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INCOME DISTRIBUTION: SECOND THOUGHTS*

BY

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1 ON THE STRUCTURE OF A THEORY OF INCOME DISTRIBUTION

1.1 *Introductory*

1.1.1 In the last decade or so numerous authors have contributed to our understanding of income distribution, both by theoretical and by empirical work. The theories presented differ in many ways, depending on the use the authors want to make of them: for suggesting radical reforms or less radical adjustments such as 'income policies,' for forecasting, for satisfying their curiosity or perhaps for opposing reforms. The theories also differ in accordance with some well-known general schools of thought, not unrelated to political preferences: neo-classical, or neo-Marxist; or in accordance with innovation ventures: human capital theory and its alternative elaborations (Mincer 1970; Blaug 1976) screening and training cost theory (Thurow 1975) *etc.*

1.1.2 Also the attempts to test statistically the various theories or versions show considerable differences in approach. Some authors restrict themselves to an attempt to explain rather general features of income distributions, such as the lognormal or similar forms (Houthakker 1974) or the values of some distribution parameters (Osberg 1975). Others (Taubman *c.s.* 1974, 1976; Wise 1975) make an attempt to explain individual incomes or earnings for samples of considerable size, using as independent variables a considerable number of relevant factors, such as job characteristics, personality traits or personal performance indicators. Often they also use, for lack of better information, a number of proxies or dummies – one of the problems to be discussed later. Among the empiricists a

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group of considerable importance shows a keen interest in the phenomenon of genetic and early environmental determinants and concentrates on these independent variables (Duncan, Featherman and Duncan 1968; Bowles 1972; Bowles and Gintis 1973, 1976; Bowles and Nelson 1974; Husén 1968; Taubman 1977). No attempt has been made to give a complete list; on the contrary, the sources mentioned are illustrations only and purposely contain two survey articles in which long lists of publications can be found. Special mention should be made, however, of empirical research carried out by Van Praag (1971, 1973, 1975) who collected data on some thousands of consumers with a view to investigate the impact of income and some other determinants on utility as measured by him.

1.1.3 The objective of this article is twofold. Part 1 contains a reformulation of a theory on income distribution published in 1975 (Tinbergen 1975). This reformulation is an attempt to: (i) profit from some critical appraisals published meanwhile (Atkinson 1975; Chiswick 1976; Haveman 1976; Kuipers 1976; Osberg 1976; Wood 1975); (ii) react to some recent contributions to the subject which I had not come across while writing my text (Bowles and Gintis 1976; Taubman 1974 and later, Thurow 1976); and (iii) clarify some misunderstandings concerning my previous work apparent from the reviews.

Part 2 of the present article constitutes a critical analysis of the empirical material available at present with a view to suggest further programmes of data collection more relevant to the threefold objective pursued in my 1975 book, namely (a) to explain income distribution; (b) to define and identify an equitable income distribution; and (c) to indicate means to approach what I consider to be an equitable income distribution.

1.1.4 It seems useful to delineate the area of research to be covered. I propose to leave out non-factor income, that is income from social security benefits. In addition only secondary attention will be given to income from land and physical capital, although part of the analysis also covers these factor incomes.

Next, I submit that among the variables to be included in our models those representing, in the widest sense, means to affect income distribution, or policy parameters, should be included. In fact, not only quantitative means (or 'instruments'), but also qualitative such as 'institutions' should be included. Among the institutions we will consider education, tax systems or research and development (R and D). When discussing changes in institutions the costs involved, in the widest sense, should be among the variables, including costs of education which I neglected in previous work. The effect on my conclusions is minor, however.

Finally, into a complete treatment of our subject we have to integrate all types of learning processes, including conceivable new learning processes. Learning processes may be irrelevant, but this only applies to human qualities which are innate in the strict sense.

1.2 *Features of a Theory of Income Formation*

1.2.1 It is essential, for an attempt to understand the formation and distribution of incomes from production, to deal with the *supply* and the *demand* side of the compartments of the factor income markets, even if some of these markets are far from perfect. At the moment of the first contacts between those who potentially are supplying a factor and those who are demanding a factor, variables are determining the behaviour of each side which are mutually exclusive. Although these first contacts may lead to a common decision on further training for a job, as emphasized by Thurow (Thurow 1972) for the labour market, which makes supply and demand partly interrelated, at the moment of the first contact this is not so. At most there is an amount of information on the general situation of the labour market that may be available to both partners. The prospective employer, in this presentation of the facts, will look for the potential employee who, because of his personality traits, will require a minimum of training costs.

Whereas I see the distinction between the supply and the demand side as relevant for the whole model I want to emphasize this relevance in particular for the so-called earnings function; but I submit that it also exists for income functions reflecting incomes from other factors (land and capital).

1.2.2 For the labour market the supply side may be characterized by what we usually call *personality traits* or performance characteristics, and the demand side by *job characteristics*, which are the subject of the process of *job evaluation* or of *occupational titles* as given, for instance, in the Dictionary of Occupational Titles. In our theory and our research inquiries we should aim at a maximum of *symmetry:* in the process of negotiations between demand and supply the aim is to find, for a set of jobs, the 'right men (women) in the right place' and this implies that we compare the job characteristics or *required qualifications* with the actually *available qualifications* or personality traits. If the job requires, in order to be carried out appropriately, some level of IQ, some level of dexterity in handling materials, some level of cooperation with various categories of other people, and so on, then we should know, as personality traits, the levels available on the supply side, that is, from the potential employees, in order to find out what additional training is required in order to perform the job to be filled.

1.2.3 I said that we should aim at a *maximum* of symmetry. This symmetry

applies to the personality traits relevant to the job. Beyond these there are personality traits or elements of needs and tastes which are relevant for the individual's satisfaction or utility, but not always to the choice of a job. They appear in that satisfaction and hence on the supply side, without having a counterpart on the demand side.

1.2.4 I also said (towards the end of Section 1.2.2) that a *sufficient* number of personality traits and job characteristics should be defined and measured. My intention here was twofold. On the one hand I wanted to admit that the examples I gave in a previous publication (Tinbergen 1975) were too restricted: they contained only the one well-known characteristic of years of schooling, with an occasional reference to a second one called 'degree of independence of decision making.' From unpublished material obtained from the personnel department of AKZO corporation I deduced with the aid of factor analysis[1] that in their system they used more aspects than necessary for the explanation of the variance in earnings, in the order of fifteen. It proved possible to reduce to four the number of (sufficiently) independent aspects, still enabling us to explain a very large part (some 85 per cent) of the variance in earnings.

1.3 *Alternative Mathematical Formulations*

1.3.1 For the *mathematical setup* of a demand-supply theory of the labour market at least *two different* approaches are available. One approach is to consider individual job characteristics and personality traits as *continuous* variables. The frequencies of some given combination of supply and demand are not, then, entered as continuous variables into supply and demand equations but represented by parameters of their distributions. These parameters will thus be hidden in the coefficients of the earnings equation derived from these functions.

Another approach is the one where job characteristics (demand) and personality traits (supply) are given *discrete values* and the frequencies in cells designated by combination of the supply and demand characteristics are dealt with as continuous variables. In Sections 1.3.2 and 1.3.3 examples will be given of these two approaches. In these sections the simple assumption will be used that demand for and supply of manpower in any one compartment only depends on the price (wage, earnings) of that compartment. A generalization toward dependency on prices in other compartments will be discussed in Section 1.3.5.

1.3.2 As an example of the *first* approach let us assume that, for one personality trait s the frequency density distribution is:

$$x^S = x_0^S - s^2 + 2\bar{s}s - \bar{s}^2 + \alpha' w \tag{1.3.1}$$

1 I want to express my thanks to Joop Hartog who carried out the factor analysis.

admitting only positive values of x^S. We also assume that for one job characteristic d, corresponding with s and measured along the same scale the demand function can be written (again only for positive values of x^D):

$$x^D = x_0^D - d^2 + \alpha_1 d - \alpha'' w_{sd} \tag{1.3.2}$$

where w_{sd} is the price or earnings for a person with personality trait s working in a job with job characteristic d. Both formulae represent, in their dependence on s resp. d part of an inverted parabola and hence a frequency distribution close to familiar forms. Equilibrium between supply of and demand for labour in a compartment around s, d will then require that the supply and demand densities are equal, leading to:

$$\alpha w_{sd} = x_0^D - d^2 + \alpha_1 d - x_0^S + s^2 - 2\bar{s}s + \bar{s}^2 \tag{1.3.3}$$

where $\alpha = \alpha' + \alpha''$.

Keeping in mind that:

(i) x_0^D, x_0^S and $\bar{s}^2$ are constants and writing $x_0^D - x_0^S + \bar{s}^2 = \alpha_0$

(ii) that for relevant (that is, non-empty) compartments the values of d and s will not be very different, and hence $s^2 - d^2$ will not be very large and assuming its value to be distributed as a random variable δ, we may conclude that a good first approximation of the earnings relation may be (with the possible exceptions of small intervals of d and s at both ends of the distribution):

$$\alpha w_{sd} = \alpha_0 + \alpha_1 d - 2\bar{s}s + \delta \tag{1.3.4}$$

This means that with an inverted parabola as the supply frequency distribution (1.3.1) and a similar demand frequency distribution (1.3.2) we may very well find an approximately linear earnings equation (1.3.4) in which the coefficients of d and s can be different. The parameters of the two distributions, x_0^S and $\bar{s}$ for supply and x_0^S and α_1 for demand are either explicitly ($\bar{s}$ and α_1) or implicitly (α_0) present in the regression coefficients of such a linear earnings equation. It is not necessary to stick to a parabola as an approximation of the frequency density; nor is it necessary to stick to one d and one s only. It should be admitted that also non-linear earnings equations may occur. It is important, however, to note that an almost linear earnings equation does not require that the frequency distributions of demand and supply be linear.

In the material referred to in Section 1.2.4 data are available on education required, z_1, actual education, z_2, experience required, z_3, and actual experience, z_4, – the only example I know of where my symmetry principle can be applied. An income equation can be established for income w, where all variables have been expressed in standardized form:

$$w = \underset{(0.0365)}{0.9732z_1} - \underset{(0.0269)}{0.1173z_2} + \underset{(0.0928)}{0.3595z_3} - \underset{(0.0564)}{0.0707z_4} \quad R^2 = 0.763 \qquad (1.3.5)$$

Here w stands for the maximum income attainable in the scale applied.

It should be noted that the four terms stand for two frequency distribution residuals such as the one shown in Equation (1.3.4) and that the algebraic signs are as expected on the basis of the demand-supply theory. The terms in parentheses are standard deviations. In terms of Equation (1.3.4), for education $\alpha_1/\alpha = 0.9732$, $2\bar{s}/\alpha = 0.1173$; and for experience $\alpha_1/\alpha = 0.3595$, $2\bar{s}/\alpha = 0.0707$.*

Equation (1.3.5) may also be *interpreted in a different way*. Applied to observed *individuals* showing given values for w, z_1, *etc. it may be used to express earnings* w as a function of job and performance characteristics z_1 through z_4. The negative terms may then be interpreted to constitute the *psychic incomes* derived from being trained and experienced.

There is even a *third* possibility to interpret Equation (1.3.5), using Thurow's concept of training costs on the job; these may be assumed to be proportional to $z_1 - z_2$, as far as educational aspects and to $z_3 - z_4$ as far as work experience aspects are concerned. Assuming, as Thurow does, that the earnings basically are determined by the job characteristics z_1 and z_3, we may write (1.3.5):

$$w = 0.8559z_1 + 0.2888z_3 + 0.1173(z_1 - z_2) + 0.0707(z_3 - z_4) \qquad (1.3.6)$$

where the terms in parentheses stand for c_t, training costs. But then c_t appears with the wrong sign, possibly rejecting Thurow's theory.

1.3.3 Examples of the *second* approach mentioned in Section 1.2.4 have been published elsewhere and part of them may be mentioned here. As said in Section 1.2.4 it is now the frequencies which are considered continuous variables, whereas the job characteristics and the personality traits appear as limited numbers of discrete values, added as indices j to their symbols. The simplest version assumes supply inelasticity:

$$x_j^S = \alpha_1 s_{j1} + \alpha w_j + \alpha_0 \quad \text{with} \quad \alpha_1 = 1, \quad \alpha = \alpha_0 = 0 \qquad (1.3.7)$$

and demand elasticity:

$$x_j^D = \beta_1 d_{j1} - \beta w_j + \beta_0 \quad \text{with} \quad \beta > 0 \qquad (1.3.8)$$

where w_j is wage or earnings; and only one characteristic and trait. More characteristics and traits can be introduced by adding correspondingly more indices j, *e.g.* ij.

* AKZO Personnel Department defines z_3 and z_4 in a non-symmetrical way; this may be one reason why the coefficient of z_4 is non-significant.

Symbols may either represent natural values (as deviations from average) or logarithms. Constants α_0 and β_0 are superfluous whenever deviations from averages are taken.

The demand-supply theory offered in Tinbergen (1975a) considered five compartments only, defined by their level of education, hence $j = 1$ through 5. All symbols were taken to represent natural logarithms of the variables used, expressed as deviations from averages. The quantities x^s were taken equal to the quantities actually working in Mexico 1960, implying that in Equation (1.3.7) we assumed $\alpha_1 = 1$ and $\alpha = \alpha_0 = 0$, which makes $x_j^s = s_{j1}$. It also implies that only one characteristic ($i = 1$) was used and its five observations are s_j ($j = 1, \ldots, 5$).

On the demand side we estimated d_{j1}, calling them 'quantities desired by the organizers of production,' by assuming:

(i) a fixed relative educational structure of the manpower used in each of 15 industries, and

(ii) a shift in the relative total manpower in each industry to the Japanese industrial structure in 1960.

(iii) Unlike α, β was assumed $\neq 0$.

The resulting earnings function:

$$w_j = \beta_j d_j/\alpha - s_j/\beta \tag{1.3.9}$$

could then be estimated. The result was (all variables as deviations from mean):

$$w_j = \underset{(0.50)}{+1.10 d_j} - \underset{(0.45)}{1.57 s_j} \qquad (\bar{R} = 0.979) \tag{1.3.10}$$

Alternative estimates, using second and third regressions as in Frisch's bunch-map analysis, supplied

$$w_j = +1.381 d_j - 1.823 s_j \ ^2 \tag{1.3.11}$$

and

$$w_j = +1.558 d_j - 1.975 s_j \ ^3 \tag{1.3.12}$$

confirming the stability of the coefficients which here constitute flexibilities; the corresponding elasticities ranging between -0.91 and -0.66 for demand and $+0.64$ and $+0.50$ for supply.

2 From $d_j = \underset{(0.292)}{0.642 w_j} + \underset{(0.189)}{1.267 s_j}$ $\quad \bar{R}^2 = 0.993$

3 From $s_j = \underset{(0.155)}{-0.547 w_j} + \underset{(0.113)}{0.756 d_j}$ $\quad \bar{R}^2 = 0.997$

1.3.4 A similar procedure was applied to American 1969 data (Tinbergen, 1975b). Supply was dealt with as set out in Section 1.3.3. For demand the concept of desired manpower d_j was estimated for the American economy as a whole, assuming now:

(i) a fixed relative educational structure of the manpower used in each main occupational group, of which the 1970 Census defines nine categories;

(ii) a shift in the relative total manpower in each main occupational group was estimated by extrapolating the historical trend between 1950 and 1970 over five years;

(iii) alternatively earnings were assumed to lag five years behind d and s or not to lag; and

(iv) again it was assumed that $\alpha = 0$ and $\beta \neq 0$.

Depending on the lags introduced various values of demand elasticity were found below 1 in absolute value.

1.3.5 As announced in Section 1.2.4, we will now mention a generalization of Equations (1.3.7) and (1.3.8) where it is assumed, as usually in economic theory, that not only the price w_j in compartment j, but also those in all other compartments enter into the supply and demand equations. We then obtain, for a case with one supply and one demand factor:

$$x_j^S = \alpha_1 s_j + \sum_{j'} \alpha_{jj'} w_{j'} \qquad j, j' = 1, \ldots, J \tag{1.3.13}$$

$$x_j^D = \beta_1 d_j + \sum_{j'} \beta_{jj'} w_{j'} \qquad j, j' = 1, \ldots, J \tag{1.3.14}$$

On the demand side it is clear that $\beta_{jj} < 0$ and $\beta_{jj'}$ $(j' \neq j) > 0$; for the supply side it is likely that $\alpha_{jj} > 0$ and $\alpha_{jj'}$ $(j \neq j) < 0$. Empirical research has been started to estimate equations of type (1.3.14).

1.4 *Deriving Demand and Supply from More Fundamental Concepts*

1.4.1 Another essential element of a complete theory of income distribution seems to me to be that both demand and supply are derived from '*deeper foundations.*' For demand this is the *production function* and for supply it is the *utility function.* The issue was raised for economics generally be Cassel (Cassel 1918) already, who chose not to include such deeper foundations. It is commonplace today to point out that the deeper foundations mentioned are necessary, however, if we want to avoid inconsistencies. Complete sets of demand or supply functions, either for commodities or for productive services cannot be chosen independently, since their connection with their underlying production

functions and utility functions have to obey certain consistency conditions due to the way demand or supply relations are derived from these 'background phenomena.' Demand for various production factors may be derived from the assumption of profit maximization by the organizers of production, or from other aims the organizers pursue. But their behaviour is dependent on the phenomenon of production, and its dependence on the quantity of production factors demanded cannot be neglected if we want to arrive at a rational theory.

Put in a different way, we can state that the choice of some type of demand function as discussed in Equations 1.3.2 through 1.3.14 implies the choice of a production function; and production functions have been proposed and tested in a number of cases. The danger of incompatibility between a demand function and the corresponding production functions is a real one, which we must avoid. An example is that demand functions in which only the labour price of one compartment appears (as dealt with in Sections 1.3.3 and 1.3.4) implies separability of the production function into terms depending on one factor only. If y represents production and d_1, d_2 *etc.* the quantities of labour with various levels of education, we have to have a production function

$$f(y) = \sum_j f_j(d_j) \tag{1.4.1}$$

in order that maximization of profits $Z = pf(y) - \sum_j w_j f_j(d_j)$ yields a demand function for labour j depending only on w_j and not on other $w_{j'}$. Such a production function may not fit the facts, however. This is an argument in favour of choosing a demand function of type (1.3.14). But even then cross elasticities have to satisfy certain conditions. A similar point can be made with regard to supply functions.

1.4.2 An even more difficult implication for the production function arises if we introduce demand functions as discussed in Secion 1.3.2. So far only production functions have been tried out in which the *quantities* of various production factors used enter as the independent variables. This implies that a finite number of production factors, including labour types, have been used, distinguished by discrete values of some characteristic, such as educational level, vintages, *etc.* The use of characteristics as continuous variables in demand functions, such as (1.3.2), where the quantities are brought in as frequency distributions, would require *functionals* instead of functions of production. This boils down to the introduction, into production 'functions,' of the parameters of frequency distributions of factor characteristics. This constitutes an open field for research into production functionals for which the following data are required: (i) frequency distributions of some of the most relevant job characteristics and (ii) personality

traits, both for a considerable number of geographical units, by production sector, if so desired; (iii) parameters sufficiently representative of these frequency distributions; and (iv) product of each of the geographical (sector) units considered. The problem to be solved would be to 'explain' product with the aid of the parameters mentioned.

1.4.3 In Subsections 1.4.1 and 1.4.2 a *neoclassical* approach was followed in which demand is supposed to be derived from profit maximization. This is not a necessary approach, however, and for short-term (year to year, for example) changes other approaches may be preferred. With given production capacities constituted by the capital goods stocks available and given demand for products, for instance by orders booked, the quantities of labour of different kinds may be determined by more rigid, limitational functions as, for instance, Leontief input coefficients, widely used in the early phases of educational planning. Wages of the various types of labour need not be equal to their marginal productivities either, but instead be determined by cost of living and employment, as familiar from short-term econometric models (*cf.* Tinbergen 1939) or, for that matter, the discussions of the 'Phillips curve.'

Since the income formation theory defended here does refer to long-term processes – covering decades – we think marginal productivity as the basis for demand equations constitutes a proper approach. Anyway for the marginal producer the point of profit maximum coincides with the point of making no losses – an alternative criterion.

1.4.4 With regard to the *utility function* it seems essential to me that a distinction be made (*cf.* Tinbergen 1975) between variables, parameters and coefficients. The introduction of parameters is meant to introduce all sorts of personality traits, not only productive, but also consumptive, such as differences in consumer tastes, size of family, health, age of members of household and so on. Once the category of parameters has been introduced and chosen as widely as possible there is no need to assume differences of coefficients. Any pretended difference in coefficients simply means that the coefficient mentioned is a parameter. Some reviewers of my book seem to have overlooked that truism and also seem to have overlooked examples I gave of age or experience as a parameter, and the (admittedly crude) attempt to introduce as a parameter an important parameter which I labelled 'degree of independent decision making.' What really matters is, of course, whether all relevant parameters are included.

The high degree of oversimplification characteristic of the examples of utility functions is mainly due to our lack of information on personality traits relevant to income formation. Too often we have only dummies for them, such as religious

affiliation, without knowing what these dummies stand for. I chose to mention my oversimplified examples since I think no theory should be presented without at least some attempt to identify and quantify the concepts introduced. The risk incurred is of course that many readers misinterpret such examples.

One theoretical setup I presented long ago (Tinbergen 1956) was based on the assumption that utility depends, among other variables, on what I called the 'tension' between a job characteristic z_1 and the corresponding performance characteristic z_2, using the notation of Equation (1.3.5) in this article. (In the source quoted they were indicated by s_{i_2} and t_i for characteristic i). The tension was defined to be $(z_1 - z_2)^2$, it being assumed that it was just as bad to have a job below one's capabilities as to have one 'beyond one's power.' Few members of the profession seem to share this view and empirical evidence will have to decide. We come back to this subject in Part 2 of the present article. Suffice it to remind the reader at this moment that the demand-supply theory of income formation and the definition of equitable income distribution do not critically depend on the presence or absence of a 'tension term' in the utility function.

1.5 *Innate vs Learnable Personality Traits*

1.5.1 The next element essential to a satisfactory demand-supply theory of earnings seems to me to be the distinction between 'innate' and 'learnable' components of relevant personality traits, or the concepts closest related to this distinction which has long been discussed already by scientists other than economists. Economists so far have only started to discover their relevance to economics. While economists have to be cautious to express opinions on a subject matter new to them, it may be of some importance to explain why and in what way economists have now started to interest themselves for the subject. Economics is a science dealing with *choices* between alternative lines of conduct so as to maximize satisfaction of individuals or groups of them. For a proper execution of their task economists have to know what choices are open to various types of individuals. Whereas traditionally the choices first discussed in economics were those of the individual as a consumer, increasingly the choices concerning the individual as a producer have entered the field of economic thinking. In the beginning of the study of producer choices it was the choices among alternative pieces of land or alternative tools to use that aroused the interest of economists. More recently the choices an individual has with regard to the development and use of his own capabilities have received attention. Many attempts have been made, in recent years, to identify the personality traits which have an impact on an individual's income, a very important economic category. Since income distribution is a phenomenon playing a considerable role in political discussions, economists feel obliged to know more about the personality

traits mentioned and the possibilities to change them. This is the reason why the subject, apart from its interest to educators and others faced with it, is now recognized also to be of great interest to economists.

More specifically economists are interested in learning processes and the possibility to influence capabilities for the following reasons. (i) Education systems already in operation nowadays absorb a large part of national income and hence compete with the satisfaction of other needs. (ii) Socio-economic policies are often based on the creation of incentives to obtain certain reactions; but there is no point in creating incentives to change things which are unchangeable. (iii) Among such incentives especially tax incentives are important and the general question comes up whether existing tax systems are optimal; it can be shown that taxes on certain capabilities may be closer to optimality – provided such capabilities can be identified and adequately measured.

Psychologists and educators may be able, therefore, to make important contributions to changes in our social system; but their insights and experience must then be translated into propositions and theses relevant to the socio-economic knowledge with which they might have to be integrated. Economists, in other words, are extending an invitation to education experts to meet.

1.6 *Means to Attain an Optimal Distribution*

1.6.1 Finally, in this summary of the second version of my theory, a few words may be said on how an *optimal income distribution*, as part of a more general socio-economic optimum, may be attained. Indeed it must be part of a more general optimum, since social welfare does not depend only on income distribution, but also on the accompanying distribution of jobs or tasks and on several other things, including the average level of real income. The word 'how' was intended to remind the reader of the choice between several instruments and institutions which can be used to attain a desired situation or development. The setting of the problem how to attain an optimum should not be restricted to a discussion of the means traditionally used but should be widened so as to include the search for new, unexpected means as well. Generally speaking any variable appearing in an explanation of incomes which can be controlled by public authorities is a potential means to be used in order to attain a desired income distribution. Of course the costs of the means to be used have to be among the variables considered.

1.6.2 A first category of variables occurring among the determinants of incomes and income distribution are *personality traits*. Scarce personality traits relevant to production contribute to a high income of the person considered. Since the beginnings of human civilization we have had schools which contributed to the

development of a number of personality traits, especially general cognitive traits, but – more particularly in Anglo-Saxon countries – also excellence in some sports, and, up to a point, team spirit. The main purpose of this education component of schooling was to contribute to the students' personal happiness. It is only in the last half century or so that the impact on income distribution was hypothesized and investigated. The diversity of opinions still prevailing on the size of this impact calls for further research, which is expanding fast. Two remarks seem to be in place here. First, I don't agree with those who dislike to use education for other purposes than the original one. I think we have the right and the duty to use all the means available to attain a general optimum. Secondly, the basic question we are up against is to find out to what extent relevant personality traits can be changed and accordingly to introduce curricula which may contain elements to develop traits which have hardly been considered eligible so far. As an example let me mention the trait of leadership. Very high incomes are paid at present to top men of big corporations. The question attached to this fact is: can we compete down these incomes by manager training courses? If the answer is yes, there is a reason to train the corresponding personality traits – if they are trainable, and depending on the costs, in the broadest sense.

1.6.3 *Job characteristics* partly depend on technology used. The development of technology can be influenced: at present part of R and D efforts are directed at energy saving, which was less the case before 1973. Job characteristics and hence the scarcity and income of some personality traits can also be consciously influenced by a change of direction of R and D. Again I don't see any reason why we shouldn't, provided that all the effects of such a change of direction be investigated and their consequences for the socio-economic optimum be taken into account for the design of an optimal policy and optimal institutions. Technology should be defined here in the broadest sense – including the organizational wing and forms of human co-operation and the delegation of decisions to 'lower' levels, whether persons or groups.

1.6.4 Income distribution has also a *demographic* aspect. Whereas the distribution of family incomes may have changed little in the USA during the last decades, the distribution of income per consumer has become less unequal (Kuznets 1974). Poor families have become smaller to a larger extent than rich families. There is no reason why not to use family planning as another means to reduce income differences. Family planning is one of the few weapons under the control of the poor, individually as well as groupwise, as European workers used it in the 'twenties and the 'thirties.

1.6.5 *Taxes* and *social security* contributions and benefits are the more traditional means of affecting income distribution. Much research has been undertaken and is continuing in order to discover the best choices in this broad field. One of the unorthodox questions to be posed here remains, notwithstanding the overwhelming difficulties connected with it, namely whether personality traits can be a tax basis bringing us closer to the socio-economic optimum. As already observed, this is an economist's question to many other disciplines.

Such a tax may be avoided, however, if sufficient competition can be stimulated to equate supply of all relevant personal performance types to demand for them. In order to clarify this issue let us first assume that the only relevant performance criterion is years of schooling completed and, as a further simplification, assume that there are three levels of schooling only, to be given the indices of 1, 2 and 3 (as in Tinbergen 1975). Supply of and demand for each of the three levels will be said to be in equilibrium, if there is no need for people with education level 2 to take jobs requiring level 3 or for people with education level 1 to take jobs requiring level 2. In that situation the 'mixed' frequencies φ_{32} and φ_{21} are both zero. It can be shown (*cf.* Tinbergen 1977) that for a not unrealistic range of structural constants in my model the income differences between groups with differing levels of schooling are then equitable in the sense of giving equal satisfaction or utility to each group.

Whether such a situation can be attained depends on the number of individuals able and willing to complete level 3 and level 2 schooling in comparison to the numbers demanded by the organizers of production. Our present knowledge about the supply function is too limited to answer the question involved. Yet the levels of schooling attained by the young generation give some hope that the ability and willingness (or motivation) may be sufficient, at least in the realm of intellectual performance. Whether the other main personality feature loosely defined by the phrase 'leadership' will be supplied to the degree required in the future production structure is still more debatable. 'Leadership' may contain a larger innate component than intelligence and be less learnable. All this underlines the importance of knowing more about the subjects mentioned. We come back to this issue in Part 2 of this article.

1.6.6 The last question to be discussed is what the possibilities are that *technological development* may be reoriented so as to contribute to a less unequal income distribution. In the past it worked in the opposite direction: it raised demand for highly qualified individuals. But changes are conceivable, since the problems the economy has to face are changing. One new requirement is to save on energy and on polluting agents (*cf.* also Section 2.5.4). A second change is that the post-industrial era needs more service activities rather than manufacturing;

this may, however, mean an increased demand for highly qualified manpower. A third change is a desire for more participation and for smaller production units. This may well entail a diminished demand for 'big leadership,' together with the higher demand for intellectuals already discussed.

2 EMPIRICAL MATERIAL: AVAILABLE VS NEEDED

2.1 *Introductory: Groups vs Individuals; Earnings Variance Explained, Independent Variables Used, Size of Sample*

2.1.1 The need for a theory to be tested against empirical evidence is now generally recognized. As a consequence a considerable number of empirical data have been collected in the last decades, with increasing frequency. Some of the material known to the present author has been arranged in Table I, alphabetically with regard to the authors from which it has been taken. These are not always the collectors of the material and these have been added as far as traced from the publications mentioned. Only surveys used for the testing of income formation theories have been listed. The list is likely to be incomplete, for which the author apologizes. Some data samples have not been mentioned since they were not, as far as this author is aware, used to express the tests performed in a regression equation – the only way to know what part of income variance has been explained. This explains why no British surveys have been included; the ones discovered by this author did not result in regression equations. Intercountry enquiries, however interesting, have been omitted since the number of explanatory (independent) variables used is small. Even though the material shown in Table I is incomplete there can hardly be any doubt that by far the largest number of inquiries are American; the backlog in this report of European activity is appalling.

2.1.2 Some general remarks on the material shown seem appropriate. Income data often, but not always, refer to earnings only. A partial justification is that by far the larger part of income variance consists of earnings variance, even though, taken separately, income from assets itself is distributed much more unequally than labour income.

Sometimes income data are taken from tax administrations; this seems to be the rule even for most non-Anglo-Saxon inquiries. Such data are not very reliable in most countries, with the exception of Scandinavian nations. Data from non-tax sources are to be preferred.

2.1.3 Table I also mentions the variables used as explanatory or independent variables and the R^2 obtained by the most successful attempts to explain incomes.

TABLE I – AUTHORS, SOURCE OF DATA, SIZE OF SAMPLE N, VARIANCE EXPLAINED R^2 AND INDEPENDENT VARIABLES USED TO EXPLAIN LOGARITHMS OF EARNINGS IN A NUMBER OF STUDIES

	Author(s)	Source of Data	N	R^2	Independent Variables
1	J. Berkouwer (1977)	AKZO employees	340	0.76	$S\ S_R\ t\ t_R$
2	S. Bowles and V. I. Nelson (1974)[1]	Duncan, Featherman, Duncan	3141	0.18	$S\ O\ A = 25$–34
3	S. Bowles and V. I. Nelson (1974)[1]	Duncan, Featherman, Duncan	3241	0.32	$S\ O\ A = 35$–44
4	S. Bowles and V. I. Nelson (1974)[1]	Duncan, Featherman, Duncan	2596	0.32	$S\ O\ A = 45$–54
5	S. Bowles and V. I. Nelson (1974)[1]	Duncan, Featherman, Duncan	1482	0.24	$S\ O\ A = 55$–64
6	B. R. Chiswick (1974)	USA 1960 Census of Pop. (states)	51	0.79	$S\ \sigma_S\ A\ \sigma_A\ ln\ Wp$ $NSD\ (p\ NSD)$
7	B. R. Chiswick (1974)	USA 1960 Census of Pop. (states)	49	0.83	same
8	B. R. Chiswick (1974)	Canada (provinces)	11	0.96	$S\ \sigma_S\ A\ \sigma_A$
9	M. Corocan, Chr. Jencks, M. Olneck[2]	USA Curr. Pop. Survey	11505	0.17	*FS FO G*
10	M. Corocan, Chr. Jencks, M. Olneck[2] (1976)	Survey Research Center	1188	0.19	*FS NS*
11	M. Corocan, Chr. Jencks, M. Olneck[2]	Survey Research Center	1774	0.12	*FS FO G I*
12	M. Corocan, Chr. Jencks, M. Olneck[2]	Nat. Opinion Res. Center	300	0.06	*FS FO G*
13	M. Corocan, Chr. Jencks, M. Olneck[2]	USA Curr. Pop. Surv. (Parnes)	2580	0.15	*FS FO NS*
14	M. Corocan, Chr. Jencks, M. Olneck[2]	Talent, Twins and Siblings	198	0.03	*FS FO NS I*
15	M. Corocan, Chr. Jencks, M. Olneck[2]	Olneck Kalamazoo Brothers	692	0.08	*FS FO MS NS I*
16	M. Corocan, Chr. Jencks, M. Olneck[2]	Sewell *et al.*, Wisconsin	2069	0.01	*FS FO MS PY I*
17	P. de Wolff, A. R. D. van Sl-pe (1972)	Husén, Fägerlind	1500	0.50	*S*(curv) *FO I*
18	I. Garfinkel, R. H. Haveman (1975)	USA Census of Pop.		0.53	S, S^2, A, A^2, t WG (white m.)
19	I. Garfinkel, R. H. Haveman (1975)	USA Census of Pop.		0.61	same (black m)
20	I. Garfinkel, R. H. Haveman	USA Census of Pop.		0.60	same (white f)
21	I. Garfinkel, R. H. Haveman	USA Census of Pop.		0.63	same (black f)
22	Z. Griliches, W. M. Mason (1972)	USA Curr. Pop. Survey	1454	0.31	*S FS FO I* (*AFQT*)
23	J. Hartog (1977)	USA 1970 Census of Pop.	88	0.44	*I SP FP CP Y*($I \cdot SP \cdot C$)
24	J. Mincer (1974)	USA Census 1/1000	ca 30000	0.56	~~*S t lnW*~~
25	J. Mincer (1974)	USA Census 1/1000	706		

26	J. Mincer (1974)	USA Census 1/1000	[illegible]		
27	J. Mincer (1974)	USA Census 1/1000	2124	0.60	$S\ lnW(t = 7\text{–}9)$
28	R. D. Morgenstern (1976)	Urban Problems Survey	2700	0.26	S (curv) t (curv) Q
29	C. M. Rahm (1971)	USA Census	500	0.71	$S\ t\ t^2\ lnW$
30	C. M. Rahm (1971)	USA Census	500	0.58	$S\ t\ t^2$
31	C. M. Rahm (1971)	USA Census	500	0.29	S
32	P. Taubman, T. Wales (1974)	Wolfe Smith Data (graduates)		0.43	S (curv) I
33	P. Taubman, T. Wales (1974)	NBER Thonrdike-Hagen	5100	0.11	S(curv) $M\ C\ I\ SP(A$ const)
34	P. Taubman, T. Wales (1974)	NBER Thonrdike-Hagen	1019	0.25	$S\ A\ G\ R\ FS\ MS\ O$
35	C. J. Ullman[3] 1972	USA Censuses 1900–1960	40	0.51	$Y\ Q_1 Q_2\ RR\ q$
36	B. M. S. van Praag	Netherl. Consumer Union	2663	0.40	$S\ S_R\ L\ A$
37	D. A. Wise	Fort (*sic*) Motor Comp.	976	0.69	S (curv) t, r, L

1 As used by J. Tinbergen (1976)

2 Independent Variables not mentioned: white; father born in USA; father white collar; son raised on farm; son not living with father at 15

3 Relative earnings w_2/w_1 (1 = elementary; 2 = higher) as dependent variable.

TABLE I – CONTINUED

Alphabetic List of Symbols Used for Independent Variables

A	age	PY	parental income
a	attendance rate for children 14–15 y	Q	quality of education
C	coordination, physical and mental	q	cost of higher education
CP	clerical perception	R	religion
FO	father's socio-econ. situation (occupation)	r	rank in college or high school
FP	form perception	RR	rate of return for higher education
FS	father's schooling	S	schooling
G	geographical area where living or born	SP	spatial perception
I	intelligence (IQ of other test score)	S_R	schooling required for job
L	leadership (various definitions)	σ_A	standard deviation of age A
M	mathematical ability	σ_S	standard deviation of schooling S
MS	mother's schooling	t	experience
NS	number of siblings	t_R	experience required
NSD	dummy: 0 = non-South, 1 = South	V	verbal capability
O	Occupation	W	weeks worked
p	percentage non-white	Y	income (average of state)
$pNSD$	interaction of p and NSD		

Curv added to symbol means any form of non-linear impact

As might be expected, the variance explained (*i.e.* R^2) is higher for inquiries using grouped data than for inquiries using individual data. The question may be raised here whether the use of individual data is preferable under all circumstances. For such precise research as done on twins this seems to be the optimal approach. For some other types of research it might be preferable to use small groups, in order to eliminate the elements of pure chance, not interesting as a social problem – the really 'small' stochastic determinants.

Other features which, upon a first superficial inspection, help to raise R^2 are non-linear influence of schooling and of age or experience, weeks worked and some non-cognitive determinant as which leadership was provisionally denoted.

What is perhaps the most striking aspect of the empirical research so far published is the low value of R^2 for enquiries in which a considerable number of determinants has been used. I submit that this is due to the absence of a set of job characteristics that are as symmetrical as possible, and the corresponding personality traits, that is, the determinants required by the demand-supply theory.

2.2 *Need for the Introduction of Demand vs Supply Factors*

2.2.1 The most striking shortcomings of the empirical material so far collected by American scholars seem to this author to be that hardly any attempt has been made to distinguish job characteristics from personality traits in a more symmetrical way (*cf.* Section 1.2.2). As a whole there is a clear bias in the direction of personality traits, strengthened by the interest for the element of heredity; understandable for a country with racial problems as pronounced as in the United States. Personality traits (or personal performance) show up in years of schooling, quality of schooling, age or experience, rank of pupil or student, various test scores, race and probably in leadership measures. Job characteristics in most cases are less specific, and hence less clearly interpretable, *e.g.* the occupational status (*cf.* Tinbergen 1976), broad industrial or occupational groups, geographical area where working, sometimes Southern *vs* non-Southern. In the latter case the choice of a crude measure of general environment is intended. Leadership when measured by place in hierarchy, probably is more indicative of a job than of a personality characteristic.

2.2.2 Nowhere in the data collected a clear distinction is made between the intensity of an aspect of the job characteristics, so well known from job evaluation systems or the Directionary of Occupational Titles and similar sources, and the intensity of that same aspect shown by the person considered. In the modest material from the AKZO corporation such a distinction has been made for three aspects and has shed some interesting light on the income effects of the two – demand and supply – sides of the labour market (*cf.* Section 1.3.2).

As a consequence of this lacuna in the available data, testing of the demand-supply theory presented by the author has not been possible so far in a satisfactory way. Neither has it been possible to test the hypothesis (*cf.* Tinbergen 1956) of the impact on utility and hence on income claims based on the 'tension between job aspects required and personality aspects available' (*cf.* Section 1.4.4).

2.2.3 The attention given to purely genetic, early family environment and environment in the broader sense has thrown some interesting light on the limitations of a deliberate income policy, but from a negative rather than a constructive point of view. By the latter we mean the search for measures to reduce income inequality by learning processes, by technological and organizational changes and tax and subsidy structures. We come back to these subjects in Section 2.5.

2.3 *Problems Around Dummies Used*

2.3.1 Several authors have made abundant use of dummies or proxies. The use of

dummies is to be applauded as an attempt to introduce measurement in two ways. On the one hand the phenomenon represented by the dummy is measured, although in an admittedly crude way. On the other hand the introduction of dummies for determinants difficult to measure improves the reliability of regression coefficients of other independent variables. An additional advantage of the use of dummies is that relevant information can be obtained in a relatively simple way, and hence that costs both in money and in effort, can be kept low.

2.3.2 But there are also some drawbacks in the use of proxies. The main difficulty is that we are not always, or sometimes hardly at all, sure about what the dummy stands for. Paul Taubman holds the record for using the largest number of dummies. Some of them are fairly clear representatives of either personality or job characteristics, such as his ability fifths, liking challenging work, or job security. Other dummies have a less clear meaning, such as religion, time spent on hobbies, or, quoting some other authors, son raised on farm, son not living with father when 15. A vague picture appears, of course, with each of them. But the fundamental question what direct indication of some well-defined 'marketable' characteristic they stand for had better been asked rightaway – although the cost involved would have been much higher. In particular it is important to know whether what we measure is a job or a personality characteristic; in addition this may be of some help to obtain information about the 'learnability' of the characteristic, or the feasibility of changing, by deliberate policy measures, the quality at issue – such as the quality of the educational process.

2.4 *Empirical Material on Utility and Production Functions*

2.4.1 To the extent that supply of and demand for factors of production are supposed to be based on utility and production functions the demand-supply theory of income formation may also be tested from these more fundamental relationships. Of course these relationships also deserve attention in their own right. It seems rewarding to take up some of the issues dealt with in Part 1 of this article in connection with possibilities of empirical testing.

2.4.2 There is an increasing interest in attempts to measure utility, whether at the macro or at the micro level. One way in which this interest manifests itself is the increased attention given to social indicators which in essence can be considered to be components of welfare or utility – two concepts which will be considered synonymous here. Another way is the work undertaken by Van Praag and collaborators and the use made of it (Van Praag 1968, 1971, 1975, Van Praag and Kapteyn 1973, Bouma, Van Praag and Tinbergen 1976). The basic assumption of Van Praag's method of estimation is that verbal qualifications of a person's

welfare, from 'very bad' through 'very good' have the same meaning to all persons concerned. While on the one hand this can be open to doubt, on the other hand it can be said to reflect the cultural environment of each individual and to help to solve some problems around the use made of the concept of welfare in order to define equity. Equity defined as equal welfare may be a more acceptable definition precisely when such cultural differences are taken account of.

The empirical evidence needed to test utility functions should not only consist of a yardstick for welfare or utility itself, but also of estimates of the most relevant parameters and variables on which it is assumed to depend. Here parameters, as set out in Section 1.4.4, should in principle stand for *innate* characteristics or, as a first approximation, characteristics *not easily changeable*, whereas variables refer to phenomena relevant to welfare and subject to fairly quick variation either for external or for internal reasons. Examples of variables changed for external reasons are earnings scales or working hours imposed by changes in general economic conditions. Examples of variables changed for internal reasons may be a voluntary change of job, a change in working speed – even though stimulated by a change in earnings scale – or changes as a consequence of additional efforts where the individual has a choice. The importance of the distinction between levels required on a job and the actual level of some personal characteristic mentioned in Section 2.2.2 may be re-emphasized here, since both enter into the utility function. Here again a plea may be made to collect empirical material of a highly concrete nature, following the terminology of job evaluation or function analysis instead of vague dummies. This may be the place to remind some of the critics of my previous attempts to estimate utility functions (Tinbergen 1975) that I did so by way of example, adding explicitly: 'This choice is extremely simple, as a first step to illustrate our procedure' (*loc.cit.* p. 60) and undertaken 'by way of experiment' (p. 68), and 'as a very simple first approach' (p. 154).

2.4.3 With regard to *production functions* we face a rather different situation. A considerable number of different production functions has been proposed and tested ever since Cobb and Douglas launched (Douglas 1934) their first attempts. This is not the place to venture to present a survey of the innumerable variants and elaborations proposed and tested since. Perhaps the reader may be reminded of the fact that the production function used in Tinbergen 1975 is not concave throughout the factor space, but that this is not a reason to reject it. Even so a completely concave function is more attractive. Two other points should be raised in the present context. One is that notwithstanding the wealth of alternatives tried out so far, the link between economists' production functions and their true foundations, the natural sciences and human psychology, is still almost absent. Some link exists for 'process industries' (with geometry, chemistry

and physics as the main input), but virtually no link exists for the majority of economic activities. Some services (teaching and management, for instance) have been analysed more thoroughly; but very much remains to be done. Some starting points are available (Boon 1976, Beyrard 1976).

The other point to be repeated here is that, as stated in Section 1.4.1, an alternative approach to the phenomenon of production by economic science may be to propose and test *production functionals* instead of production functions.

2.5 *Empirical Data Relevant to Socio-Economic Policy Formulation*

2.5.1 In this final section we will concentrate on some aspects of socio-economic policies connected with income distribution. We will focus on the policies aiming at a further reduction of income differences, without endangering other objectives of socio-economic policies. From the analysis of Part 1 we may conclude that the most promising avenues through which to affect income distribution can be briefly indicated as the realms of learning, of technological development, of demography and of taxation. Some brief remarks will be made on each of them, as far as relevant to the collection of additional empirical material.

2.5.2 To the extent that relative scarcity of a number of personal performance types or personality traits causes undesired income inequalities, the latter may be reduced by increased supply of scarce abilities. In a general way an increased supply can be attained by learning processes in the broadest sense: schooling, training or learning by doing. An empirically tested quantitative theory of learning processes exists for a few narrowly defined activities; we would need them for learning processes for capabilities of wide relevance to income distribution. Probably the most important single question to be answered in this realm is whether we can learn some of the *capabilities needed for leadership.* The highest income differences are those between top managers and the average employee. Can these differences be reduced by increased competition among eligible candidates? To what extent is this road towards less inequality blocked by a possible non-learnability of the capabilities typical for leadership?

2.5.3 Apart from increased supply the scarcity of leading capability may also be reduced by a *reduction in demand* (*cf.* Section 1.6.6). Decentralizing tendencies can be expected in the post-industrial society, first because the average size of production units may require qualitatively less – although quantitatively more – leading personalities; second, because of increased participation in decision making. This is an almost entirely new aspect of society's demand for leadership, but in need of much more research.

2.5.4 Increasingly we have become aware of a certain degree of malleability of technological development. For a long time technology was concentrated on the substitution of capital (goods) for labour. In the last decade or so we have increasingly discovered the necessity of substituting scarce natural resources by other inputs, partly labour. Among the scarce resources such formerly free commodities as clean air and fresh water have now to be included. Recycling has become much more important than it already was. Why cannot we add further goals to technological development – such as the reduction of alienation, or the improvement of satisfaction derived from work?

2.5.5 *Demography* (*cf.* Section 1.6.4) comes into the picture as soon as we are aware that the number of children in a family has an impact on the resources which can be made available to each child. This awareness is not new; it has existed for a long period, although very different in length for groups of different social and religious characteristics. There is scope for further empirical research into the motivations behind birth control.

2.5.6 Since the preceding text has been concentrated on the formation of primary incomes, the usual role of taxes has been left out, that is, their transformation of primary into secondary and tertiary income distribution. Strictly speaking taxes cannot, however, be left out of any theory of income formation whatever, because they affect the supply of students at various levels, in addition to the supply of manpower in the various compartments of the labour market and the supply of capital. Apart from the existing taxes and their role in income formation we may want to analyse the operation of hitherto non-existent, but nevertheless conceivable taxes. This is why for completeness' sake taxes should be mentioned as a subject where more empirical material is needed on the way they operate, or where they are avoided or evaded. In other publications some contributions to this subject have been made by the present author (Tinbergen 1976). Empirical testing of what was set forth in Section 1.6.5 seems to constitute another challenging subject.

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Summary

INCOME DISTRIBUTION: SECOND THOUGHTS

As a follow-up of his book on income distribution the author reformulates his version on the scarcity theory of income from productive contributions. The need to introduce into an earnings theory several job characteristics, non-cognitive as well as cognitive, and the corresponding personality traits is stressed, the latter subdivided into innate and learnable capabilities. The theory is presented in two alternative mathematical versions: one where job and person characteristics are continuous and one where they have discrete values and their frequencies assume continuous values. Although, mainly in the United States, numerous empirical inquiries have been made, job characteristics and the corresponding personal characteristics have not been included in sufficient number.