inequality." The Social Contract and Discourses, translated and with an introduction by G.D.H. Cole, 2 volumes, (New York: E.P. Dutton & Co, 1950), volume 1, pp. 265-268.

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.[6]

Classical economists forgot completely about egalitarianism, or interpreted it in such a way that the results were not obvious to those who favor egalitarianism.[7]

Marshall and Pigou[8] 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

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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.

6. John Stuart Mill, An Outline of the Science of Political Economy, (n.p., 1836), p. 2.

7. See example in T.W. Hutchison, "Economists and Social Justice in the History of Economic Thought", Economics and Equality, edited by Aubrey Jones, (Deddington: Philip Allen Publishers, 1976), p. 51.

8. See, for example, Alfred Marshall, Principles of Economics, (New York: The Macmillan Company, 1952), p. 518, and A.C. Pigou, Wealth and Welfare, (London: Macmillan and Co., 1912), pp. 20-24.

situations of wellbeing without using normative ideas.[9]

All attempts to circumvent the problem of normative versus positive economics using social welfare functions may also be categorized into that group.[10]

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.
J.R. Hicks, "The Foundations of Welfare Economics," Economic Journal 49 (December 1939), pp. 696-712.
Nicholas Kaldor, "Welfare Propositions in Economics," Economic Journal 49 (September 1939), pp. 549-552.
Tibor Scitovsky, "A Note on Welfare Propositions in Economics," Review of Economic Studies 8 (1941), pp. 77-88.

10. Fields mentions various authors using welfare functions including Lewis, Jorgenson, and himself. See G.S. Fields, Poverty, Inequality, and Development, (Cambridge: Cambridge University Press, 1980), p. 36.

leads away from the only path towards prosperity and freedom.[11]

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.[12] 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[13] pointed out, they are closer to a principle that could be described as "everybody is entitled to his property, and no redistribution is justified,"[14] a philosophy mostly related to Nozik's writings.

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

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11. Arguments are mostly based on individual freedom and utilitarianism. For details see Milton Friedman, Capitalism and Freedom, (Chicago: University of Chicago Press, 1962), or Friedrich A. Hayek, Individualism and the Economic Order, (Chicago: University of Chicago Press, 1948).

12. Norman B. Ture in his paper "Taxation and the Distribution of Income" suggests for replacing progressive income taxes with proportional ones, arguing that if investing is no longer punished with taxes, savings will increase, society will become richer and the poor will gain most.
See Norman B. Ture, "Taxation and the Distribution of Income," Wealth Redistribution and the Income Tax, edited by Arleen A. Leibowitz, (Lexington: Lexington Books, 1978), pp. 3-41.

13. Martin Feldstein, "Commentary," Leibowitz (ed.), op.cit., p. 58.

14. See, for example, Robert Nozik, Anarchy, the State, and Utopia, (New York: Basic Books, 1974), pp. 235-238.

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.[15] 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.[16]

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.[17]

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15. See J.E. Meade, Efficiency, Equality, and the Ownership of Property, (Cambridge: Harvard University Press, 1965), p. 75.

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.

17. Norman Bowie and Robert L. Simon, The Individual and the Economic Order, (Englewood Cliffs: Prentice-Hall, 1977), p. 178.

Referring to the neoclassical point of view, Dahrendorf epitomizes his interpretation into an "inequality produces hope and hope is the stimulus of progress."[18]

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.[19]

The last group of economists to be mentioned in the context of distribution is what shall be called the neo-fiscalists. 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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18. Ralf Dahrendorf, Inequality, Hope, and Progress, (Liverpool: Liverpool University Press, 1976), p. 2.

19. ibid., pp. 3-4.

distribution.[20] He is also one of the defenders of equity, arguing that the efficiency approach is not free of value judgements.[21]

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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20. In "Zero-sum Society" Thurow mentions redistribution as one of the challenges for present days economics together with inflation and unemployment. See Lester Thurow, The Zero-sum Society, (New York: Basic Books, 1971), pp. 191-194.
In "Generating Inequality" he puts forth the idea that keeping an equitable distribution as a main aim solves, or least reduces, the other problems. See Lester Thurow, Generating Inequality, (New York: Basic Books, 1975), pp. 207-209.

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.[22]

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-

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22. See Ian Bowen, Acceptable Inequalities, (London: George Allen and Unwin, 1970), p. 31.

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

Gans[23] 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.[24] Replacing this assumption with the alternative

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23. Herbert J. Gans, More Equality, (New York: Pantheon Books, 1973), p. 68.

24. Alan S. Blinder, Towards an Economic Theory of Income Distribution, (Cambridge: The MIT Press. 1974), p. 2-3.

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 population. 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 increase 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 revolutionary changes in the political and economic order.[25] Although there is no full agreement over whether concentrations of wealth in czaristic Russia favored the Russian Revolution or not,[26] 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.[27]

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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 and Co., 1977), p. 22.

26. See Aubrey Jones, "The Economics of Equality," Aubrey Jones (ed.), op.cit., p. 2.

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.[28]

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28. See Ronald Chester, Inheritance, Wealth, and Society (Bloomington: Indiana University Press, 1982), p. 9.

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]

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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 the longrun development of inequality see Kenneth E. Boulding, "The Stability of Inequality," Review of Social Economy 23 (April 1975), pp. 3-5.
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.[30]

The author finds the analyses of both Okner/Pechman and Stiglitz[31] 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.

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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.

31. See Josef E. Stiglitz, "Equality, Taxation, and Inheritance," Personal Income Distribution, edited by Wilhelm Krelle and Anthony F. Shorrocks, (New York: North-Holland, 1978), p. 271. Okner/Pechman show that the incidence of income tax is more or less proportional. See B.A. Okner and J.A. Pechman, Who Bears the Tax Burden?, (Washington: The Brookings Institution, 1974), p. 64.

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.[1] 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

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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.[2]

Most macroeconomic simulation applications use DYNAMO[3] as a computerlanguage 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.[4]

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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 Forresters 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),
A. Pugh, DYNAMO II User's Manual, (Cambridge, Mass.: The MIT-Press, 1972),
D. Meadows, Club of Rome. The Limits to Growth, (New York: Universe Books, 1972).

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.[6]

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.[7] 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.[8]

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.[9]

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7. The author is aware of the following papers:
Frederic L. Pryor, "Simulation of the Impact of Social and Economic Institutions on the Size Distribution of Income and Wealth," American Economic Review 63 (March 1973), pp. 50-72,
and Frederic L. Pryor, Economic System and the Size Distribution of Income and Wealth, (Bloomington, Ind.: The International Development Research Center, Indiana University, 1971).

8. See Alan S. Blinder, Towards an Economic Theory of Income Distribution, (Cambridge: The MIT-Press, 1974), pp. 3-16.

9. For representative developed countries see:
Royal Commission on the Distribution of Income and Wealth, "The International Comparison of Income Distributions," reprinted in Wealth, Income, and Inequality, edited by A.B. Atkinson, (Oxford: Oxford University Press, 1980), pp. 79-99.
For developing countries see:
Gary S. Fields, op.cit., pp. 88-93.

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 exogeneously.[10] 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,[11] the relation of abilities and earnings,[12] or the human capital approach have been put forth as explanations.[13]

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.[14]

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

11. See, for example, Milton Friedman, "Choice, Chance, and the Personal Distribution of Income," Journal of Political Economics 61 (August 1953), p. 283.

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.
See Simon Kuznets, "Economic Growth and Income Inequality," American Economic Review 45 (March 1955), pp. 1-28,
and Irving B. Kravis, "International Differences in the Distribution of Income," Review of Economics and Statistics 42 (November 1960), pp. 408-416.

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 fotlowing 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.[15] It must also be pointed out that in real life other taxes probably influence the size distribution of wealth.[16]

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.[17]

- 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.[18]

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.[19]

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.[20]

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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.

19. See J. Aitchison and J.A.C. Brown, The Log-normal Distribution, (Cambridge: at the University Press, 1957), pp. 111-120.

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.[21]

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.

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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.[22] 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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22. See Frederic L. Pryor [1973], op.cit., pp. 55 and 58.

intention of a class-adequate marriage.[23]

Coleman published a lengthy list of correlation coefficients for a sample of married couples. These data also support the above analysis.[24]

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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23. See C.D. Harbury and D.M.W.N. Hitchens, Inheritance and Wealth Inequality in Britain, (London: George Allen & Unwin, 1979), p. 95.

24. D.A. Coleman, "Assortative Mating in Britain," Equalities and Inequalities in Family Life, edited by R. Chester and J. Peel, (London: Academic Press, 1977).

- 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.[25] 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 disregar-

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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 intergrated.[26]

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.

Wealth Class	Number of Children	Mean
poor	2.0 - 3.5	2.75
medium	1.25 - 2.75	2.00
rich	0.5 - 2.0	1.25

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,[27] 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-

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

a) Mean income for families with "n" children

n	Mean
0	22,397
1	22,423
2	22,782
3	22,426
4	20,980
5	19,831
6	15,914
	22,370

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

Class	av.#
- 2,500	2.90
- 10,000	2.00
- 15,000	1.98
- 20,000	2.14
- 25,000	2.20
- 30,000	2.12
- 40,000	1.92
- 70,000	1.92
+ 70,000	1.92

See U.S. Bureau of the Census, Current Population Reports. Series P-60, No. 129. Money Income of Families and Persons of the United States, (Washington: U.S. Government Printing Office, 1981), p. 104.

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

Wealth Class	Ranges of Coefficients	Mean
poor	0.0 - 1.333	.666
medium	0.333 - 1.666	1.0
rich	0.666 - 2.0	1.333

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."[28]

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 additional 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 tuition fees.[29]

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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28. D.E. Black, K.A. Lewis, and C.R. Link, "Wealth 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 obtaines 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:

$$S[i] = W[i] / (k N - i + 1)$$

with:

S [i] the share of the ith child;

W [i] the parents' wealth account <u>before</u> the transfer to the ith 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.[30]

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.[31]

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30. <u>Proof</u>:

$$S[i] = W[i] / (k N - i + 1) \quad \text{and}$$
$$S[i+1] = W[i+1] / [k N - (i+1) + 1] =$$
$$W[i+1] / (k N - i).$$

As $W[i+1] = W[i] - S[i] = W[i] - W[i] / (k N - i + 1)$
$= W[i] (k N - i) / (k N - i + 1)$

$S[i+1] = [W[i] (k N - i)] / [(k N - i + 1) (k N - 1)] =$
$= W[i] / (k N - i + 1) = S[i]$

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.[32]

Further discussion was done by Friedman[33] and after that,

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32. The theoretical model was first published in Franco Modigliani and Richard Brumberg, "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data," Post-Keynesian Economics, edited by K. Kurihara, (New Brunswick, N.J.: Rutgers University Press, 1954), pp. 390-406.

33. Milton Friedman, A Theory of the Consumption Function, (Princeton: Princeton University Press, 1957).

many of studies tried to find evidence for that hypothesis in the consumption expenditures of the aged. There has not been a common result,[34] however, as some authors find empirical evidence and others do not.[35]

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.[36] 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-

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34. For Great Britain see A.B. Atkinson, Distribution of Personal Wealth in Britain, (Cambridge: Cambridge University Press, 1978), or A.F. Shorrocks, "The Age-Wealth Relationship: A Cross-Section and Cohort Analysis," in Review of Economics and Statistics 57 (May 1975), pp. 155-163, or A.B. Atkinson, "The Distribution of Wealth and the Individual Life-Cycle," Oxford Economic Papers 23 (July 1971), pp. 239-254.

35. See, for example, Harold F. Lydall, "The Life-Cycle in Income, Saving, and Asset Ownership," Econometrica 23 (April 1955), pp. 131-150, or T.W. Mirer, "The Wage-Age Relationship Among the Aged," American Economic Review 69 (June 1979), pp. 435-443.

36. See Alan S. Blinder, R.W. Gordon, and D.E. Wise, Life-Cycle Savings and Beguests: Cross-Section Estimates of the Life-Cycle Model, National Bureau of Economic Research Working Paper 619.

ted for differences in pe manent income due to retirement.[37]

Since the permar nt income assumptions will not be used within the model for te hnical reasons, it is assumed that no changes in the general c nsumption structure occur due to being retired. Further complic tions can also easily be ruled out, as long as transfer programs adressing to the aged especially, are not included.[38]

The bequeathing ehavior has already been discussed in part. The remaining qu stion is when and to whom bequests are given.

It is obvious t at every transfer of real capital from the parents to the chil ren is bequeathing, whether it takes place after the parents' eath or before. However, it is necessary to consider separate t e money transfer that took place at the childrens' 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 int r vivos, it is easy to circumvent this tax. This consideration rought up the inheritance/gift tax com-

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37. M.A. King nd L.-D. Dicks-Mireaux, "Asset Holding and the Life-Cycle," Econ nic Journal 92 (June 1982), p. 265.

38. See this a gument discussed by T.W. Mirer, "The Dissaving Behavior of the Retired Aged," Southern Economic Journal 46 (April 1980), p. 1204, and Martin Feldstein, "Social Security and the Distribu ion of Wealth," Journal of the American Statistical Association 7 (December 1976), pp. 800-801.

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.[39] 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.[40]

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

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39. See, for example, Pryor [1973] and Pryor [1971], and Paul L. Menchik, "Primogeniture, Equal Sharing, and the U.S. Distribution of Wealth," Quarterly Journal of Economics 94 (March 1980), pp. 304-305.

40. A.B. Atkinson, The Economics of Inequality, (Oxford: Claredon Press, 1975), pp. 147-151.

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,[41] 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"[42] 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."[43]

This technique has been applied in some studies with divergent results.[44] 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."[45]

The author favors a suggestion made by Menchik[46] who mentioned family size as an influencing factor. If it is assumed that wealthy people are more likely to have one child only,[47] 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:
Distribution of Personal Wealth in Britain," Economic Journal 72 (December 1962), pp. 863-865, and C.D. Harbury and P.C. McMason, "Inheritance and the Characteristics of the Top Wealth Leavers in Britain," Economic Journal 83 (September 1973), pp. 832-833. Menchik, on the other side, found a different result. See Paul L. Menchik [1980], op.cit., p. 314 and Paul L. Menchik, "Intergenerational Transmission of Inequality: An Empirical Study of Wealth Mobility," Economica 46 (November 1979), p. 360.

45. See James D. Adams, "Personal Wealth Transfers," Quarterly Journal of Economics 95 (August 1980), p. 176.

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 inheritance 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 processes of the households.

It was intended to parallel reality as closely as possible 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 forall. 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.

3.3.3.2 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 everbody.

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.[48]

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,[49] 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.[50]

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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48. See Gary S. Becker [1975], op.cit., pp. 83-85, and 158-160.

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.

50. See discussion and verification in A.D. Roy, "The Distribution of Earnings and of Individual Output," Economic Journal 60 (September 1950), pp. 489-505, and Benoit Mandelbrot, "Paretian Distribution and Income Maximation," Quarterly Journal of Economics 76 (February 1962), pp. 57-85.

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.[51]
3. An amount of n dollars can be added a second time, if either skills or human capital exceed the 95%-level.[52]
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[53], Jacob Mincer[54], Harold F.

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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.

53. Gary S. Becker [1975], op.cit., pp. 83-88.

54. Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," Journal of Political Economy 66 (August 1958), pp. 281-302.

Lydall[55], Melvin W. Reder[56], and T.W. Schultz,[57] are covered.

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[58] are unable to completely explain wage differentials. Age-earnings profiles reflect job experience, which is a form of human capital.[59]

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55. Harold F. Lydall, The Structure of Earnings, (Oxford: Claredon Press, 1968), p. 104.

56. Reder argued that also allocation of labor within a firm plays a role. See Melvin W. Reder, "A Partial Survey of the Theory of Income Size Distribution," Six Papers on the Size Distribution of Wealth and Income, edited by Lee Soltow, (New York: National Bureau of Economic Research, 1969), pp. 235-239.

57. T.W. Schultz, "Investment in Human Capital," American Economic Review 51 (March 1961), pp. 1-17.

58. See, for example, Zvi Griliches and William M. Mason, "Education, Income, and Ability," Journal of Political Economy 80 (Supplement, May/June 1972), pp. 74-103, or John C. Hause, "Earnings Profile: Ability and Schooling," Journal of Political Economy 80 (Supplement, May/June 1972), pp. 108-138.

59. See Jacob Mincer, "On-the-Job Training: Costs, Returns, and Some Implications," Journal of Political Economy 70 (Supplement October 1962), pp. 50-59, and Jacob Mincer, "Human Capital and Earnings," Economic Dimensions of Education, edited by D. Windham, reprinted in Wealth, Income, and Inequality, edited by A.B. Atkinson [1980], op.cit., p. 108.

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,[60] 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,[61] or that the portfolio of the top wealth owners is somewhat different from other households'.[62]

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.[63]

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61. Lester Thurow [1971], op.cit., p. 173.

62. A.B. Atkinson and A.J. Harrison [1978], op.cit., p. 231.

63. See James Tobin, "Liquidity Preference as Behavior Towards Risk," Review of Economic Studies 25 (February 1958), p. 67.

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,[64] 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.

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64. It is also called Sharpe-Lintner model on behalf of the names of the authors. See W.F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance 19 (September 1964), pp. 425-442, and J. Lintner, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," Review of Economics and Statistics 47 (February 1965), pp. 13-37.

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.[65] 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.

Class	Range	Mean
poor	0.0 - 1.3333	.6667
medium	0.3333 - 1.6667	1.0
rich	0.6667 - 2.0	1.3333

Table 3.3: Distribution of risk parameters

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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 catastrophies 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 occuring 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.[66] This value will change, however, if the

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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

distribution of wealth classes is no longer symmetric, since wealth classes influence the risk parameter.

3.3.3.5 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.[67]

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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 life style of the groups in society. The following Table 3.4 presents the sums used.

Wealth Class	Lump Sum per Person
poor	$ 1,000
medium	$ 1,500
rich	$ 2,000

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.

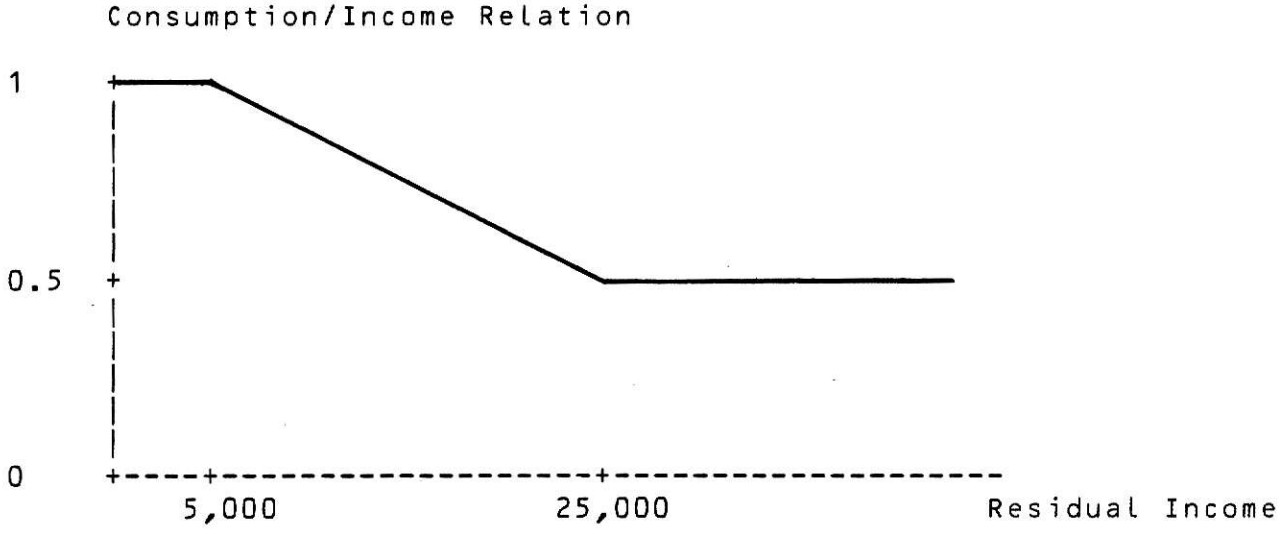

Figure 3.2: Marginal propensity to consume as a function of residual income used to determine the income-dependent part of consumption.

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 pattern 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,[1] whereas the amount for the allow-

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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.[2]

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.[3] 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 zerobracket 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.

3. U.S. Congress, Joint Economic Committee, Economic Growth and Total Capital Formation, (Washington: US. Government Printing Office, February 18, 1976).

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.

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

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.[4]

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.

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4. Since the average wealth per household is significantly 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,[5] 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.

Year	Uniform Distrib.		Normal Distrib.		Lognormal Distr.	
	Gini-C.	Av.% Ch.	Gini-C.	Av.% Ch.	Gini-C.	Av.% Ch.
1	0.1491	-.-	0.1875	-.-	0.4631	-.-
11	0.4090	+10.618	0.4559	+9.292	0.5125	+1.019
21	0.4831	+9.983	0.5280	+5.313	0.5619	+0.972
31	0.5744	+4.598	0.5353	+3.558	0.5767	+0.734
41	0.6063	+3.569	0.6293	+3.073	0.5918	+0.615
51	0.5949	+2.806	0.6548	+2.533	0.6461	+0.668
61	0.6745	+2.547	0.6803	+2.171	0.6729	+0.625
71	0.6708	+2.172	0.6748	+1.846	0.6922	+0.576
81	0.7289	+2.003	0.6694	+1.604	0.7115	+0.538
91	0.7336	+1.786	0.6660	+1.418	0.7306	+0.508
101	0.7284	+1.599	0.6627	+1.270	0.7497	+0.483

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.

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5. The other indicators of inequality are listed in the Appendix Two as they do not provide additional information.

Year	Uniform Distrib.		Normal Distrib.		Lognormal Distr.	
	P/C Wealth	Rate	P/C Wealth	Rate	P/C Wealth	Rate
1	98,537	-.-	103,233	-.-	126,464	-.-
11	162,394	5.1	174,144	5.4	186,111	4.0
21	231,992	4.4	254,768	4.6	266,600	3.8
31	321,139	4.0	333,128	4.0	344,230	3.4
41	380,183	3.4	442,966	3.7	445,187	3.2
51	530,176	3.4	658,141	3.8	617,911	3.2
61	656,593	3.2	867,308	3.6	738,502	3.0
71	795,966	3.0	1,189,153	3.5	857,096	2.8
81	1,079,279	3.0	1,392,973	3.3	977,329	2.6
91	1,387,060	2.5	1,406,545	2.9	1,267,548	2.6
101	1,530,175	2.8	1,618,614	2.8	1,174,366	2.2

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.

Year	Uniform Distrib.		Normal Distrib.		Lognormal Distr.	
	P/C Income	Rate	P/C Income	Rate	P/C Income	Rate
1	33,118	-.-	34,058	-.-	34,235	-.-
11	38,435	1.5	40,482	1.7	39,464	1.4
21	42,131	1.2	44,736	1.4	44,953	1.4
31	45,608	1.1	48,850	1.2	49,129	1.2
41	47,613	0.9	53,504	1.1	53,397	1.1
51	59,165	1.2	71,592	1.5	66,594	1.3
61	65,935	1.2	86,562	1.6	78,084	1.4
71	77,664	1.2	102,856	1.6	88,726	1.4
81	94,168	1.3	112,754	1.5	91,463	1.2
91	102,208	1.3	114,075	1.5	107,356	1.3
101	116,816	1.3	120,737	1.3	97,680	1.0

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.

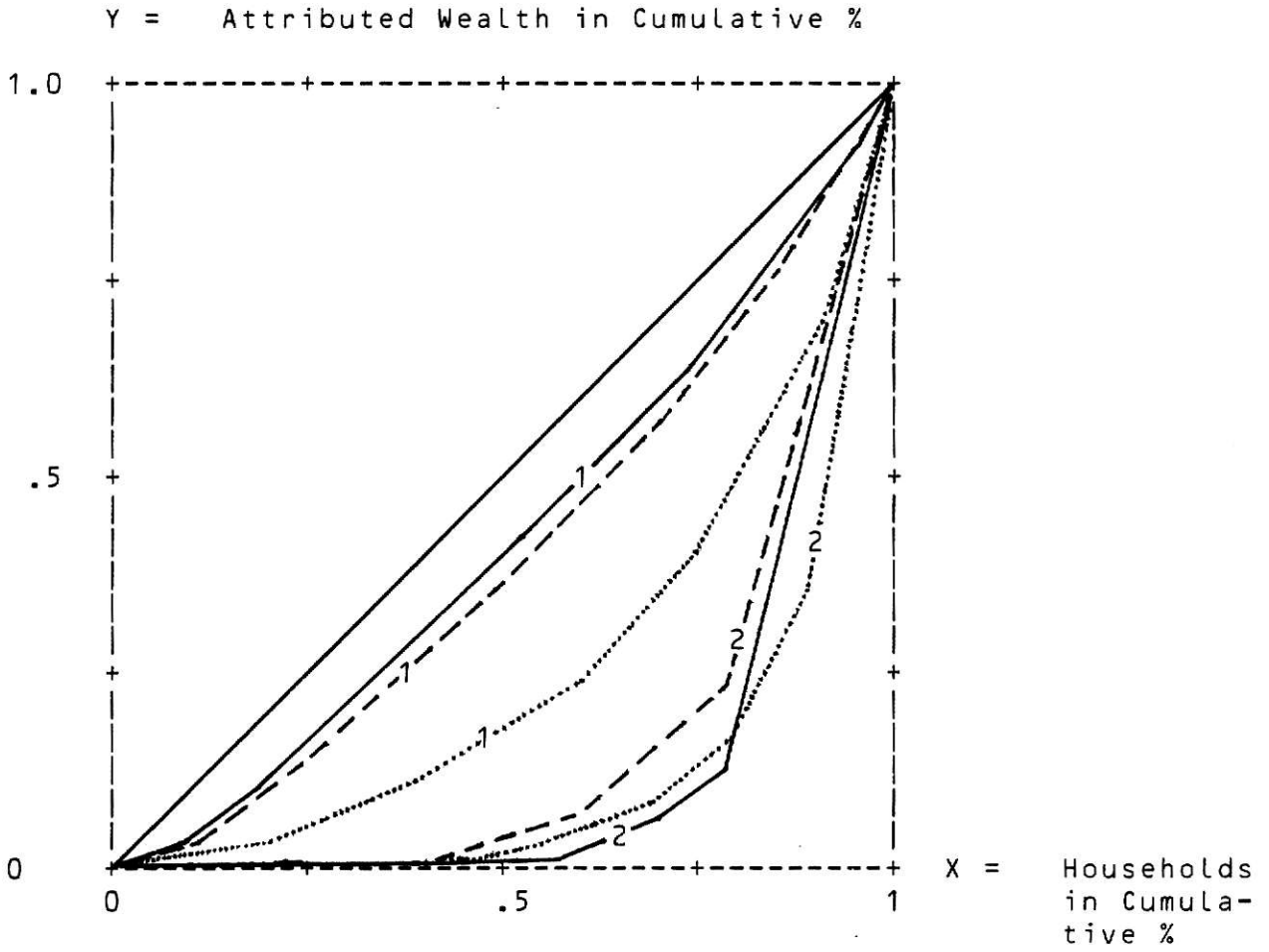

Figure 4.1: The Lorenz-Curves of the initial and the final distributions in the simulation runs for uniform, normal, and lognormal distribution.

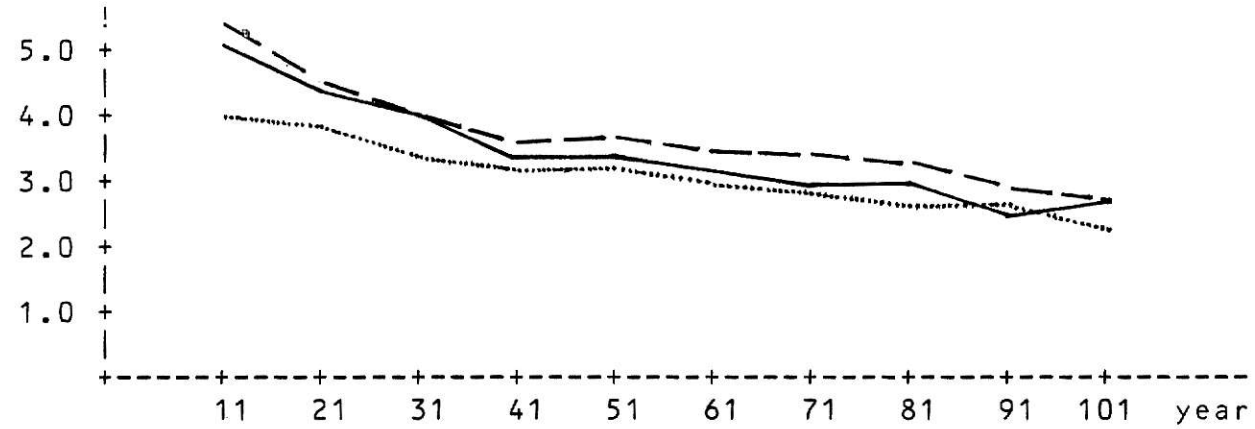

Figure 4.2: Average growth rates of wealth plotted for uniform, normal, and lognormal distribution.

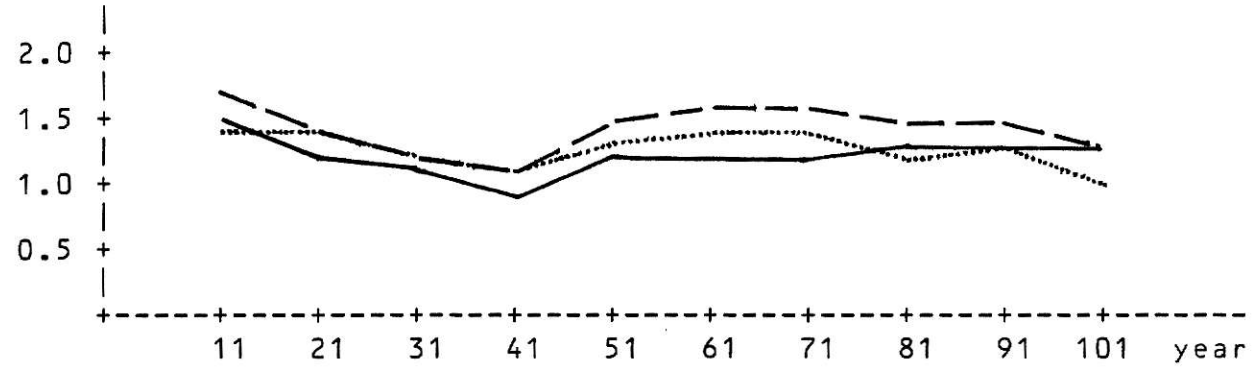

Figure 4.3: Average growth rates of income plotted for uniform, normal, and lognormal distribution.

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 long-run stability of inequality.[6]

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.[7]

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:

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

7. See Jacob Mincer, "Human Capital and Earnings," in Wealth, Income, and Inequality, edited by A.B. Atkinson, (Oxford: Oxford University Press, 1980), pp. 118-120, and Gary S. Becker [1975], op.cit., pp. 115-116.

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.[8]

Skills	Educ.Expenses	Human Capital
100	2,500	15,000
500	12,500	35,000
750	18,750	47,500
1000	25,000	60,000
1250	31,250	72,500
1500	37,500	85,000
1900	47,500	105,000

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.

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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.[9] 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:

$$T = (I-6{,}000)\ 0.15 + (I-18{,}000)\ 0.15 + (I-54{,}000)\ 0.15$$

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

$$T = (I-6{,}000)\ 0.15$$

Figure 4.4 shows the curves of both tax rates.

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9. See Pechman/Okner, op.cit., p. 78.

Income	Hypothesis 2			Control Simulation		
	Marg.%	Tax Amount	Av.%	Marg.%	Tax Amount	Av.%
5,000	0.0	0	0.0	0.0	0	0.0
6,000	0.0	0	0.0	0.0	0	0.0
10,000	15.0	600	6.0	15.0	600	6.0
15,000	15.0	1,350	9.0	15.0	1,350	9.0
18,000	15.0	1,800	10.0	15.0	1,800	10.0
20,000	30.0	2,400	12.0	15.0	2,100	10.5
25,000	30.0	3,900	15.6	15.0	2,850	11.4
30,000	30.0	5,400	18.0	15.0	3,600	12.0
40,000	30.0	8,400	21.0	15.0	5,100	12.7
50,000	30.0	11,400	22.8	15.0	6,600	13.2
54,000	30.0	12,600	23.3	15.0	7,200	13.3
60,000	45.0	15,300	25.5	15.0	8,100	13.5
80,000	45.0	24,300	30.4	15.0	11,100	13.9
100,000	45.0	33,000	35.2	15.0	14,100	14.1
120,000	45.0	42,300	35.2	15.0	17,100	14.2
150,000	45.0	55,800	37.2	15.0	21,600	14.4
200,000	45.0	78,300	39.2	15.0	29,100	14.6

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

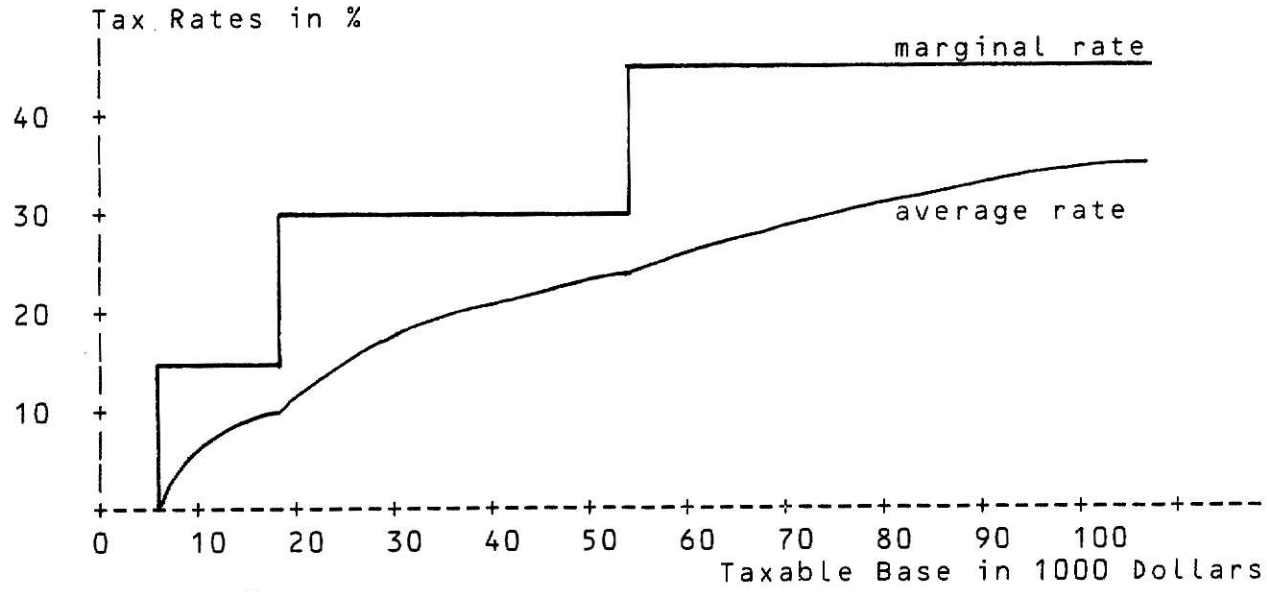

Figure 4.4: Curves of marginal and average income tax rates used in hypothesis two.

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 :

$$T = (B-100{,}000)\ 0.05 + (B-300{,}000)\ 0.05 + (B-900{,}000)\ 0.10 + \\ + (B-2{,}700{,}000)\ 0.20 + (B-8{,}100{,}000)\ 0.40$$

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

$$T = (B-100{,}000)\ 0.05$$

Bequest	Hypothesis 2			Control Simulation		
	Marg.%	Tax Amount	Aver.%	Mar.%	Tax Amount	Ave.%
100,000	0.0	0	0.0	0.0	0	0.0
150,000	5.0	2,500	1.7	5.0	2,500	1.7
200,000	5.0	5,000	2.5	5.0	5,000	2.5
300,000	5.0	10,000	3.3	5.0	10,000	3.3
500,000	10.0	30,000	6.0	5.0	20,000	4.0
750,000	10.0	55,000	7.3	5.0	32,500	4.3
900,000	10.0	70,000	7.7	5.0	40,000	4.4
1,000,000	20.0	90,000	9.0	5.0	45,000	4.5
1,250,000	20.0	140,000	11.2	5.0	57,500	4.6
1,500,000	20.0	190,000	12.6	5.0	70,000	4.7
2,000,000	20.0	290,000	14.5	5.0	95,000	4.7
2,500,000	20.0	390,000	15.6	5.0	120,000	4.8
3,000,000	40.0	530,000	18.3	5.0	145,000	4.8
5,000,000	40.0	1,350,000	27.0	5.0	145,000	4.9
10,000,000	80.0	4,110,000	41.4	5.0	495,000	4.9
15,000,000	80.0	8,110,000	54.1	5.0	795,000	5.0

Table 4.7: Inheritance tax rates used in hypothesis two together with the values used in the control simulation

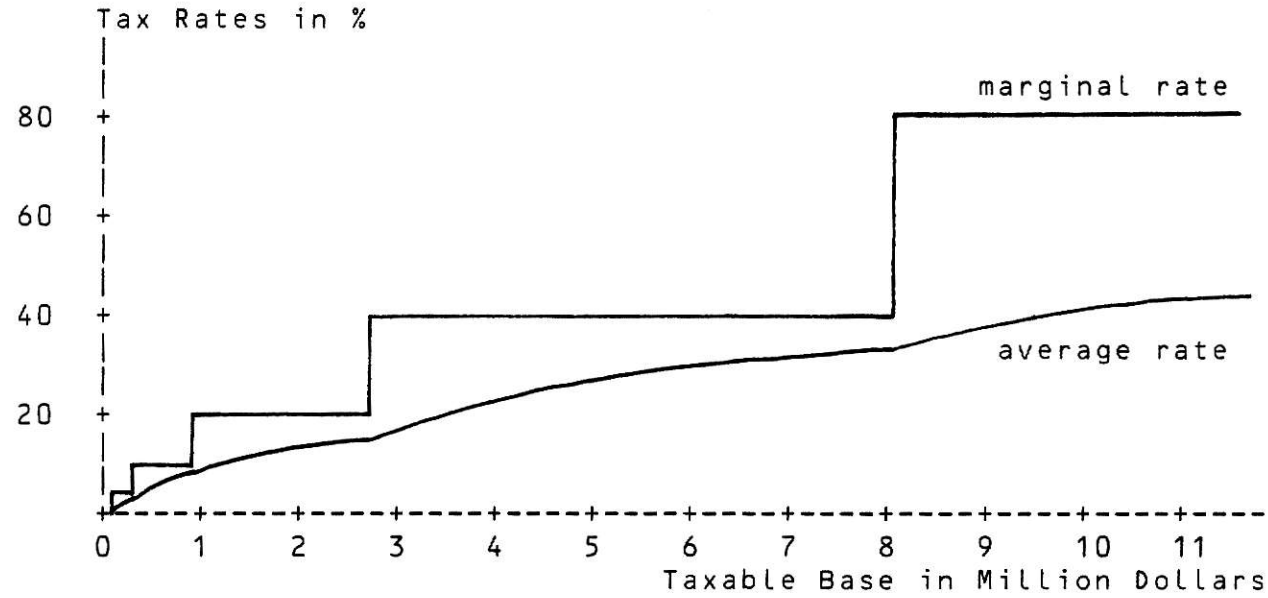

Figure 4.5: Curves of marginal and average inheritance tax rates used in hypothesis two.

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" is 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.[10]

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.[11]

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.[12]

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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10. See Alan S. Tait, The Taxation of Personal Wealth, (Urbana: University if Illinois Press, 1967), pp. 193-194.

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

12. See Bernard P. Herber, op.cit., p. 226.

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.[14]

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13. See Martin Feldstein, "Charitable Bequests, Estate Taxation, and Intergenerational Wealth Transfers," Public and Urban Economics, edited by Ronald Grieson, (Lexington: Lexington Books, 1976), pp. 104 and 106

14. See Josef E. Stiglitz, "Estate Taxes, Growth, and Redistribution," Public and Urban Economics, op.cit., p. 231

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:

$$T = (W-50{,}000)\ 0.005 + (W-150{,}000)\ 0.005 + (W-450{,}000)\ 0.01 + \\ + (W-1{,}350{,}000)\ 0.02 + (W-4{,}050{,}000)\ 0.04$$

Wealth	Marg. Tax Rate	Tax Amount	Tax as a Percentage of Wealth	Interest suppose rate is 4.6%	7.6%	12.5%
100,000	0.5	250	0.25	5.4	3.3	2.0
200,000	1.0	1,250	0.62	13.5	8.2	5.0
300,000	1.0	2,250	0.75	16.3	9.9	6.0
500,000	2.0	4,750	0.95	20.6	12.5	7.6
750,000	2.0	9,750	1.3	28.3	75.2	10.4
1,000,000	2.0	14,750	1.475	32.1	19.5	11.8
1,500,000	4.0	27,750	1.85	40.2	24.4	14.8
2,000,000	4.0	47,750	2.39	51.9	31.55	19.12
5,000,000	8.0	205,750	4.11	89.3	54.26	32.88
10,000,000	8.0	605,750	6.05	131.5	79.88	48.4
15,000,000	8.0	1,005,750	6.7	145.6	88.45	53.6

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.

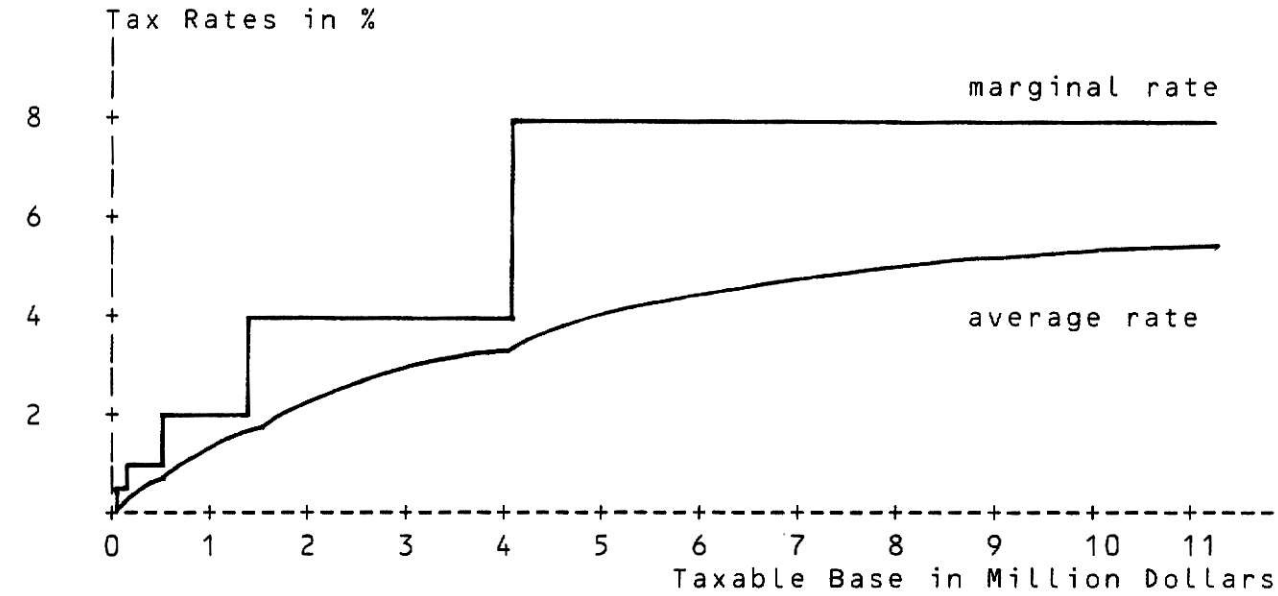

Figure 4.6: Curves of average and marginal tax rates of the general wealth tax.

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:

```
+       net wealth year [n-1] after taxes
-       expenditures for the education
-       possible losses of wealth
+       savings
-       dissavings
---------------------------------------
=       taxable base of wealth tax
-       wealth tax
---------------------------------------
=       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.[15] 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

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15. See documentation of these statements in Geoffrey Gordon, The Application of GPSS V to Discrete System Simulation, (Englewood Cliffs, N.J.: Prentice-Hall, 1975), p. 348

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 occurences 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.

Variable	Control	Hypothes.1	Hypothes.2	Hypothes.3
Year 1:				
Gini	0.46313	0.44919	0.45856	0.45513
Mean/Median	1.517	1.508	1.484	1.480
CRV	105.466	103.429	104.147	100.775
Year 51:				
Gini	0.64615	0.60180	0.49648	0.44071
Mean/Median	2.687	2.441	1.426	1.267
CRV	151.592	130.639	97.093	82.860
Year 101:				
Gini	0.74969	0.72407	0.55876	0.47129
Mean/Median	6.908	5.301	1.900	1.253
CRV	231.244	239.857	114.360	91.128

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 positivly 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 redistributional 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.

Variable	Hypoth.1	Hypoth.2	Hypoth.3	Hypoth.4	Hypoth.5
year 51					
Gini	-0.044	-0.149	-0.205	-0.105	-0.055
	-6.9%	-23.2%	-31.8%	-16.3%	-8.6%
m/m	-0.245	-1.261	-1.420	-1.016	-0.159
	-9.1%	-46.9%	-52.8%	-37.8%	-5.9%
CRV	-20.953	-54.499	-68.732	-33.546	-47.779
	-13.8%	-35.9%	-45.3%	-22.1%	-31.5%
year 101					
Gini	-0.025	-0.191	-0.278	-0.165	-0.087
	-3.4%	-25.5%	-37.1%	-22.0%	-11.7%
m/m	-1.607	-5.008	5.655	-3.401	-0.647
	-23.3%	-72.5%	-81.9%	-49.2%	-9.4%
CRV	8.613	-116.884	-140.116	-125.497	-23.232
	+3.7%	-50.5%	-60.6%	-54.3%	-10.0%

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.

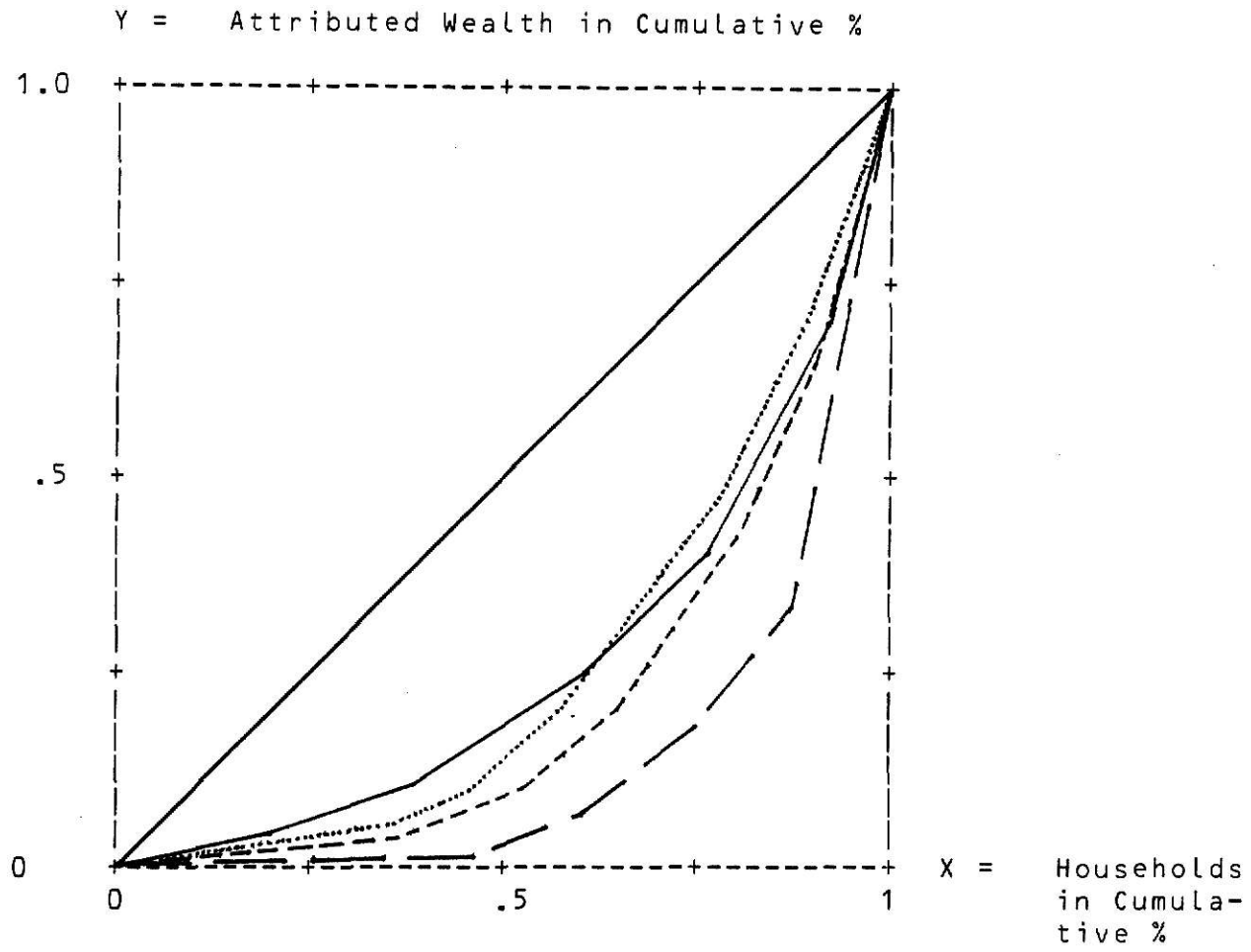

Figure 4.7: Lorenz-Curves for the hypotheses tested

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.

Variable	Hypoth.1	Hypoth.2	Hypoth.3	Hypoth.4	Hypoth.5
income					
51 vs 1	+1.58%	+0.33%	+0.17%	-1.25%	-0.16%
101 vs 1	+1.64%	+0.35%	+0.08%	-1.29%	-0.27%
wealth					
51 vs 1	+3.65%	+1.74%	+1.39%	-1.91%	-0.35%
101 vs 1	+2.98%	+1.44%	+0.90%	-1.54%	-0.54%

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.

Variable	Hypoth.1	Hypoth.2	Hypoth.3	Hypoth.4	Hypoth.5
income					
51 vs 1	+0.28%	-0.97%	-1.13%	-1.25%	-0.16%
101 vs 1	+0.64%	-0.65%	-0.92%	-1.29%	-0.27%
wealth					
51 vs 1	+0.43%	-1.46%	-1.81%	-1.89%	-0.35%
101 vs 1	+0.73%	-0.76%	-1.30%	-1.91%	-0.54%

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 redistributional 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.

A P P E N D I C E S

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.

```
BLOCK                                                                    STATEMENT
NUMBER  *LOC   OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS             NUMBER
               REALLOCATE BLO,500,VAR,60,BVR,20,COM,80000                     1
               RMULT      2002                                                2
               SIMULATE                                                       3
                                                                              4
        *      INFLUENCES ON THE PERSONAL DISTRIBUTION OF WEALTH              5
        *                                                                     6
        *      MATRICES:  MX1 (SAMPLESIZE,15)                                 7
        *                 CC   CONTENT                                        8
        *                 1    INDICATOR  0 -- NOT ACTIVE, 1 -- ACTIVE        9
        *                 2    WEALTH (BALANCED VARIABLE; WT=WT-1 +/-CHANGES) 10
        *                 3    HUMAN CAPITAL ACCUMULATED                      11
        *                 4    INGENUITY-PARAMETER                            12
        *                 5    RISK-PARAMETER FOR DETERMINING WEALTH-INTERESTS 13
        *                 6    ECONIMIC YEAR OF THE HOUSEHOLD ENTERING THE SYSTEM 14
        *                 7    YEAR  WHICH EDUCATION STARTS                   15
        *                 8    YEAR IN WHICH MARRIAGE TAKES PLACE             16
        *                 9    YEAR  WHICH FIRST SPOUSE DIES IN               17
        *                 10   YEAR  WHICH LAST SPOUSE DIES IN                18
        *                 11   WAELTH CLASS (1 - 2 - OR MORE)                 19
        *                 12   NUMBER OF CHILDREN (0 -- 4)                    20
        *                 13   LINE IN XREFERENCE MATRIX                      21
        *                 14   LINE OF PRECEDESSOR                           22
        *                 15   LINE OF PRECEDESSOR (WIFE)                     23
        *                                                                     24
        *      MATRIX MX2 (LINES,8)                                           25
        *      PROVIDES INFORMATION ABOUT NOT YET MARRIED GIRLS               26
        *                 CC   CONTENT                                        27
        *                 1    PLANNED HUMAN CAPITAL                          28
        *                 2    ACCUMULATED HUMAN CAPITAL                      29
        *                 3/4  YEAR IN WHICH EDUCATION/MARRIAGE STARTS        30
        *                 5    YEAR OF DEATH                                  31
        *                 6    WEALTH CLASS                                   32
        *                 7    PREDECESSOR'S LINE                             33
        *                 8    POINTER FOR WEALTH CLASS                       34
        *                                                                     35
```

```
*      MATRIX MX3 (LINES,8) IS CROSS-REFERENCE MATRIX                    36
*                 CC    CONTENT                                          37
*                 1     BEQUESTOR'S LINE                                 38
*                 2     NUMBER OF HEIRS                                  39
*                 3-8   HEIRS' LINES                                     40
*                                                                        41
*      MATRIX MX4 (4,6) IS POINTER MATRIX                                42
*                 CC    CONTENT                                          43
*                 1;1   AVAIL. SPACE MATRIX 1                            44
*                 1;2   "                   2                            45
*                 1;3   "                   3                            46
*                 3;1   FIRST ELEMENT OF WEALTH CLASS 1                  47
*                 3;N   FIRST ELEMENT OF WEALTH CLASS N                  48
*                 4;1   LAST ELEMENT OF WEALTH CLASS 1                   49
*                 4;1   LAST ELEMENT OF WEALTH CLASS N                   50
*                                                                        51
*      MATRIX MX5 (7,RUNTIME)  STORAGE MATRIX FOR ANNUAL VALUES          52
*                                                                        53
*                 1     WEALTH (BALANCED)                                54
*                 2     LABOR INCOME                                     55
*                 3     INTEREST INCOME                                  56
*                 4     TAXES PAID                                       57
*                 5     CONSUMPTION                                      58
*                 6     LOSSES                                           59
*                 7     SAMPLE SIZE                                      60
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*                2     LENGTH OF MATRIX 2                               65
*                3     LENGTH OF MATRIX 3                               66
*                4     STANDARD DEVIATION OF WEALTH DISTRIBUTION        67
*                5     MEAN OF WEALTH DISTRIBUTION                      68
*                6     MEAN OF HUMAN CAPITAL                            69
*                7     STANDARD DEVIATION OF SKILL DISTRIBUTION         70
*                8     MEAN OF SKILL DISTRIBUTION                       71
*                9     TAX-ALLOWANCE INHERITANCE TAX                    72
*               10     TAX-ALLOWANCE INCOME TAX                         73
```

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*                11-17 STORAGE VARIABLES FOR INCOME DATA                    74
*                18    TAX-ALLOWANCE WEALTH TAX                             75
*      HALFWORD  MAGE  MAXIMUM AGE IN PRE-SIMULATION                        76
*                SIZE  LAST LINE IN USE IN MATRIX 1                         77
*                SIZ1  LAST LINE IN USE IN MATRIX 2                         78
*                RUN   SIMULATION RUN TIME IN YEARS                         79
*                MIN   MINIMUM LABOR INCOME                                 80
*      BYTESIZE  VERS  VERSION CODE FOR INITIAL DISTRIBUTION                81
*                CLASS WEALTH CLASSES IN USE                                82
*                WAT   WEALTH TAX FLAG (1: WEALTH TAX LEVIED-- 0:NOT)       83
*                PRO   PROGRESSIVE TAX RATES FLAG (1: YES-- 0: NO)          84
*                EDPUB PUBLIC EDUCATION FLAG (1: YES-- 0: NO)               85
*      FLOATING  INT   INTEREST RATE WEALTH  (MAXIMUM RISK)                 86
*                ZIN   INTEREST RATE HUMAN CAPITAL (AVERAGE)                87
*                TAX   MINIMUM MARGINAL RATE INCOME TAX                     88
*                TAM   MAXIMUM MARGINAL RATE INCOME TAX                     89
*                IHT   MINIMUM MARGINAL RATE INHERITANCE TAX                90
*                IHM   MAXIMUM MARGINAL RATE INHERITANCE TAX                91
*                WAT   MINIMUM MARGINAL RATE WEALTH TAX                     92
*                WTM   MAXIMUM MARGINAL RATE WEALTH TAX                     93
*                                                                           94
*      DEFINITIONS                                                          95
*      MATRICES                                                             96
*                                                                           97
 1    MATRIX      MX,200,15                                                 98
 2    MATRIX      MX,100,8                                                  99
 3    MATRIX      MX,200,8                                                 100
 4    MATRIX      MX,4,6                                                   101
 5    MATRIX      MX,7,102                                                 102
*                                                                         103
```

```
*       TABLES                                                                  104
*                                                                               105
 1      TABLE       PF11,20000,20000,50         TABLE FOR WEALTH TABUL.         106
 2      TABLE       PF11,20000,20000,50         TABLE FOR WEALTH TABUL.         107
 3      TABLE       PF11,20000,20000,50         TABLE FOR WEALTH TABUL.         108
 4      TABLE       PF11,50000,50000,50         TABLE FOR WEALTH TABUL.         109
 5      TABLE       PF11,50000,50000,50         TABLE FOR WEALTH TABUL.         110
 6      TABLE       PF11,50000,50000,50         TABLE FOR WEALTH TABUL.         111
 7      TABLE       PF11,100000,100000,50       TABLE FOR WEALTH TABUL.         112
 8      TABLE       PF11,100000,100000,50       TABLE FOR WEALTH TABUL.         113
 9      TABLE       PF11,100000,100000,50       TABLE FOR WEALTH TABUL.         114
 10     TABLE       PF11,100000,100000,50       TABLE FOR WEALTH TABUL.         115
 11     TABLE       PF11,100000,100000,50       TABLE FOR WEALTH TABUL.         116
*                                                                               117
*       FUNCTIONS                                                               118
*                                                                               119
 1      FUNCTION    RN1,C2                      STOCH.EQUAL DISTRIBUTION        120
0,-1/1,1                                                                        121
*                                                                               122
 2      FUNCTION    RN1,C25                     STANDARD NORMAL DISTRIBUTION    123
0,-5/.00003,-4/.00135,-3/.00621,-2.5/.02275,-2/.06681,-1.5                      124
.11507,-1.2/.15866,-1/.21186,-.8/.27425,-.6/.34458,-.4/.42074,-.2               125
.5,0/.57926,.2/.65542,.4/.72575,.6/.78814,.8/.8134,1/.88493,1.2                 126
.93319,1.5/.97725,2/.99379,2.5/.99865,3/.99997,4/1,5                            127
*                                                                               128
 3      FUNCTION    RN1,C25                     LOGNORMAL DISTRIBUTION          129
0,.02352/.00003,.04979/.00135,.10540/.00621,.15335/.02275,.22313                130
.06681,.32465/.11507,.40656/.15866,.47237/.21186,.54881                         131
.27425,.63763/.34458,.74082/.42074,.86071/.5,1/.57926,1.16183                   132
.65542,1.34986/.72575,1.56831/.78814,1.82212/.8134,2.117                        133
.88493,2.45960/.93319,3.08022/.97725,4.48169/.99379,6.52082                     134
.99865,9.48773/.99997,20.08553/1,42.5102                                        135
*                                                                               136
 4      FUNCTION    RN1,C25                     INGENUITY PARAMETER             137
0,-5/.00003,-4/.00135,-3/.00621,-2.5/.02275,-2/.06681,-1.5                      138
.11507,-1.2/.15866,-1/.21186,-.8/.27425,-.6/.34458,-.4/.42074,-.2               139
.5,0/.57926,.2/.65542,.4/.72575,.6/.78814,.8/.8134,1/.88493,1.2                 140
.93319,1.5/.97725,2/.99379,2.5/.99865,3/.99997,4/1,5                            141
```

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 5     FUNCTION   RN1,C2                          AGING RANDOM YEARS               143
0,1/1,50                                                                         144
*                                                                                145
 6     FUNCTION   RN1,C2                          MARRIAGE AGE                     146
0,19/1,21                                                                        147
*                                                                                148
 7     FUNCTION   RN1,C2                          AGE OF DEATH                     149
0,56/1,75                                                                        150
*                                                                                151
 8     FUNCTION   PF2,C23                         AGE-INCOME PROFILE               152
15,.5/20,.75/25,.9/28,1/30,1.05/35,1.175/40,1.25/43,1.28                         153
45,1.3/47,1.275/50,1.2/53,1.1/55,1/58,.85/60,.7/62,.5                            154
63,.4/64,.375/65,.35/68,.275/70,.25/75,.2/100,.2                                 155
*                                                                                156
 9     FUNCTION   PF8,C11                         STOCHASTIC FOR WEALTH LOSSES     157
0,.184/250,.208/500,.236/750,.268/1000,.303/1250,.344                            158
1500,.389/1750,.441/1850,.464/1950,.488/2000,.5                                  159
*                                                                                160
 10    FUNCTION   RN1,D2                          PROBABILITY OF LOSSES            161
.95,0/1,1                                                                        162
*                                                                                163
 11    FUNCTION   PF10,E7                         LOCATIONS                        164
1,PF11/2,PF3/3,PF4/4,PF6/5,PF7/6,PF9/7,1                                         165
*                                                                                166
 12    FUNCTION   PF14,L7                         COLUMN CHANGE (MH2>MH1)          167
,2/,3/,7/,8/,10/,11/,14                                                          168
*                                                                                169
 13    FUNCTION   V32,C4                          WEALTH CLASS DETERMINATION       170
-4000,.001/-1,.001/1,.999/4000,.999                                              171
*                                                                                172
 14    FUNCTION   RN1,D2                          SEX DETERMINATION                173
.5,0/1,1000                                                                      174
*                                                                                175
 15    FUNCTION   V41,D12                         LOCATIONS FOR REORDERING         176
1,3/2,7/3,8/4,10/5,11/6,14/1001,1/1002,3/1003,4/1004,5                           177
1005,6/1006,7                                                                    178
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```

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 16    FUNCTION   V41,D12                          VALUES FOR REORDERING          180
1,3/2,7/3,8/4,9/5,11/6,1/1001,3/1002,7/1003,8/1004,9                               181
1005,11/1006,1                                                                     182
*                                                                                  183
 17    FUNCTION   RN1,C2                           AGING OF KIDS DURING BIRTH     184
0,1/1,4                                                                            185
*                                                                                  186
 18    FUNCTION   PF9,C4                           RATE OF INCOME-DEP. CONSUMP.   187
0,1/5000,1/25000,.5/100000000,.5                                                   188
*                                                                                  189
*      VARIABLE STATEMENTS                                                         190
*                                                                                  191
 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(4,PF13)'E'0)+(MX4(3,PF13)'E'0)                             194
 4     BVARIABLE  (PH1'LE'XH$MAGE)*(MX1(PF1,12)'E'0)                              195
 5     BVARIABLE  (PF15'E'PF1)+(PF16'E'PF1)                                       196
 6     BVARIABLE  BV7+BV8                                                         197
 7     BVARIABLE  (PF15'E'MX1(PF1,14))+(PF15'E'MX1(PF1,15))                       198
 8     BVARIABLE  (PF16'E'MX1(PF1,14))+(PF16'E'MX1(PF1,15))                       199
 9     BVARIABLE  (1200'L'MX1(PF1,4))+(160000'L'MX1(PF1,3))                       200
 10    BVARIABLE  (1300'L'MX1(PF1,4))+(170000'L'MX1(PF1,3))                       201
 11    BVARIABLE  (1300'L'MX1(PF1,4))*(170000'L'MX1(PF1,3))                       202
 12    BVARIABLE  BV13+(MX1(PF1,1)'E'0)                                           203
 13    BVARIABLE  ((MX1(PF1,13)'E'0)*(MX1(PF1,1)'E'1))                            204
*                                                                                  205
 1     VARIABLE   PF1+1                           POINTER LINE                    206
 2     FVARIABLE  XF5+XF4*FN*XB$VERS              WEALTH CREATION                 207
 3     FVARIABLE  (RN1/1000+FN13)*XF6             HUMAN CAPITAL CREATION          208
 4     FVARIABLE  FN4*XF7+XF8                     INGENUITY/GIFTS                 209
 5     FVARIABLE  (RN1/1000+FN13)*1000            RISK PARAMETER (0-2000)         210
 6     VARIABLE   FN5                             AGING START SAMPLE              211
 7     VARIABLE   PF6+12                          EDUCATION                       212
 8     VARIABLE   PF6+FN6                         MARRIAGE                        213
 9     FVARIABLE  FN13*15+PF6+FN7                 DEATH OF YOUNGER SPOUSE         214
,10    FVARIABLE  PF9+FN17                        DEATH OF ELDER SPOUSE           215
 11    FVARIABLE  FN13*XB$CLASS+1                 WEALTH CLASS (0-XB$CLAS)        216
 12    FVARIABLE  (RN1+RN1)/1330+2.75-0.75*PF11   NUMBER OF CHILDREN              217
```

```
13    VARIABLE    (PH1-XH$MAGE)@10                TABLE YEAR                              218
14    VARIABLE    (PH1-XH$MAGE)/10+1              TABLE NUMBER                            219
15    FVARIABLE   PF20*FN8*MX1(PF1,4)/1000+XH$MIN LABOR INCOME                            220
16    FVARIABLE   MX1(PF1,3)*XL$ZIN               RETURN ON HUMAN CAPITAL                 221
17    FVARIABLE   MX1(PF1,2)*XL$INT*FN9           WEALTH INCOME                           222
18    VARIABLE    PF3+PF4                         TOTAL INCOME                            223
19    VARIABLE    PF3+PF4-PF6                     DISPOSIBLE INCOME                       224
20    VARIABLE    PH1-MX1(PF1,6)                  PERSON'S AGE                            225
21    FVARIABLE   V19-V38                         CONSUMPTION                             226
22    FVARIABLE   MX1(PF1,2)*FN9*FN10             LOSSES OF WEALTH SPECULATION            227
23    VARIABLE    PF3+PF4-PF6-PF7                 NET WEALTH INCREASE                     228
24    VARIABLE    PH1-XH$MAGE+1                   STORAGE COLUMN IN MX1                   229
25    VARIABLE    PF5+10                          RENUMBER SAVEVALUES                     230
26    VARIABLE    PF10+10                         "                                       231
27    VARIABLE    PH1-5                           TIME RECALCULATION                      232
28    FVARIABLE   PF12*MX1(PF13,12)/5+1           YEARLY HUM. CAP COST                    233
29    FVARIABLE   PF12/5+1                        YEARLY HUM CAP AM. PER KID              234
30    VARIABLE    PF12-PF15                       ADJUSTED VALUE FOR HUM. CAP.            235
31    FVARIABLE   MX1(PF13,2)/(MX1(PF13,12)*5)  FINANCIABLE HUM. CAPITAL                 236
32    FVARIABLE   (PF2-XF5)/XF4                   WEALTH RELATIONSHIP                     237
33    FVARIABLE   MX1(PF13,2)/10                  WEALTH TRANSFER FOR MARRIAGE            238
34    FVARIABLE   (PF9+PF10)/2                    PARENTS' AVERAGE WEALTH                 239
35    VARIABLE    V36+V37                         STARTING WEALTH OF COUPLE               240
36    FVARIABLE   PF9/(4*MX3(PF27,2)+MX1(PF7,12)+1)  PERCENTAGE                           241
37    FVARIABLE   PF10/(4*MX3(PF28,2)+MX1(PF8,12)+1)  PERCENTAGE                          242
38    VARIABLE    (2+MX1(PF1,12)-PB2)*(MX1(PF1,11)*500+500) LUMP CONS                     243
39    VARIABLE    PF3+1000                        MATRIX CHANGE                           244
40    VARIABLE    PF9/1000+1                      MATRIX #                                245
41    VARIABLE    PF9+PF12                        INPUT FOR REORDER FUNCTION              246
42    VARIABLE    PF9+2                                                                   247
43    VARIABLE    MX1(PF1,3)*2+10000              PUBLIC SHARE OF EDUCATION               248
44    FVARIABLE   MX1(PF1,4)*XF6*PB1/1000         PUBLIC EDUCATION                        249
45    FVARIABLE   (MX1(PF1,2)-PF32)/(PF14-19)    EACH HEIR'S SHARE                       250
46    FVARIABLE   PF9*FN18                        INCOME DEP. CONSUMPTION                 251
47    VARIABLE    PH1+5                           TIME RELATIVATION                       252
48    VARIABLE    PF7-3                           COLUMN CHECK IN X-REF                   253
49    VARIABLE    MX3(PF12,2)+2                   POSSIBLE HEIRS                          254
50    VARIABLE    PF31-PF11                       WEALTH AFTER WEALTH-TAX                 255
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          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
                *                                                                        259
                *       CREATE MATRICES WITH POINTERS FOR AVAILABLE SPACE                260
                *                                                                        261
    1             GENERATE   ,,,1,,2PH,32PF,2PL,2PB      TRANSACTION                      262
    2             ASSIGN     1-2,1,PF                    LINE COUNTER AND MATRIX #        263
    3             MSAVEVALUE PF2,PF1,4,V1,MX             POINTER AVAIL. SPACE MAT #1      264
    4             ASSIGN     1+,1,PF                     INCREMENTLINE COUNTER            265
    5             TEST G     PF1,XF*PF2,*-2              1ST MATRIX READY?                266
    6             ASSIGN     2+,1,PF                     NEXT MATRIX                      267
    7             ASSIGN     1,1,PF                      INCREMENT LINE COUNTER           268
    8             TEST G     PF2,3,*-5                   3RD MATRIX READY?                269
    9             MSAVEVALUE 4,1,1-3,1,MX                INPOINTERS FOR MAT #1-3          270
                *                                                                        271
                *       CREATE ORIGINAL SAMPLE (50 HOUSEHOLDS)                           272
                *                                                                        273
   10      LOS    ASSIGN     1,1,PF                      CREATE SAMPLE                    274
   11             MSAVEVALUE 4,1,1,MX1(PF1,4),MX         UPDATE AVAIL. SPACE              275
   12             ASSIGN     1,2,PB                      ROW COUNTER                      276
   13             ASSIGN     PB1,V*PB1,PF                DEFINE VARIABLE #PB1             277
   14             MSAVEVALUE 1,PF1,PB1,PF*PB1,MX         STORE VARIABLE IN C PB1          278
   15             ASSIGN     1+,1,PB                     INCREMENT COLUMN COUNTER         279
   16             TEST GE    PB1,13,*-3                  LAST RELEVANT COLUMN DONE?       280
   17             MSAVEVALUE 1+,PF1,3,MX1(PF1,3),MX      UPDATE HUMAN CAPITAL             281
   18             TEST E     XB$EDPUB,1,*+4              PUBLIC EDUCATION?                282
   19             ASSIGN     1,2,PB                      SET 2-PERSON FLAG                283
   20             TEST L     MX1(PF1,3),V44,*+2          PUBL. ED. NECESSARY?             284
   21             MSAVEVALUE 1,PF1,3,V44,MX              DO PUBL. EDUCATION               285
   22             MSAVEVALUE 1,PF1,3,V43,MX              UPDATE HUMAN CAPITAL             286
   23             TEST G     PF6,XH$MAGE,*+2             ACTUAL AGE>MAX YEAR IN USE?      287
   24             SAVEVALUE  MAGE,PF6,XH                 RESET MAX YEAR                   288
   25             ASSIGN     1+,1,PF                     INCREMENT LINE COUNTER           289
   26             TEST G     PF1,XH$SIZE,LOS+1           SAMPLE COMPLETE?                 290
                *                                                                        291
   27             MSAVEVALUE 1,1-XH$SIZE,1,1,MX          MAKE SAMPLE ACTIVE               292
   28             SAVEVALUE  RUN+,XH$MAGE,XH             INCR. # OF RUNS WITH MAX AGE     293
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                *                                                                    294
                *       PRELIMINARY SIMULATION FOR AGING AND START OF MAIN SIMULATION 295
                *                                                                    296
29              ASSIGN  1,1,PH                      INITIALIZE YEAR COUNTER          297
30       CON    ASSIGN  1,1,PF                      INITIALIZE LINE COUNTER          298
31              TEST LE PF1,XH$SIZ1,*+7             SKIP IF MATRIX DONE              299
32              TEST NE BV2,1,*+6                   SKIP FOR EMPTY LINE              300
33              TEST LE MX2(PF1,3),PH1,*+3          EDUCATION DUE (FEMALE)?          301
34              TEST NE MX2(PF1,1),MX2(PF1,2),*+2   EDUCATION COMPLETE?              302
35              TRANSFER SBR,EDUF,5PF               EDUCATION                        303
36              TEST L  MX2(PF1,4),V27,*+2          UPDATE NECESSARY?                304
37              TRANSFER SBR,UPDF,5PF               UPDATE                           305
38              TEST NE BV1,1,REP                   SKIP EMPTY LINE                  306
39              TEST E  MX1(PF1,1),0,*+4            SKIP FOR ALREADY SAMPLED         307
40              TEST LE MX1(PF1,7),PH1,*+3          EDUCATION PROCESS STARTS?        308
41              TEST NE MX1(PF1,3),MX1(PF1,4),*+2   EDUCATION COMPLETE?              309
42              TRANSFER SBR,EDUM,5PF               SUBROUTINE EDUCATION             310
43              TEST E  BV12,1,LAT                  SKIP FOR ALREADY SAMPLED         311
44              TEST E  MX1(PF1,8),PH1,*+2          MARRIAGE DUE?                    312
45              TRANSFER SBR,MAR,5PF                SUBROUTINE MARRIAGE              313
46              TEST E  MX1(PF1,1),0,*+3            SKIP IF ALREADY SAMPLED          314
47              TEST L  MX1(PF1,8),V27,*+2          UPDATE NECESSARY?                315
48              TRANSFER SBR,UPDM,5PF               UPDATE MALE                      316
49       LAT    TEST E  MX1(PF1,10),PH1,*+2         DEATH DUE?                       317
50              TRANSFER SBR,DIE,17PF                                                318
                *                                                                    319
                *       UPDATE NEXT SAMPLE MEMBER                                    320
                *                                                                    321
51       REP    ASSIGN  1+,1,PF                     INCREMENT LINE COUNTER           322
52              TEST G  PF1,XH$SIZE,CCN+1           LAST SAMPLE MEMBER?              323
53              TEST GE PH1,XH$MAGE,ZUK             AV. RECORDS FOR AGING YEARS      324
54              TEST NE BV1,1,*+3                   SKIP FOR EMPTY LINE              325
55              TEST NE MX1(PF1,1),0,*+2            SKIP FOR YOUNGSTER               326
56              TRANSFER SBR,REC,5PF                RECORDING                        327
57              LOOP    1PF,*-3                     "                                328
58              ASSIGN  5,7,PF                      DUMMY VARIABLE                   329
59              MSAVEVALUE 5,PF5,V24,XF*V25,MX      KEEP YEARLY VARIABLES            330
60              LOOP    5PF,*-1                     DO ALL 5 VARIABLES               331
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61              TEST E      V13,0,*+3                                          332
62              SAVEVALUE   5,TB*V14,XF          UPD. VALUE "AVERAGE WEALTH"   333
63              SAVEVALUE   4,TD*V14,XF          " 'STD DEV WEALTH'            334
64              SAVEVALUE   11-17,0,XF           CLEAR VARIABLES               335
65              ADVANCE     1                    NEW YEAR IN REAL SIMUL.       336
66      ZUK     ASSIGN      1+,1,PH              INCREASE YEAR COUNTER         337
        *                                                                      338
        *       NEW SIMUALTION YEAR                                            339
        *                                                                      340
67              TEST G      PH1,XH$RUN,CON       RUNS ALL DONE?                341
68              TERMINATE   1                    STOP                          342
        *                                                                      343
        *       SUBROUTINE: RECORD MONEY VALUES FOR HOUSEHOLDS                 344
        *                                                                      345
69      REC     ASSIGN      2,V20,PF             PERSON'S AGE                  346
70              ASSIGN      20,V16,PF            1ST RETURN PART               347
71              TEST E      BV9,1,*+6            FURTHER RETURNS?              348
72              ASSIGN      20+,V16,PF           2ND RETURN PART               349
73              TEST E      BV10,1,*+4           FURTHER RETURNS?              350
74              ASSIGN      20+,V16,PF           3RD RETURN PART               351
75              TEST E      BV11,1,*+2           FURTHER RETURNS?              352
76              ASSIGN      20+,V16,PF           4TH RETURN PART               353
77              ASSIGN      8,MX1(PF1,5),PF      RISK VARIABLE                 354
78              ASSIGN      3,V15,PF             LABOR INCOME                  355
79              TEST E      V13,1,*+4            WEALTH-CLASS UPDATE NEC.?     356
80              TEST G      PH1,V51,*+3          UPDATE RELEVANT FOR HOUSEH.?  357
81              ASSIGN      2,MX1(PF1,2),PF      WEALTH                        358
82              MSAVEVALUE  1,PF1,11,V11,MX      DO UPDATE                     359
83              ASSIGN      4,V17,PF             INTEREST INCOME               360
84              ASSIGN      6,0,PF               RESET TAXES                   361
85              ASSIGN      30,XF10,PF           ALLOWANCE                     362
86              ASSIGN      1,XL$TAX,PL          RATE                          363
87              ASSIGN      31,V18,PF            INCOME                        364
88              TEST G      PF31,PF30,*+6        INCOME TAXABLE?               365
89              ASSIGN      6+,V52,PF            TAX AMOUNT                    366
90              ASSIGN      30,V53,PF            NEW ALLOWANCE                 367
91              ASSIGN      1+,XL$TAX,PL         NEW RATE                      368
92              TEST LE     PL1,XL$TAM,*+2       ALL THROUGH?                  369
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93    TEST E      XB$PRO,0,*-5          PROGRESSIVE RATES?                370
94    ASSIGN      2,0,PB                SET 2 SPOUSES                     371
95    TEST L      MX1(PF1,9),PH1,*+2    BOTH SPOUSES ALIVE?               372
96    ASSIGN      2,1,PB                SET 1 SPOUSE                      373
97    ASSIGN      7,V38,PF              LUMPSUM CONSUMPTION               374
98    ASSIGN      9,V21,PF              NOT USED INCOME                   375
99    TEST L      PF9,0,*+3             ENOUGH INCOME?                    376
100   ASSIGN      7,V19,PF              RESET CONSUMPTION                 377
101   ASSIGN      9,0,PF                RESET NOT UNSED INCOME            378
102   ASSIGN      7+,V46,PF             INC. DEPENDENT CONS.              379
103   ASSIGN      9,0,PF                RESET NOT UNSED INCOME            380
104   TEST G      PF8,700,*+2           NO LOSSES WITH SECURE ASSETS      381
105   ASSIGN      9,V22,PF              LOSSES DUE?                       382
106   ASSIGN      11,MX1(PF1,2),PF      WEALTH (T-1)                      383
107   ASSIGN      11-,PF9,PF            ADJUST FOR LOSSES                 384
108   ASSIGN      11+,V23,PF            ADJUST FOR YEARLY CHANGES         385
109   TEST LE     PF11,0,*+2            WEALTH NEGATIVE?                  386
110   ASSIGN      11,0,PF               IF SO, RESET TO ZERO              387
111   TEST E      XB$WAT,1,*+12         WEALTH TAX LEVIED?                388
112   ASSIGN      30,XF18,PF            ALLOWANCE                         389
113   ASSIGN      1,XL$WTA,PL           RATE                              390
114   ASSIGN      31,PF11,PF            WEALTH                            391
115   ASSIGN      11,0,PF               SET TAXES ZERO                    392
116   TEST G      PF31,PF30,*+5         WEALTH TAXABLE?                   393
117   ASSIGN      11+,V52,PF            TAX AMOUNT                        394
118   ASSIGN      30,V53,PF             NEW ALLOWANCE                     395
119   ASSIGN      1+,PL1,PL             NEW RATE                          396
120   TEST G      PL1,XL$WTM,*-4        ALL THROUGH?                      397
121   ASSIGN      6+,PF11,PF            SUM UP TAXES                      398
122   ASSIGN      11,V50,PF             AFTER TAX WEALTH                  399
123   MSAVEVALUE  1,PF1,2,PF11,MX       UPDATE WEALTH  (T)                400
124   TEST E      V13,0,*+2             TABLE DUE? (EACH 20TH YEAR)       401
125   TABULATE    V14                   DO TABLE                          402
126   ASSIGN      10,7,PF               DUMMY                             403
127   SAVEVALUE   V26+,FN11,XF          STORE VARIABLES                   404
128   LOOP        10PF,*-1              RUN AROUND                        405
129   TRANSFER    PF,5,1                                                  406
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        *                                                                       407
        *       SUBROUTINE: EDUCATION OF FEMALES                                408
        *                                                                       409
130      EDUF   ASSIGN      12,MX2(PF1,1),PF          PLANNED H.C.              410
131             ASSIGN      13,MX2(PF1,7),PF          LINE OF FATHER (PREDECESSOR) 411
132             ASSIGN      15,MX2(PF1,2),PF          ACCUMULATED H.C.          412
133             TRANSFER    SBR,EDU,16PF              GOSUB EDUCATION GENERAL   413
134             MSAVEVALUE  2+,PF1,2,PF14,MX          UPDATE ACCUMULATED HC     414
135             TRANSFER    PF,5,1                    RETURN                    415
        *                                                                       416
        *       SUBROUTINE: EDUCATION MALES                                     417
        *                                                                       418
136      EDUM   ASSIGN      12,MX1(PF1,3),PF          PLANNED HC                419
137             ASSIGN      13,MX1(PF1,14),PF         PREDECESSOR               420
138             ASSIGN      15,MX1(PF1,4),PF          ACCUMULATED HC            421
139             TRANSFER    SBR,EDU,16PF                                        422
140             MSAVEVALUE  1+,PF1,4,PF14,MX          UPDATE ACC. HC            423
141             TRANSFER    PF,5,1                    RETURN                    424
        *                                                                       425
        *       SUBROUTINE: EDUCATION COMMON                                    426
        *                                                                       427
142      EDU    TEST G      MX1(PF13,2),V28,*+6       WEALTH LARGE ENOUGH?      428
143             ASSIGN      14,V29,PF                 HC VALUE                  429
144             TEST L      V30,PF14,*+2              OVER-PAID?                430
145             ASSIGN      14,V30,PF                 RESET HC VALUE            431
146             MSAVEVALUE  1-,PF13,2,PF14,MX         UPDATE FATHER'S WEALTH    432
147             TRANSFER    PF,16,1                   RETURN                    433
148             ASSIGN      14,V31,PF                 SET AFFORDABLE HC         434
149             TRANSFER    ,*-3                                                435
        *                                                                       436
        *       SUBROUTINE: CREATE ONE HEAD FAMILY -- MOTHER                    437
        *                                                                       438
150      UPDF   ASSIGN      3,PF1,PF                  RESET LINE COUNTER        439
151             ASSIGN      1,MX4(1,1),PF             AVAILABLE LINE            440
152             MSAVEVALUE  4,1,1,MX1(PF1,4),MX       UPDATE POINTER            441
153             ASSIGN      14,7,PF                   DUMMY                     442
154             MSAVEVALUE  1,PF1,FN12,MX2(PF3,PF14),MX  REWRITE DATA           443
155             LOOP        14PF,*-1                                            444
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156             MSAVEVALUE 1,PF1,3,0,MX                    CLEAR "HIS" H.C.          445
157             MSAVEVALUE 1,PF1,15,MX1(PF1,14),MX         HER FATHER'S LINE         446
158             ASSIGN     6,MX1(PF1,7),PF                 START YEAR                447
159             ASSIGN     6-,12,PF                        REDO START YEAR           448
160             MSAVEVALUE 1,PF1,6,PF6,MX                  STORE START YEAR          449
161             TRANSFER   SBR,MAR1,16PF                   GOSUB                     450
162             MSAVEVALUE 1,PF1,14,0,MX                   "                         451
163             MSAVEVALUE 1,PF1,9,1,MX                    SET 1-SPOUSE MARK         452
164             ASSIGN     1,PF3,PF                        RESET OLD LINE            453
165             TRANSFER   PF,5,1                          RETURN                    454
          *                                                                          455
          *     SUBROUTINE: CREATE ONE HEAD FAMILY -- FATHER                         456
          *                                                                          457
166       UPDM  ASSIGN     7-8,MX1(PF1,14),PF              FATHER'S LINE             458
167             MSAVEVALUE 1,PF1,3,MX1(PF1,4),MX           UPDATE HC                 459
168             TRANSFER   SBR,MAR0,16PF                   GOSUB                     460
169             MSAVEVALUE 1,PF1,9,1,MX                    SET 1-SPOUSE MARK         461
170             TRANSFER   PF,5,1                          RETURN                    462
          *                                                                          463
          *     SUBROUTINE: SPECIAL "MARRIAGE" FOR PRE-SIMULATION                    464
          *                                                                          465
171             TRANSFER   SBR,MAR1,16PF                   GOSUB MAR1                466
172             TRANSFER   PF,5,1                          GO BACK                   467
          *                                                                          468
          *     SUBROUTINE: MARRIAGE -- FIND GIRL FOR MARRYING                       469
          *                                                                          470
173       MAR   TEST E     MX1(PF1,1),0,*-2                SKIP FOR PRE-SIMULATION   471
174             ASSIGN     2-4,MX1(PF1,11),PF              WEALTH CLASS              472
175             ASSIGN     3,MX4(3,PF2),PF                 1ST MATCHING GIRL         473
176             TEST NE    PF3,0,SEC                       ANY GIRL IN THAT CLASS?   474
177             TEST LE    MX2(PF3,4),V47,SEC              OLD ENOUGH?               475
178             TEST NE    MX1(PF1,14),MX2(PF3,7),*+3      NO BROTHER/SISTER MARRIAGE 476
179             TRANSFER   SBR,MAR1,16PF                   GOSUB                     477
180             TRANSFER   PF,5,1                          RETURN                    478
181             ASSIGN     3,MX2(PF3,8),PF                 NEXT GIRL                 479
182             TEST E     PF3,0,MAR+4                     GO BACK                   480
183       SEC   TEST E     PF2,PF4,THI                                               481
184             TEST L     PF2,XB$CLASS,THI                ANY HIGHER CLASS?         482
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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
        *                                                                                   489
        *       MARRIAGE RELATED UPDATING                                                   490
        *                                                                                   491
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             TEST NE     PF14,PF3,*+2                    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,*+3                     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
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220          MSAVEVALUE 1,PF1,5,V5,MX                STORE RISK-PARA                    521
221          ASSIGN     27,MX1(PF7,13),PF            HIS FATHER'S X-REF LINE            522
222          ASSIGN     28,MX1(PF8,13),PF            HER FATHER'S X-REF LINE            523
223          MSAVEVALUE 1,PF1,2,V35,MX               WEALTH                             524
224          MSAVEVALUE 1,PF1,4,V4,MX                INGENUITY                          525
225          MSAVEVALUE 1-,PF7,2,V36,MX              UPD. HIS FATHER'S WEALTH           526
226          MSAVEVALUE 1-,PF8,2,V37,MX              UPD. HER FATHER'S WEALTH           527
227          TEST NE    MX1(PF1,15),0,*+5            SINGLE MAN?                        528
228          MSAVEVALUE 1,PF1,12,V12,MX              # OF KIDS                          529
229          MSAVEVALUE 2,PF3,1-8,0,MX               CLEAR HER LINE                     530
230          MSAVEVALUE 2,PF3,4,MX4(1,2),MX          UPD. POINTER AV. SPACE             531
231          MSAVEVALUE 4,1,2,PF3,MX                 "                                  532
232     MAR1 TEST E     BV4,1,*+2                   NO KID IN PRELIM?                  533
233          MSAVEVALUE 1,PF1,12,1,MX                RESET # OF KIDS                    534
234          ASSIGN     4,MX4(1,3),PF                AV SPACE X-REF                     535
235          MSAVEVALUE 4,1,3,MX3(PF4,4),MX          UPD. AV. SPACE                     536
236          MSAVEVALUE 3,PF4,1-8,0,MX               CLEAR LINE IN X-REF                537
237          MSAVEVALUE 3,PF4,1,PF1,MX               STORE SOURCE IN X-REF              538
238          MSAVEVALUE 1,PF1,13,PF4,MX              STORE X-REF# DOWNSTREAM            539
239          TEST NE    MX1(PF1,12),0,*+2            KIDS?                              540
240          TRANSFER   SBR,KID,30PF                 GOSUB KIDS                         541
241          TRANSFER   SBR,NOK,30PF                 GOSUB NOKIDS                       542
242          TEST E     MX1(PF1,1),0,*+6             SKIP FOR PRE-SIMULATION            543
243          MSAVEVALUE 1,PF1,1,1,MX                 MAKE ACTIVE SAMPLE                 544
244          TEST E     XB$EDPUB,1,*+3               PUBL EDUCATION?                    545
245          TEST L     MX1(PF1,3),V44,*+2           PUBL. ED. NECESS.?                 546
246          MSAVEVALUE 1,PF1,3,V44,MX               SET PUBL. ED.                      547
247          MSAVEVALUE 1,PF1,3,V43,MX               ADD PUBL. SHARE TO H.C.            548
248          TEST NE    MX1(PF1,15),0,*+10           SINGLE MAN?                        549
249          ASSIGN     8,MX1(PF1,15),PF             PREC. LINE                         550
250          ASSIGN     15,MX1(PF8,13),PF            X-REF LINE OF FATHER               551
251          ASSIGN     17,3,PF                      DUMMY                              552
252          TEST NE    MX3(PF15,PF17),0,*+6         LINE IN X-REF THROUGH              553
253          TEST E     MX3(PF15,PF17),V39,*+3       RELEVANT LINE?                     554
254          MSAVEVALUE 3,PF15,PF17,PF1,MX           RESET LINE IN HERITAGE             555
255          TRANSFER   ,*+3                         END                                556
256          ASSIGN     17+,1,PF                     INCREASE DUMMY                     557
257          TRANSFER   ,*-5                         GOBACK                             558
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258             TRANSFER   PF,16,1                                                    559
        *                                                                             560
        *       SUBROUTINE: CREATING CHILDREN                                         561
        *                                                                             562
259      KID    ASSIGN     7,MX1(PF1,12),PF          # OF KIDS                       563
260             MSAVEVALUE 3,PF4,2,PF7,MX            STORE # OF KIDS                564
261             ASSIGN     8,3,PF                    DUMMY                          565
262      ZIE    ASSIGN     9-11,FN14,PF              ATTACH SEX                     566
263             ASSIGN     10,MX4(1,V40),PF          AV. SPACE                      567
264             MSAVEVALUE 4,1,V40,MX*V40(PF10,4),MX UPD. AV. SPACE                 568
265             ASSIGN     11+,PF10,PF               FIND LINE                      569
266             ASSIGN     6,PH1,PF                  ENTER AGE                      570
267             ASSIGN     6+,FN17,PF                SPREAD KIDS' BIRTHYEAR         571
268             MSAVEVALUE V40,PF10,4,0,MX           CLEAR LINE                     572
269             MSAVEVALUE V40,PF10,6,PF6,MX         STORE ENTER YEAR               573
270             MSAVEVALUE 3,PF4,PF8,PF11,MX         STORE VALUE IN X-REF           574
271             ASSIGN     1-,1,PF                   RESET LINE#                    575
272             ASSIGN     12,6,PF                   DUMMY                          576
273             MSAVEVALUE V40,PF10,FN15,V*FN16,MX   CREATE VALUES FOR THE KIDS     577
274             LOOP       12PF,*-1                  CIRCLE AROUND                  578
275             ASSIGN     1+,1,PF                   RESET PF1                      579
        *                                                                             580
        *       ORDER WOMEN IN THEIR MATRIX                                           581
        *                                                                             582
276             TEST G     PF11,1000,EMIL-3          SKIP FOR MALE KIDS             583
277             TEST G     PF10,XH$SIZ1,*+2          NEW LAST LINE IN MATRIX?       584
278             SAVEVALUE  SIZ1,PF10,XH              RESET "LAST LINE"              585
279             ASSIGN     13,MX2(PF10,6),PF         WEALTH CLASS                   586
280             ASSIGN     14,MX4(4,PF13),PF         LAST GIRL                      587
281             TEST NE    BV3,1,EMIL                FIRST ENTRY?                   588
282             TEST GE    MX2(PF10,4),MX2(PF14,4),VORN                             589
283             MSAVEVALUE 2,PF14,8,PF10,MX          UPDATE POINTER                 590
284             MSAVEVALUE 4,4,PF13,PF10,MX          "                              591
285             TRANSFER   ,EMIL+1                                                   592
286      VORN   ASSIGN     14,MX4(3,PF13),PF         ORDER TO COMPARE               593
287             TEST LE    MX2(PF10,4),MX2(PF14,4),*+7  IN PLACE ?                  594
288             MSAVEVALUE 2,PF10,8,PF14,MX          DOWN POINTER                   595
289             TEST E     MX4(3,PF13),PF14,*+3      FIRST OF ROW?                  596
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290             MSAVEVALUE 4,3,PF13,PF10,MX          NEW INPOINTER                    597
291             TRANSFER   ,*+2                                                       598
292             MSAVEVALUE 2,PF15,8,PF10,MX          UPDATE ALTERNATIVELY             599
293             TRANSFER   ,EMIL+1                                                    600
294             ASSIGN     15,PF14,PF                RESET                            601
295             ASSIGN     14,MX2(PF15,8),PF         REDEFINE PH14                    602
296             TRANSFER   ,VORN+1                                                    603
297             TEST G     PF10,XH$SIZE,*+4          SKIP FOR NOT LAST LINE           604
298             SAVEVALUE  SIZE,PF10,XH              RESET LAST LINE                  605
299             TRANSFER   ,*+2                      SKIP LINE                        606
300     EMIL    MSAVEVALUE 4,3-4,PF13,PF10,MX        BOTH POINTERS                    607
301             ASSIGN     8+,1,PF                   NEW X-REF COLUMN                 608
302             ASSIGN     7-,1,PF                   DECREASE # OF KIDS DUE           609
303             TEST LE    PF7,0,ZIE                 READY?                           610
304             TRANSFER   PF,30,2                   RETURN                           611
        *                                                                             612
        *       SUBROUTINE: INHERITAGE RULES FOR NO-CHILDREN SITUATION                613
        *                                                                             614
305     NOK     ASSIGN     7,3,PF                    X-REF COLUMN                     615
306             ASSIGN     8,MX1(PF1,15),PF          HER FATHER'S LINE                616
307             TEST NE    PF8,0,ZWI                 LINE EXISTS?                     617
308             ASSIGN     11,MX1(PF8,13),PF         FATHER'S X-REF                   618
309             TEST G     MX3(PF11,2),1,ZWI         MORE THAN 1?                     619
310             ASSIGN     9,MX3(PF11,2),PF          FATHER HAD # KIDS                620
311             ASSIGN     10,3,PF                   COLUMN #                         621
312             TEST LE    PF10,V42,*+7              THROUGH?                         622
313             TEST L     MX3(PF11,PF10),1000,*+4   NOT MARRIED SISTER?              623
314             TEST NE    MX3(PF11,PF10),PF1,*+3    YOURSELF?                        624
315             MSAVEVALUE 3,PF4,PF7,MX3(PF11,PF10),MX  TRANSFER                      625
316             ASSIGN     7+,1,PF                   INCREASE CHECK COLUMN            626
317             ASSIGN     10+,1,PF                  INCREASE TAKEN CLOUMN            627
318             TRANSFER   ,*-6                                                       628
319     ZWI     TEST NE    MX1(PF1,14),PF8,ENDE      BOTH PARENTS THROUGH?            629
320             TEST NE    MX1(PF1,14),0,ENDE        ALREADY DONE?                    630
321             ASSIGN     8,MX1(PF1,14),PF          RESET PF8                        631
322             TRANSFER   ,NOK+3                                                     632
323     ENDE    MSAVEVALUE 3,PF4,2,V48,MX            STORE # OF SUCCESS.              633
324             TRANSFER   PF,30,1                   RETURN                           634
```

```
*                                                                          635
*       SUBROUTINE: DEATH AND BEQUEST                                      636
*                                                                          637
325     DIE   ASSIGN      2-16,0,PF                                        638
326           ASSIGN      20-32,0,PF                                       639
327           ASSIGN      12,MX1(PF1,13),PF       X-REFERENCE              640
328           ASSIGN      13,3,PF                 DUMMY #1                 641
329           TEST NE     MX3(PF12,2),0,RID       NO HEIR AT ALL?          642
330           ASSIGN      14,20,PF                DUMMY #2                 643
331           ASSIGN      PF13,MX3(PF12,PF13),PF  POSSIBLE HEIR'S LINE     644
332           TEST LE     PF*PF13,1000,WEI        RELEVANT LINE?           645
333           ASSIGN      15,MX1(PF*PF13,14),PF   THIS MAN'S FATHER        646
334           ASSIGN      16,MX1(PF*PF13,15),PF   THIS WOMAN'S FATHER      647
335           TEST E      BV5,1,SIS               CHILDREN EXIST?          648
336           ASSIGN      1,1,PB                  FLAG FOR CHILDREN        649
337           ASSIGN      PF14,PF*PF13,PF         REORDER VALUE            650
338           ASSIGN      14+,1,PF                INCREMENT                651
339     WEI   ASSIGN      13+,1,PF                INCREMENT                652
340           TEST G      PF13,V49,DIE+6          ALL THROUGH?             653
341           ASSIGN      14-,1,PF                RESET PF14               654
342           TEST G      PF14,19,RID+1           SKIP FOR NO VALID HEIR   655
343           ASSIGN      31,MX1(PF1,2),PF        WEALTH                   656
344           ASSIGN      30,XF9,PF               ALLOWANCE                657
345           ASSIGN      1,XL$IHT,PL             TAXRATE                  658
346           ASSIGN      32,0,PF                 RESET TAX AMOUNT         659
347           TEST G      PF31,PF30,*+6           DUE?                     660
348           ASSIGN      32+,V52,PF              AMOUNT                   661
349           ASSIGN      30,V53,PF               NEW ALLOWANCE            662
350           ASSIGN      1+,PL1,PL               NEW RATE                 663
351           TEST LE     PL1,XL$IHM,*+2          ALL THROUGH?             664
352           TEST E      XB$PRO,0,*-5            PROGRESSIVE RATES?       665
353           TEST E      PB1,2,*+4               2ND DEGREE HEIRS?        666
354           ASSIGN      32+,PF32,PF             NEW AMOUNT               667
355           TEST L      PF31,PF32,*+2           TAXES > 100%?            668
356           ASSIGN      32,PF31,PF              RESET THEN               669
357           ASSIGN      11,V45,PF               EACH HEIR'S SHARE        670
358           MSAVEVALUE  1+,PF*PF14,2,PF11,MX    BEQUEST                  671
359           ASSIGN      14-,1,PF                DECREMENT                672
```

```
360             TEST L      PF14,20,*-2                 DO ALL                          673
        *                                                                               674
361             SAVEVALUE   14+,PF32,XF                 INHERITANCE TAX                 675
362      CLE    MSAVEVALUE  1,PF1,1-15,0,MX             CLEAR LINE                      676
363             MSAVEVALUE  1,PF1,4,MX4(1,1),MX         UPD. AV. SPACE                  677
364             MSAVEVALUE  4,1,1,PF1,MX                UPD. POINTER                    678
365             MSAVEVALUE  3,PF12,1-8,0                CLEAR X-REF                     679
366             MSAVEVALUE  3,PF12,4,MX4(1,3),MX        UPD. AVAIL. SPACE               680
367             MSAVEVALUE  4,1,3,PF12,MX               UPD. POINTER                    681
368             TRANSFER    PF,17,1                     RETURN                          682
        *                                                                               683
369      SIS    TEST E      BV6,1,RID                   NO HEIR?                        684
370             ASSIGN      1,2,PB                      FLAG FOR BROTHERS/SISTERS       685
371             TRANSFER    ,WEI-2                                                      686
        *                                                                               687
372      RID    TEST E      PF13,3,WEI                  VALID CHECK?                    688
373             SAVEVALUE   14+,MX1(PF1,2),XF           INHERITANCE TAX                 689
374             TRANSFER    ,CLE                                                        690
        *                                                                               691
                INITIAL     XF1,200/XF2,100/XF3,200/XF4,20000/XF5,100000                692
                INITIAL     XF6,25000/XF7,200/XF8,1000/XF9,100000                       693
                INITIAL     XF10,6000/XF11-XF17,0/XF18,50000/XL$WTA,.005                694
                INITIAL     XH$MAGE,0/XH$SIZE,50/XH$SIZ1,0/XH$RUN,100                   695
                INITIAL     XB$WAT,0/XB$EDPUB,0/XL$WTM,.08/XB$PRO,0                     696
                INITIAL     XL$TAX,.15/XL$TAM,.45/XL$IHT,.05/XL$IHM,.8                  697
                INITIAL     XL$INT,.25/XL$ZIN,.10                                       698
                INITIAL     XB$CLASS,3/XB$VERS,1/XH$MIN,5000                            699
        *                                                                               700
                START       1                                                           701
        *                                                                               702
                CLEAR                                                                   703
                INITIAL     XF1,200/XF2,100/XF3,200/XF4,20000/XF5,100000                704
                INITIAL     XB$WAT,0/XB$EDPUB,0/XL$WTM,.08/XB$PRO,0                     705
                INITIAL     XB$CLASS,3/XB$VERS,2/XH$MIN,5000                            706
        *                                                                               707
                START       1                                                           708
        *                                                                               709
```

```
         CLEAR                                                                  710
 4       FVARIABLE  75485*FN*XB$VERS                                            711
         INITIAL    XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000                712
         INITIAL    XB$WAT,0/XB$EDPUB,0/XL$WTM,.08/XB$PRO,0                     713
         INITIAL    XB$CLASS,3/XB$VERS,3/XH$MIN,5000                            714
*                                                                               715
         START      1                                                           716
                                                                                717
         CLEAR                                                                  718
         INITIAL    XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000                719
         INITIAL    XB$WAT,0/XB$EDPUB,1/XL$WTM,.08/XB$PRO,0                     720
         INITIAL    XB$CLASS,3/XB$VERS,3/XH$MIN,5000                            721
*                                                                               722
         START      1                                                           723
*                                                                               724
         CLEAR                                                                  725
         INITIAL    XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000                726
         INITIAL    XB$WAT,0/XB$EDPUB,1/XL$WTM,.08/XB$PRO,1                     727
         INITIAL    XB$CLASS,3/XB$VERS,3/XH$MIN,5000                            728
*                                                                               729
         START      1                                                           730
*                                                                               731
         CLEAR                                                                  732
         INITIAL    XF1,200/XF2,100/XF3,200/XF4,75505/XF5,100000                733
         INITIAL    XB$WAT,1/XB$EDPUB,1/XL$WTM,.08/XB$PRO,1                     734
         INITIAL    XB$CLASS,3/XB$VERS,3/XH$MIN,5000                            735
*                                                                               736
         START      1                                                           737
         END                                                                    739
```

-SYMBOL	NUMBER	CROSS-REFERENCE BLOCKS REFERENCES				
CLE	362	690				
CON	30	323	341			
DIE	325	318	653			
EDU	142	413	422			
EDUF	130	303				
EDUM	136	310				
EMIL	300	583	588	592	600	
ENDE	323	629	630			
KID	259	541				
LAT	49	311				
LOS	10	290				
MAR	173	313	480	484	485	488
MARH	201	500				
MARI	191	450	477			
MARO	210	460				
MAR1	232	466				
NOK	305	542	632			
REC	69	327				
REP	51	306				
RID	372	642	655	684		
SEC	183	474	475			
SIS	369	648				
THI	187	481	482			
UPDF	150	305				
UPDM	166	316				
VORN	286	589	603			
WEI	339	645	686	688		
ZIE	262	610				
ZUK	66	324				
ZWI	319	617	619			

CROSS-REFERENCE
FLOATING POINT SAVEVALUES

-SYMBOL	NUMBER	REFERENCES		
IHM	8	664	697	
IHT	7	658	697	
INT	2	222	698	
TAM	4	369	697	
TAX	3	363	368	697
WTA	5	390	694	
WTM	6	397	696	
ZIN	1	221	698	

-SYMBOL	NUMBER	REFERENCES		CROSS-REFERENCE BYTE SAVEVALUES
CLASS	2	216	482	699
EDPUB	3	282	545	696
PRO	4	370	665	696
VERS	1	207	699	
WAT	5	388	696	

CROSS-REFERENCE
HALFWORD SAVEVALUES

-SYMBOL	NUMBER	REFERENCES							
MAGE	1	195	218	219	229	287	288	293	324695
MIN	2	220	699						
RUN	4	293	341	695					
SIZE	3	290	292	323	604	605	695		
SIZ1	5	299	584	585	695				

**** ASSEMBLY TIME = .04 MINUTES ****

Appendix Two:

Development of Inequality Due to Different Initial Distributions

a) "uniform distribution"

Year	Gini-Coefficient		Mean/Median Rel.		CRV	
	Absol.	Av.% Ch.	Absol.	Av.% Ch.	Absol.	Av.% Ch.
1	0.1491	-.-	1.003	-.-	26.40	-.-
11	0.4090	+10.618	1.203	+1.829	76.93	+11.288
21	0.4831	+9.983	1.550	+2.197	94.679	+6.594
31	0.5744	+4.598	2.129	+2.538	123.00	+5.263
41	0.6063	+3.569	2.162	+1.937	137.63	+4.214
51	0.5949	+2.806	1.857	+1.238	119.84	+3.072
61	0.6745	+2.547	4.336	+2.469	143.52	+2.865
71	0.6708	+2.172	3.666	+1.868	150.77	+2.520
81	0.7289	+2.003	8.498	+2.706	186.34	+2.473
91	0.7336	+1.786	8.013	+2.335	198.15	+2.265
101	0.7284	+1.599	17.748	+2.914	221.37	+2.149

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

b) normal distribution

Year	Gini-Coefficient		Mean/Median Rel.		CVR	
	Absol.	Av.% Ch.	Absol.	Av.% Ch.	Absol.	Av.% Ch.
1	0.1875	-.-	1.019	-.-	34.61	-.-
11	0.4559	+9.292	1.583	+4.503	87.47	+9.714
21	0.5280	+5.313	1.779	+2.825	107.11	+5.811
31	0.5353	+3.558	2.379	+2.866	130.79	+4.531
41	0.6293	+3.073	2.692	+2.458	140.78	+3.570
51	0.6548	+2.533	2.742	+1.999	139.45	+2.826
61	0.6803	+2.171	3.881	+2.254	160.57	+2.590
71	0.6748	+1.846	3.716	+1.865	172.57	+2.322
81	0.6694	+1.604	4.601	+1.902	183.19	+2.105
91	0.6660	+1.418	5.410	+1.872	175.89	+1.823
101	0.6627	+1.270	5.423	+1.686	243.69	+1.971

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

c) Lognormal distribution

Year	Gini-Coefficient		Mean/Median Rel.		CRV	
	Absol.	Av.% Ch.	Absol.	Av.% Ch.	Absol.	Av.% Ch.
1	0.4631	-.-	1.517	-.-	105.47	-.-
11	0.5125	+1.019	1.801	+1.731	122.43	+1.502
21	0.5619	+0.972	2.051	+1.519	116.66	+0.506
31	0.5767	+0.734	2.687	+1.924	141.00	+0.973
41	0.5918	+0.615	2.782	+1.528	153.47	+0.942
51	0.6461	+0.668	2.687	+1.150	151.59	+0.728
61	0.6729	+0.625	3.691	+1.493	167.50	+0.774
71	0.6922	+0.576	3.636	+1.257	163.92	+0.634
81	0.7115	+0.538	5.390	+1.597	193.20	+0.759
91	0.7306	+0.508	4.225	+1.144	211.66	+0.777
101	0.7497	+0.483	6.908	+1.527	231.24	+0.788

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 be 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

ENTRIES IN TABLE	MEAN	STANDARD DEV	SUM OF ARGUMENTS ...
60	22,081	118,109.7	1,341,500

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE
10,000	20	33.33	33.3
20,000	9	15.00	48.3
30,000	12	20.00	68.3
OVERFLOW	19	31.67	100.0
AVERAGE VALUE OF OVERFLOW		42,000	

The corrected sum of arguments is

	1,341,500
- 19 times average value of overflow	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	535,000
unexplained		8,500
per argument (divided by 60)		207.3

Reorganized table adjusted with 207.3

OBSERVED FREQUENCY	PERCENT OF TOTAL	CUMULATIVE PERCENTAGE	CLASS MEAN	PERCENT OF TOTAL	CUMULATIVE PERCENTAGE
20	33.33	33.3	5,207.3	7.76	7.8
9	15.00	48.3	15,207.3	10.20	18.0
12	20.00	68.3	25,207.3	22.55	40.5
19	31.67	100.0	42,000	59.49	100.0

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

OBSERVED FREQUENCY	PERCENT OF TOTAL	CUMULATIVE PERCENTAGE	CLASS MEAN	PERCENT OF TOTAL	CUMULATIVE PERCENTAGE
20	33.33	33.3	5,207.3	7.76	7.8
19	35.00	68.3	20.921.6	32.75	40.5
19	31.67	100.0	42,000	59.49	100.0
60	100.00	---	20,081	100.00	---

Out of this information the Gini-Coefficient is calculated.

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METHODS OF INFLUENCING THE DISTRIBUTION OF WEALTH: A SIMULATION STUDY

by

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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.