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Utilitarism, Equivalence Scales and Logarithmic Utility

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Abstract:
It is shown that if social welfare is the sum of logaritmic utility function, the optimal income distribution and the welfare effect of any income redistribution is independet of the equivalence scales. In optimum all households have the same per capita income. Based on this observation it is discussed to what extent traditional welfare theory can be said to be concerned about fair income distribution.

Keywords: Equivalence scales, income distribution, logarthmic utility.

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1 Introduction

The logarithmic utility function is probably the most used functional form in applied analysis. Bernoulli (1738) resolved the St.Petersburg paradox and introduced expected utility by arguing that people have logarithmic utility. For a review of different attempts to measure cardinal utility, see Tinbergen (1991). More recently Jorgenson and Slesnick (1983) and Jorgenson (1991) have used logarithmic utilities in combination with equivalense scales. This note will point at a striking observation about this combination.

We will show that the equivalence scales does not at all matter for the evaluation of social welfare, defined as the sum of logarithmic utility functions. For any set of equivalence scales, the optimal income distribution is that all households have the same per capital consumption. Given the functional form of the utility function, the equivalence scales determines both the ordinal level comparison and the cardinal unit comparison of utility between household. Since Arrows impossibility theorem (Arrow, 1963) and later the results of Parks (1976) and Kemps and Ng (1976), such comparisons has been known to be essential to social welfare functions of the Bergson Samuelson type. It may thus be a bit of a surprise that the equivalence scale does not at all affect the optimization of this welfare functions.

2 Welfare and equivalence scales

2.1 The main result

Let $u(y,z)$ be the utility function of the household h with income y and characteristics z, and let n_h denote the number of individuals in this household. Assuming that the utility function is logarithmic, we normalize the utility function for the reference household z_0 such that $u(y,z_0) = \ln(y)$. The utility function of household z can now be written as

$$u(y,z) = \ln(\frac{y}{m(z)}) = \ln(y) - \ln(m(z)),$$

where $m(z)$ is the equivalence scale of this household. We note first that a shift in the equivalence scale only affects the last term, and hence the marginal utility of this household is independent of the equivalence scale.

Assuming that all individuals in the household have the same utility, the total utility of the household h with income y_h and characteristics z_h is $n_h u(y_h; z_h)$. If the welfare function is utilitarian, i.e., the sum of all individual utility functions, social welfare is

$$(1) \qquad \sum_{h=1}^{H} n_h \ln(\frac{y_h}{m(z_h)}) = \sum_{h=1}^{H} n_h \ln(y_h) - \sum_{h=1}^{H} n_h \ln(m(z_h)),$$

where H is the number of households. Maximizing this welfare subject to the budget constraint $\sum_h y_h = W$, where W is total wealth, we get $\frac{n_h}{y_h} = \lambda$, where λ is the shadow price on the budget constraint. For any two household h and h' we thus have

$$(2) \qquad \frac{y_h}{n_h} = \frac{y_{h'}}{n_{h'}}.$$

Thus all households should have the same per capita income.

This result reflects a delicate balance between two different effects. Note that the higher the ratio $\frac{n_h}{m(z_h)}$, the better off is the household in the optimum, and the better off the household is, the lower its marginal utility. But at the same time the ratio $\frac{n_h}{m(z_h)}$ measures the efficiency of the household. While it takes $n_h \Delta y$ to increase the income of n_h single households with the amount Δy, a similar improvement of utility for the n_h individuals in the household h only takes $m(z_h)\Delta y$. This is true provided the households and the single persons was initially equally well off. Thus the society gets more utility per dollar by giving it to the household rather than to the single person. A shift in the equivalence scale will shift both the level of utility and the efficiency of the household. With logarithmic utility these two effects just balances, and the optimum income distribution is not affected by a shift in the equivalence scales.

This result is only valid when the utility function is logarithmic and the social welfare function is sum of individual utility. Moreover it only applies to income distribution. To illustrate the importance of them, we consider how altering these assumption would affect the result. We first consider the assumption that utility is logarithmic.

2.2 CRRA-utilities

The logarithmic utility function is a special case of the CRRA class of utility functions

$$u(y) = \begin{cases} \frac{1}{1-\alpha} y^{1-\alpha} & \text{for} \quad \alpha \geq 0, \alpha \neq 1 \\ \ln(y) & \text{for} \qquad \alpha = 1 \end{cases}.$$

Within this class of utility function the optimal income distribution is easily shown to satisfy, for $\alpha \neq 0$,

$$\frac{y_h}{n_h}\left(\frac{m(z_h)}{n_h}\right)^{\frac{1-\alpha}{\alpha}} = \frac{y_{h'}}{n_{h'}}\left(\frac{m(z_{h'})}{n_{h'}}\right)^{\frac{1-\alpha}{\alpha}}.$$

In this case the equivalence scales have very different effect depending on the size of α. One extreme case is $\alpha = 0$, then the household with the highest $\frac{n_h}{m(z_h)}$ ratio get all the income. The reason for this is that marginal utility is insensitive to the level of income. A family with many members relative to their equivalence scale will thus generate most utility per dollar independent of the initial income distribution.

The other extreme is $\alpha = \infty$. in this case the marginal utility is extremely sensitive to the income level, and completely dominates the effect of scale efficiency. Since

$$\lim_{\alpha\to\infty} \frac{y_h}{n_h}\left(\frac{m(z_h)}{n_h}\right)^{\frac{1-\alpha}{\alpha}} = \frac{y_h}{m(z_h)},$$

the optimum income is distributed so that all are equally well off.

2.3 Weighting household utility

Within the utilitarian tradition of maximizing total utility, the household utility should be given a weight equal to the number of individuals in the household. But this is not the only choice used in the literature. In the welfare function introduced by Jorgenson and Slesnick (1983), each household is given a weight equal to its equivalence scale. In the limiting case with no 'inequality aversion', their welfare function is proportional to

$$\sum_{h=1}^{H} m(z_h)\ln(\frac{y_h}{m(z_h)}).$$

In this case the optimal income distribution is to make everybody equally well off in terms of utility. (This is seen from (2) simply by substituting m for n.) But why should the household utility be weighted this way?

There is n_h members of the household no matter what it takes to make them as well off as the reference household. The utilitarian welfare function is thus to use n_h as weights. On the other hand, the famous argument of utilitarianism due to Harsanyi (1955) only proved that welfare should be a weighted sum of individual utilities. The welfare weights used by Jorgenson and Slesnick (1983) is thus consistent with Harsanyi's theorem. The observation that utility is equally distributed when $m(z_h)$ is chosen as weight may then be used to justify this approach. Note that the standard assumption that all household share their resources

to give everybody within the household the same utility, implies that the households uses similar weights within the household.

2.4 Aversion to inequality

The welfare function of Jorgenson and Slesnick (1983) also deviates from the utilitarian by an aversion to inequality. Aversion to inequality may be represented through a non-linear social welfare function. Let social welfare be $W(u_1, \ldots, u_I)$, where I is the number of *individuals* in the society. Each individual has the utility of its household, thus each households utility appears n_h times in the welfare function. Inequality aversion would be represented as the assumption that $W''_{u_i} < 0$, i.e., an extra unit of utility to individual i in household h contributes less to social welfare the higher utility household h has. Maximizing social welfare with logarithmic utility subject to the social budget constraint, give that for any two households

$$\frac{y_h}{n_h} = \frac{W'_{u_h}}{W'_{u_{h'}}} \frac{y_{h'}}{n_{h'}}.$$

Thus per capita income should be proportional to the social value of household utility, $W'_{u_h} = W'_{u_i}$ where i is any member of household h. The higher the equivalence scale the household has the lower its welfare and hence the higher is the social value of household utility, and hence the larger share of the total wealth will the household get in optimum.

2.5 Price changes

An important application of equivalence scales is the study of the effects of price changes. Generally the equivalence scale will depend on the price vector, p, thus the equivalence scale may be written $m(p, z_h)$. A shift in the price will affect the last term of the welfare function (1) and hence these effects will depend on the equivalence scales. Thus, even with utilitarian welfare functions and logarithmic utility, equivalence scales are needed to evaluate the welfare effects of shift in relative prices.

3 Equality and utilitarism

Utilitarism only requires interpersonal comparision of utility differences, comparison of utility levels is not needed. The equivalence scale determines how huch a household need to be as well off as a reference household, which is an level comparions. In the particular case

of logarithmic utilities, the equivalence scale has no effect on marginal utility, and hence has no effect on a utilitarian maximization. The conclusion of this paper is in this sence intuitively obvious.

On the other hand, the measures of inequality in income distribution proposed by Atkinson (1970) may be given an utilitarian interpretation. If everybody has the same utility function and marginal utility is decreasing, the optimal income distribution is total equality, and the inequality measure is the welfare loss compared to the case where the same total income is equally distributed. From this perspective it seems surprising that the equivalence scale does not at all matter.

Under the heading "equality of what" Sen (1992) argues that all moral philosophies are concerned about equality in some space. Rawls (1972) argues for equal rights and equal distribution of primary goods. Dworkin (1981) argues for equal distribution of resources, and Sen himself for equality in terms of functionings or capabilities and utilitarians argues that marginal utility should be equal. In a review of Sen (1992), Sugden (1993) questions this argument. He points out that while it is true that utilitarianism prescribes equal marginal utility, it is misleading to interpret this as a concern about equality; it is just an equivalent statement of the objective to maximize total utility. It does not make sense to say that utilitarians consider marginal utility to be so important that it should be distributed fairly, while the same statement with marginal utility replaced with primary goods, would be a reasonable description of Rawls position. The above result further illustrates this point.

Consider the distribution of income between two single-person households, one able and one strongly handicapped. The utilitarians may agree that the handicapped person needs much more income than the able to be equally well off, that is the equivalence scale may be quite high. The welfare effect of a redistribution of income between them will, however, be independent of such consideration. If the equivalence scale is low, close to 1, the disabled is almost as well off as the able, and need no extra income, while if the equivalence scale is high, the disable is much worse off if their income is equal. Still a redistribution is not optimal, since the disable is less efficient to produce utility from a dollar. The one parameter that determines both ordinal level and cardinal unit comparability does not matter. The inequality in terms of utility may be quite substantial, depending upon how much it takes for the disabled to be as well off as the able person. No matter how large the equivalence scale is, the utilitarian optimum is equal per capita income.

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