On the Evaluation of Economic Mobility

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Abstract

This paper provides an explicit welfare basis for evaluating economic mobility. Our social welfare function can be seen as a natural dynamic extension of the static social welfare function presented in Atkinson and Bourguignon (1982). Unlike Atkinson and Bourguignon, we use social preferences à la Kreps-Porteus, for which the timing of resolution of uncertainty may matter. Within this generalized framework, we show that welfare evaluation of mobility depends on the interplay between aversion to inequality, risk aversion, and aversion to intertemporal fluctuations.

This framework allows us to provide a welfare analysis not only of "reversal" (which has been the focus of much of the literature) but also of "origin independence" (which has not received an explicit welfare foundation in the literature). We use our framework to develop welfare measures of mobility, and apply these measures to intergenerational mobility in the United States using PSID data. We show that the value of origin independence is quantitatively important. We also show that different subpopulations experience different mobility patterns: reversal is more important than origin independence for blacks but the opposite is true for non-blacks.

1. Introduction

When is a society more "mobile" than another? What are the welfare gains or losses (if any) associated with more or less mobility? It is widely recognized in the literature that these questions do not have simple answers. In a recent survey, Fields and Ok (1997) write:

> "...the mobility literature does not provide a unified discourse of analysis. This might be because the very notion of income mobility is not well-defined; different studies concentrate on different aspects of this multi-faceted concept. ... a considerable rate of confusion confronts a newcomer to the field."

This paper provides a welfare analysis of economic mobility that directly addresses its "multidimensionality". In particular, we argue that one can gain important insights on the nature of mobility and its measurement by explicitly introducing preferences for the fundamentals that may be affected by mobility:

inequality, consumption fluctuations, and uncertainty. This approach allows us to distinguish among different welfare aspects of mobility in an explicit and intuitive way.

This paper builds on two distinct literatures. In two important papers, Atkinson (1981) and Atkinson and Bourguignon (1982) provide a welfare foundation for ranking of different transition matrices. When the marginal utility of consumption in each period is assumed to be higher for individuals with lower consumption in the other period, a "reversal" of positions raises the consumption of those who would benefit the most. Hence, the social objective is to have as much reversal as possible. The Atkinson-Bourguignon approach captures an important dimension of the "social value of mobility". However, it leaves out an equally important dimension: "origin independence". It has often been argued that a society may be characterized as being more mobile when the future is less "predetermined", or, put alternatively, there is less "origin dependence" (e.g., future incomes are less dependent on present incomes for individuals and/or families). [1] Shorrocks (1978) shows that there is a fundamental contradiction in specifying that a mobility measure must increase monotonically both with greater income movement (i.e. reversal) and with the degree of origin independence. Our approach to this potential conflict in goals is to develop a welfare analysis of mobility that derives preferences for reversal and origin independence from primitives of the social welfare function.

We show that a rigorous welfare foundation can be built by using extensions of utility theory that allow for preferences for "early" or "late" resolution of uncertainty as well as preferences over reversal.[2] In particular, a welfare analysis of mobility can be built on work by Kreps and Porteus (1978, 1979a, 1979b), Epstein and Zin (1989, 1991), and Weil (1990). We build a bridge between the literature on economic mobility and the literature on dynamic choice under uncertainty when utility is not additively separable.[3] The resulting welfare analysis allows us

[1] "Origin independence" has usually been studied from a "descriptive" or "intuitive" perspective rather than from a "welfarist" perspective. A classic axiomatic discussion is provided by Shorrocks (1978).

[2] The Atkinson-Bourguignon analysis can be interpreted as an application to social welfare of multidimensional static expected utility theory.

[3] A different use of Kreps-Porteus preferences can be found in an interesting paper by Benabou (1997), who employs a specific Kreps-Porteus framework in order to study the 'pure efficiency' effects of redistributive policies, i.e., to provide a measure of economic efficiency that incorporates insurance effects of redistributional policies but does not involve any interpersonal comparison

to evaluate the social welfare consequences of reversal and origin independence. Our objective, therefore, is not to determine whether one society is descriptively "more mobile" than another but rather whether social welfare is higher given differences in these two key aspects of mobility.

The primary focus of our paper is the evaluation of different aspects of mobility in "their own right". That is, we are primarily interested in building a framework that attributes welfare content to different mobility patterns even when marginal distributions of consumption are kept constant (in other words, even when the "size of the pie" and its cross-sectional distribution are independent of mobility patterns). One should note that our framework can also be used for the welfare comparison of different societies when there are endogenous links between mobility patterns and marginal distributions of consumption (for instance, when "mobility" is associated with higher average consumption because of higher productive efficiency). However, the study of the complex relationships between economic mobility and production is beyond the scope of this paper.

We use our framework to develop welfare measures of mobility, and apply these measures to intergenerational mobility in the United States using PSID data. We show that the value of origin independence is quantitatively important for reasonable values of the parameters. We also show that blacks and non-blacks experience different mobility patterns: reversal is more important than origin independence for blacks but the opposite is true for non-blacks.

The paper is organized as follows. Section 2 discusses mobility and preferences for intertemporal equality. Section 3 introduces preferences for the timing of resolution of uncertainty, and links the welfare analysis of mobility to the Kreps-Porteus framework. Section 4 develops some welfare measures of mobility. Section 5 briefly discusses mobility and production. Section 6 illustrates an empirical application of our approach.

2. Economic Mobility and Intertemporal Inequality.

Does "mobility" matter for welfare? In this section we will provide a simple framework that allows us to fix ideas and illustrate some important analytical points. In particular, we discuss the key role that "intertemporal concavity" plays in utility-based evaluations of economic mobility.

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of utilities.

Consider a society in which individuals live for two periods. In each period, half the population have low consumption (say $c_L > 0$) and the other half have high consumption (say $c_H > c_L > 0$).[4]The conditional probabilities are given as follows:

$$\begin{bmatrix} \Pr(c_2 = c_L | c_1 = c_L) = 1 - \delta & \Pr(c_2 = c_H | c_1 = c_L) = \delta \\ \Pr(c_2 = c_L | c_1 = c_H) = \delta & \Pr(c_2 = c_H | c_1 = c_H) = 1 - \delta \end{bmatrix} \tag{2.1}$$

The above "transition matrix" means that each individual will have the same level of consumption in both periods with probability $(1-\delta)$ and different levels of consumption with probability δ. In order to clarify issues, we can adopt a common definition of "immobility": the society in our example will be called "immobile" if $\delta = 0$.

We now ask "what is the optimal δ"? That is, we take a welfare rather than an axiomatic approach.[5] In order to address this question, we need to evaluate different $\delta's$ by using some well-defined social welfare function.[6] A special class of social welfare functions can be derived from "individualistic" preferences by using Harsanyi's (1955) "veil-of-ignorance". From a "veil-of-ignorance" perspective, our question can be rephrased as "What δ would be chosen by an individual who maximizes her utility, assuming that she attaches equal chances to each situation (high or low consumption) in the first period?".

A natural starting point is the standard time-separable Von Neumann - Morgenstern (VNM) utility function, which, in our two-period example, takes the following form:

$$W = E_0[u(c_1) + v(c_2)] \tag{2.2}$$

[4]We focus on "consumption" rather than "income" or other indices of economic status. Consumption and income would coincide if individuals had to consume a nonstorable endowment in each period, and no borrowing or lending could take place in the economy. As the explicit modeling of consumption/saving decisions, intergenerational transfers, credit markets etc. is beyond the scope of this paper, we prefer to focus directly on consumption levels.

[5]See Fields and Ok (1997) for a comprehensive discussion of alternative approaches.

[6]As it is usual in this literature, we will evaluate different $\delta's$ taking the marginal distributions of consumption in each period as given. In other words, in this section we abstract from any endogenous effect of "mobility" on the marginal distributions of consumption in each period (and viceversa). As we indicate in Section 3.3, our framework can be used in order to evaluate different policies that affect both mobility and marginal distributions once the endogenous links are specified. Such analysis is, however, not the primary focus of this paper.

Where W (social welfare) is given by expected utility at time 0 (i.e., behind a veil of ignorance), E_0 denotes the mathematical expectation conditional only on the information available at time 0, and $u(.)$ and $v(.)$ are two increasing and concave functions. Since expected utility is given by

$$\begin{aligned} W &= \frac{1}{2}[u(c_L) + (1-\delta)v(c_L) + \delta v(c_H)] + \frac{1}{2}[u(c_H) + (1-\delta)v(c_H) + \delta v(c_L)] = \\ &= \frac{1}{2}[u(c_L) + v(c_L) + u(c_H) + v(c_H)] \end{aligned} \tag{2.3}$$

it is independent of δ.

In fact, if we assume that the appropriate social welfare function is a time-separable VNM utility function (an assumption commonly made in the analysis of intertemporal allocation), we must accept that economic mobility has no welfare significance per se (δ is irrelevant).[7] Only marginal distributions matter.[8] One way of making mobility directly relevant from a welfare perspective is to introduce some form of intertemporal concavity.[9]

As a useful starting point we follow Atkinson and Bourguignon (1982) by looking at a concave transformation of (1):

$$W = E_0 G[u(c_1) + v(c_2)] \tag{2.4}$$

where $G' > 0$ and $G'' < 0$. This modified expected utility is monotonically increasing in δ. In fact, we have that

$$\begin{aligned} W &= \frac{1}{2}\{(1-\delta)G[u(c_L) + v(c_L)] + (1-\delta)G[u(c_H) + v(c_H)] + \delta G[u(c_H) + v(c_L)] \\ &\quad + \delta G[u(c_L) + v(c_H)]\} \end{aligned} \tag{2.5}$$

which, as G(.) is concave, implies

$$\frac{dW}{d\delta} = \frac{1}{2}\{[G[u(c_H) + v(c_L)] - G[u(c_L) + v(c_L)]]$$

[7] See Atkinson (1981) and Markandya (1982).

[8] For instance, a reduction in inequality in each period is welfare improving, as $u(.)$ and $v(.)$ are concave.

[9] An interesting alternative approach which maintains "linearity" but drops "symmetry" (i.e., the assumption that each position receives equal weight behind a veil of ignorance) has been developed by Dardanoni (1993).

$$-[G[u(c_H)+v(c_H)]-G[u(c_L)+v(c_H)]]\}>0 \tag{2.6}$$

Hence, any increase in δ improves social welfare. The "optimal δ" is equal to 1, which implies the following "first-best" transition matrix:

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \tag{2.7}$$

This result can be obtained for any social welfare function of the form

$$W = E_0 U(c_1, c_2) \tag{2.8}$$

as long as $U_{12} < 0$. In fact, Atkinson (1981) and Atkinson and Bourguignon (1982) show that, for any social welfare function (2.8) with $U_{12} < 0$, moving weight off the diagonal of a transition matrix is welfare improving.[10] This property allows Atkinson and Bourguignon to make a partial ranking of distributions. Intuitively, a distribution A ranks above a distribution B if A can be obtained from B through a finite number of transformations in which marginals are unchanged, but weight is moved away from the "diagonal". This partial ranking is applied directly to income mobility by Atkinson (1981), and is called Atkinson's mobility ordering in the mobility literature.

Atkinson's mobility ordering is rooted in aversion to inequality. More specifically, Atkinson and Bourguignon (1982) note that the sign of U_{12} depends on the difference between "inequality aversion" and degree of intertemporal substitution. Aversion to inequality places positive value on reversal but aversion to intertemporal fluctuations places negative value on reversal.

If preferences are isoelastic, the social welfare function used by Atkinson and Bourguignon can be written as

$$W = \{E_0 V^{1-\epsilon}\}^{\frac{1}{1-\epsilon}} \tag{2.9}$$

where

$$V = (\alpha_1 c_1^{1-\rho} + \alpha_2 c_2^{1-\rho})^{\frac{1}{1-\rho}}$$

[10] The intuition for this result goes as follows: when the marginal utility of consumption in period 2 decreases with consumption in period 1, welfare gains are obtained by reducing the probability that individuals who had high consumption in the first period will have high consumption in the second period, and by increasing the probability that individuals who had low consumption in the first period will have high consumption in the second period.

The parameter ϵ measures the degree of aversion to "inequality of multiple-period consumption" (we can interpret it as relative "risk aversion" behind the veil of ignorance). ρ measures aversion to intertemporal fluctuations: the higher is ρ, the less substitutable is consumption across periods (the elasticity of intertemporal substitution is $1/\rho$), and the higher is, therefore, the aversion to deviate from smooth consumption paths.

If $\epsilon > \rho$, the "optimal δ" is equal to 1, and any increase in "reversal" is welfare improving.[11] When $\epsilon > \rho$, the aversion to lifetime inequality is high enough to overcome the aversion to deviations from smooth consumption paths. Conversely, when the degree of intertemporal substitution is low (i.e., ρ is high) relative to inequality aversion, a "static society" is preferred, in which consumption is smooth but at the cost of greater inequality of multiple-period consumption paths across individuals.

The Atkinson-Bourguignon approach implies that, if we prefer a mobile society ($\delta \neq 0$) to a static society ($\delta = 0$), we also prefer a society with complete reversal ($\delta = 1$) to any society with incomplete reversal ($\delta < 1$). This conclusion is not surprising, as the preference for mobility is rooted in inequality aversion, and complete reversal ensures the minimum amount of multiperiod inequality. In particular, the matrix with $\delta = 1/2$ (which implies origin independence in the sense that second-period consumption is independent of first-period consumption) has no special role in the Atkinson-Bourguignon framework.

3. Economic Mobility and Dynamic Choice

In this section we provide conditions under which $\delta = 1/2$ (and, more generally, any transition matrix in which every row is the same as every other) plays a special role. Such a matrix presents independence between consumption in period 1 and consumption in period 2, a property that is sometime referred to as "origin independence" or "time independence". Some authors have noted that the welfare value of mobility for society is often prescribed in terms of "time independence", in contrast with Atkinson's ordering (e.g., see Fields and Ok, 1997, p. 26).The fact that Atkinson's mobility ordering does not give any special role to $\delta = 1/2$ has been seen by some authors as at odds with the intuitive notion of "mobility" and with the idea that "origin independence" should have some welfare value

[11] $\frac{dW}{d\delta}$ is larger (equal, smaller) than 0 if and only if ϵ is larger (equal, smaller) than ρ.

for society.[12] Is there any welfare-based reason why one should attach special meaning to $\delta = 1/2$? How could that be reconciled with "preferences for reversal" and inequality aversion as illustrated in the above example? In the rest of this paper, we attempt to provide an analysis that can shed some light on these issues.

The identity matrix ($\delta = 0$) and the "reversal" identity matrix ($\delta = 1$) have a feature in common: in both cases, consumption in the first period exactly "determines" consumption in the second period. All uncertainty about consumption in period 2 is resolved as soon as we know consumption in period 1. By contrast, when $\delta = 1/2$, first-period consumption provides no information about second period consumption. In a society with either $\delta = 1$ or $\delta = 0$, the future economic status is predetermined by current economic status for each individual or family, while values of δ closer to 1/2 keep future income more "uncertain". In general, the temporal profile of uncertainty resolution depends on the value of δ.

In this section we show how the timing of uncertainty resolution is related to the welfare value of mobility. In particular, we link the concept of "origin or time independence" with the utility analysis of the resolution of uncertainty, a set of well-developed concepts which, to our knowledge, have not been used in this context. In the following subsection we will briefly review the relevant literature on preferences for temporal resolution of uncertainty. We then link those concepts to the welfare analysis of economic mobility.

3.1. Preferences for Temporal Resolution of Uncertainty

Standard expected utility theory assumes that the timing of uncertainty resolution is irrelevant. Irrelevance is a direct consequence of the axiom of compound lotteries. Compound lotteries are lotteries whose prizes are tickets to other lotteries. The axiom states that an agent faced with compound lotteries cares only about the *compound probability of each prize*.[13] This clearly implies indifference to the *timing* of uncertainty over temporal lotteries. As expected utility theory was originally introduced within a static framework, indifference to timing of uncertainty resolution is not surprising. However, this feature of standard expected utility has been seen by many authors as excessively restrictive when utility theory

[12]By contrast, axiomatic measures of mobility assign maximum "mobility" to the matrix with $\delta = 1/2$ (see Pais (1955) and Shorrocks (1978)).

[13]The fact that "intermediate phases of randomization" do not matter for expected utility is an important part of Diamond (1967)'s classic criticism of expected utility as a foundation for ethical preferences (see the discussion in Sen, 1970, pp.142-145).

is extended to a dynamic framework.[14] As shown by Kreps and Porteus (1978), a natural generalization of a lottery in a dynamic setting is a "temporal lottery". In this generalization, uncertainty is dated by the time of its resolution, and this allows one to introduce preferences which can distinguish between temporal lotteries precisely because the times at which their uncertainty resolves are different. Specifically, Kreps and Porteus (1978) provide an axiomatic foundation of preferences when a) the axiom of compound lotteries is abandoned; b) all other axioms of VNM utility theory are maintained; c) the temporal consistency of optimal plans is imposed axiomatically.

A useful way of representing preferences with Kreps-Porteus foundations is:

$$U_t = F_t(c_t, E_t U_{t+1}) \tag{3.1}$$

where U_t is utility at time t, c_t is consumption at time t, E_t is the mathematical-expectation operator conditional on information available at time t, and $F_t(.,.)$ (the "aggregator function") aggregates current consumption and future utility.[15] If the aggregator function is linear in its second argument, these preferences are identical to standard VNM preferences, and the consumer is indifferent to the timing of the resolution of uncertainty. In terms of our mobility analysis, people behind a veil of ignorance are indifferent to living in a society in which second-period incomes are known in the first period (e.g., because children's incomes are fully predictable from their parents' status) and one in which future incomes are unpredictable in the first period.

However, if the aggregator function is *concave* in its second argument, the consumer prefers late resolution of uncertainty.[16] Intuitively, when present utility is concave in future utility, individuals prefer 'not to know' about the future because the utility loss associated with bad news is larger than the utility gain

[14] Note that the Atkinson-Bourguignon analysis itself builds on the static analysis of choice under uncertainty in the multidimensional case. In other words, consumption levels in the two periods are seen as different goods, but the temporal aspect is absent. In fact, Atkinson and Bourguignon (1982) illustrate their analysis by applying to a static multidimensional problem: the evaluation of the international distribution of income and life expectancy. The application to economic mobility assumes that the social planner evaluates ex-post consumption levels (in other terms, that all uncertainty about second-period consumption is resolved in the first period).

[15] If the function $F(.,.)$ is time-invariant, preferences are said to exhibit "payoff history independence". Payoff history independence is usually assumed in the literature on non-additive utility.

[16] Convexity in the second argument implies a preference for early resolution of uncertainty.

associated with good news. In terms of mobility, people behind a veil of ignorance prefer a society where first-period income conveys little information about second-period income because the "utility loss" from knowing in advance that one will be poor is higher than the "utility gain" coming from knowing that one will be rich.

Building on the Kreps-Porteus utility representation, one can represent preferences for which the timing of uncertainty resolution may matter as

$$U_t = J_t[c_t, h_t(U_{t+1})] \tag{3.2}$$

where *J(.,.)* aggregates present consumption and the certainty equivalent of future utility, denoted by $h_t(U_{t+1})$. For instance, if preferences are isoelastic and time-invariant, the above utility can be specified as[17]

$$U_t = [(1-\beta)c_t^{1-\rho} + \beta h_t^{1-\rho}]^{\frac{1}{1-\rho}} \tag{3.3}$$

where

$$h_t = (E_t U_{t+1}^{1-\gamma})^{\frac{1}{1-\gamma}}$$

The parameter β measures the relative weight of second-period consumption. If $\beta = 1/2$, the subjective discount rate is zero. The parameter ρ is the inverse of the elasticity of intertemporal substitution: it measures aversion to intertemporal fluctuations in consumption. γ is the coefficient of relative risk aversion over second-period "lotteries".

In general, Kreps-Porteus preferences link attitudes towards temporal resolution of uncertainty with attitudes toward risk aversion (aversion to fluctuations of consumption across 'states') and intertemporal substitution (aversion to fluctuations of consumption across 'dates'). A heuristic explanation of this relationship has been provided by Philippe Weil (1990, p. 32). Weil notes that,

> "... lotteries in which uncertainty resolves early (...) are less risky than late resolution lotteries with the same distribution of prizes (...). Early resolution lotteries, however, feature certainty equivalent fluctuations of utility over time which are of larger amplitude. There is therefore, in general, a trade-off between safety and stability of utility.

[17]For $\rho = 1$, we have $U_t = (1-\beta)\ln c_t + \beta \ln h_t$. For $\gamma = 1$, we have $h_t = E_t \ln U_{t+1}$. Weil (1990) provides an alternative isoealstic specification in which those special cases can be obtained directly from the general formula by applying De l'Hôspital's rule.

Therefore, agents who dislike risk "more" than intertemporal fluctuations prefer, ceteris paribus, early resolution; but consumers who have a stronger distaste for intertemporal fluctuations than for risk prefer late resolution."

For instance, an individual with isoelastic preferences as in 3.3 prefers late resolution of uncertainty for $\rho > \gamma$, while she prefers early resolution for $\rho < \gamma$. For $\rho = \gamma$ the utility function reduces to a standard VNM expected utility and the individual is indifferent to the timing of uncertainty resolution.

Epstein and Zin (1991) estimate the parameters that determine the attitudes toward risk and intertemporal substitution by using time series data. They find moderate degrees of risk aversion (a coefficient of relative risk aversion γ around 1) but larger aversion to intertemporal fluctuations (i.e., their elasticity of intertemporal substitution $1/\rho$ is significantly smaller than 1), which implies a preference for later resolution of uncertainty.

These estimates seem consistent with experiments and 'introspection' according to which people tend to be less risk averse than 'temporal instability' averse, and tend to prefer late resolution of uncertainty. A striking example is given by the behavior of children of parents with Huntington's chorea. Huntington's chorea is a terrible genetic disorder which causes death through the slow deterioration of the nervous system. It usually appears at about the age of forty, with death, on average, at fifty. By that age, children have usually been born, and they have a fifty-fifty chance of developing the disorder. The probability of correct diagnosis is practically one. However, children of a parent with Huntington's chorea are very reluctant to be tested and about 90 percent do not (Cavalli-Sforza and Cavalli-Sforza, 1995, p. 250).

3.2. Temporal Resolution of Uncertainty and Mobility

We now make the link between extended utility specifications and economic mobility. For simplicity's sake we will limit our analysis to three periods: period 0 ("behind the veil of ignorance"), in which no consumption takes place, and periods 1 and 2, in which individuals consume c_1 and c_2, respectively. Building on the Kreps-Porteus representation of preferences (3.2), we can write the social welfare function as

$$W = U_0 = J_0[h_0(U_1)] \tag{3.4}$$

where

$$U_1 = J_1[c_1, h_1(J_2(c_2))]$$

Although we could pursue our analysis with the above general specification, it will be easier to illustrate our approach by using an isoelastic specification. Our social welfare function can then be written as

$$W = U_0 = [E_0 U_1^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{3.5}$$

where

$$U_1 = \{(1-\beta)c_1^{1-\rho} + \beta[(E_1 c_2^{1-\gamma})^{\frac{1}{1-\gamma}}]^{1-\rho}\}^{\frac{1}{1-\rho}}$$

The four parameters $(\beta, \varepsilon, \rho, \gamma)$ can be interpreted as follows:

- β measures the relative weight of second-period consumption. If $\beta = 1/2$, each period's consumption receives the same weight.
- ε measures risk aversion behind a veil of ignorance.[18] In general, ε can be interpreted as aversion to inequality of multiple-period consumption paths
- ρ is the inverse of the elasticity of intertemporal substitution. It measures aversion to intertemporal fluctuations in consumption.
- γ is the coefficient of relative risk aversion over second-period outcomes. It measures aversion to risk after the veil of ignorance is removed.

The above specification differs from the time-invariant isoelastic varieties commonly used in the literature in one crucial respect: we allow for different coefficients of risk aversion, depending on whether uncertainty is evaluated behind a veil of ignorance or after the veil of ignorance is removed (the standard isoelastic representation is given by the special case $\varepsilon = \gamma$).

The following proposition is immediate:

[18] When preferences take into account only first-period consumption ($\beta = 0$) or only second-period consumption ($\beta = 1$), ε is identical to the coefficient of (static) inequality aversion in the Atkinson (1970) inequality index.

Proposition 1: *When $\varepsilon = \rho = \gamma$, the social welfare function W reduces to a standard, additively separable isoelastic VNM utility function, and the timing of uncertainty resolution is irrelevant.*

In general, when the condition in proposition 1 is not satisfied (i.e., when the three parameters are not identical), the timing of resolution of uncertainty matters and, hence, mobility can affect social welfare through gains (or losses) that result from not knowing second period outcomes with certainty (i.e. origin independence). In particular, as we prove in the Appendix, we have that

Proposition 2:*Late resolution of uncertainty is socially preferred for all marginal distributions of consumption if and only if $\gamma \leq \min\{\rho, \varepsilon\}$ and $\gamma < \rho$ if $\rho = \varepsilon$. In other words, late resolution is preferred if $\rho \geq \gamma$ and $\varepsilon \geq \gamma$, and at least one inequality is strict.*[19]

Some intuition for Proposition 2 can be obtained by extending Weil's heuristic explanation, which we cited in the previous subsection. Once the veil of ignorance is removed, later resolution has the same effect as in the standard time-invariant case: it reduces intertemporal fluctuations by replacing second period earnings with their expectation. It also increases risk since second period outcomes are not known with certainty. Therefore, all other things being equal, late resolution is preferred for high values of ρ and for low values of γ. However, when different individuals' utilities are evaluated behind a veil of ignorance, late resolution also reduces ex-ante inequality. Therefore, ceteris paribus, preferences for equality (high ε) are associated with preferences for later resolution.

We are ready to gain some insights on the relationship between preference for late resolution and economic mobility. The preceding analysis can be used to make precise the statement that mobility improves social welfare by reducing origin independence. If the underlying preference parameters (ε, ρ and γ) lead to a preference for later resolution, then social welfare will be higher if second period outcomes are not known with certainty. Welfare can be evaluated under the assumption that information about second period consumption is inferred from first period consumption. When c_2 cannot be perfectly predicted from c_1

[19]Note that for $\varepsilon = \gamma$ the condition reduces to the well-known condition $\rho > \gamma$. However, when we extend our utility function in order to consider decisions behind a veil of ignorance, and allow risk aversion to differ before and after the veil of ignorance is removed, we can have preference for late resolution of uncertainty even when $\rho = \gamma$, as long as $\varepsilon > \gamma$.

there is value to the resulting later resolution of uncertainty. In terms of our analysis in Section 2, there is value to having a transition matrix that does *not* have 1's either on the diagonal or off diagonal elements.

Consider our transition matrix example in Section 2, in which c_1 took on two values: $c_H > c_L > 0$. The social welfare function is given by [20]

$$\begin{aligned} W &= \{\frac{1}{2}[\frac{1}{2}c_L^{1-\rho} + \frac{1}{2}[(1-\delta)c_L^{1-\gamma} + \delta c_H^{1-\gamma}]^{\frac{1-\rho}{1-\gamma}}]^{\frac{1-\varepsilon}{1-\rho}} \\ &\quad + \frac{1}{2}[\frac{1}{2}c_H^{1-\rho} + \frac{1}{2}[(1-\delta)c_H^{1-\gamma} + \delta c_L^{1-\gamma}]^{\frac{1-\rho}{1-\gamma}}]^{\frac{1-\varepsilon}{1-\rho}}\}^{\frac{1}{1-\varepsilon}} \end{aligned} \quad (3.6)$$

We show in the Appendix that one can derive the following relationship between the optimal amount of movement off of the diagonal in a transition matrix, as given by δ, and the parameters of the social welfare function.

Proposition 3: *Assuming that $\gamma < \min\{\rho, \varepsilon\}$ (i.e., late resolution of uncertainty is preferred), the optimal δ - i.e., the value of δ that maximizes the social welfare function given in equation 3.6 - is larger/equal/smaller than 1/2 if ε is larger/equal/smaller than ρ.*

The intuition for the above result is straightforward. Uncertainty resolution depends on our choice of δ. If we choose $\delta = 1/2$, we obtain the maximum amount of late resolution. As the condition in Proposition 2 is satisfied, we like late resolution. When $\varepsilon = \rho$, we don't care about reversal or stability, and are free to choose the δ that gives as much "time independence" as possible ($\delta = 1/2$) . When we care about reversal ($\varepsilon > \rho$), we both like more reversal (a δ as close as possible to 1) and later resolution (a δ as close as possible to 1/2), but there is a trade-off between the two goals. The optimal δ will be the result of this trade off, and will take a value between 1/2 and 1. The converse will be true when $\varepsilon < \rho$.[21]

[20] For simplicity and symmetry we assume $\beta = 1/2$.

[21] The above analysis can also shed some light on the scope and limits of partial ordering of mobility matrices when "origin independence" matters. An important goal behind Atkinson's (1981) seminal paper and the following literature (e.g., Dardanoni, 1993) has been the extension of the Lorenz inequality ordering to mobility measurement. Within our framework, "origin independence" and "reversal" are potentially conflictual objectives. A partial ordering can be obtained only when we limit comparisons within the set of matrices for which no conflict occurs. For instance, the following sufficient condition holds: for all our social welfare functions with

In summary, our analysis shows that "mobility" captures at least three sometimes conflicting forces. First, mobility may reduce multiperiod inequality by increasing "reversal". This is the aspect of mobility that has gained most attention in the literature.[22] Second, these reversals introduce multiperiod fluctuations that reduce social welfare. Third, mobility also affects the degree of origin dependence. Social welfare may be higher if future utility is not perfectly predictable from current consumption. In particular, we have specified a social welfare function in which the timing of uncertainty resolution plays a crucial role, therefore allowing us to integrate this third aspect of mobility into our overall framework.

4. Economic Mobility and Production

Thus far we have focused exclusively on the role of preferences in evaluating the optimal level of mobility. Sections 2 and 3 considered the choice between living in two societies with the same marginal distributions of consumption, i.e., where the size of the "pie" and its cross-sectional division were purposefully held constant in order to derive conditions under which origin independence and/or reversal are valued in their own right. In this section we briefly expand our analysis by considering the possibility that changes in mobility are associated with changes in production.[23] As might be expected, when production and mobility are endogenously connected, preferences and technologies both play a role in determining the efficient degree of mobility behind a veil of ignorance. While we consider the links between mobility and production in this section, we stress that a full treatment of this important topic would require a paper on its own. Our purpose is not to be exhaustive but rather to point to the ways in which these two aspects interact and may affect the welfare evaluation of mobility.

Even if there were no preferences over mobility ($\varepsilon = \rho = \gamma$), social welfare would still be affected if production was affected by the degree of mobility (δ in

$\varepsilon \geq \rho > \gamma$, moving weight off of the diagonal of a 2x2 transition matrix is welfare improving if the original matrix and the resulting matrix have diagonal entries larger or equal to 1/2. Similar partial ranking criteria could be obtained for more general classes of social welfare functions and/or transition matrices. As our main point is that, from both a descriptive and a welfare perspective, mobility is intrinsically a multidimensional concept, we do not pursue that line of analysis in this paper.

[22] For instance, see Atkinson, Bourguignon and Morrisson (1992).

[23] For recent contributions to the study of the endogenous links between mobility and growth see, for instance, Galor and Tsiddon (1997) and their references.

our simple example). For example, output might be higher in a society in which individuals could be matched to jobs regardless of their social background than in a static society in which children could only enter the jobs held by their parents.

It is worth noting that, in general, "origin independence" is neither necessary nor sufficient for productive efficiency or growth maximization. Although one may expect that in most circumstances obstacles to economic mobility would reduce effort and/or induce a misallocation of talent, there are circumstances where higher production may be obtained with less "origin" independence." For instance, in some social and economic environments, it is possible that investing in the children of the rich may increase production more than investing the same amount of resources in the children of the poor. Higher output may also be associated with lower intergenerational mobility when childrens' ability depends on parental specific human capital (as in Galor and Tsiddon, 1997). The criterion of output maximization may then lead to prefer a society with a higher correlation in ability across generations and, therefore, in some cases, lower intergenerational mobility.[24] Another case in which *obstacles* to mobility may foster productive efficiency and growth is when the highest consumption levels are obtained through unproductive rent-seeking activities (see Murphy, Shleifer and Vishny, 1991). In the absence of obstacles to mobility, the most talented individuals would become "rent seekers", independently of their backgrounds. If obstacles to mobility prevent some talented individuals (e.g., individuals outside a predetermined "aristocracy', members of religious minorities, etc.) from entering the high-return rent-seeking sector, more talent may be allocated in the more productive, growth-enhancing sector.

In general, let δ^t be the value of δ that would maximize output per capita, given the existing technology. As long as W increases with output per capita, δ^t is the value of δ that would be chosen behind the veil of ignorance if there were no preferences over δ . In terms of our previous analysis, it is the value of δ that would be chosen if mobility was not valued in its own right (i.e. $\varepsilon = \rho = \gamma$).[25] Now consider the other extreme in which δ reflects preferences but does not affect

[24] In Galor and Tsiddon (1997), a higher serial correlation in ability across generations has a negative effect on mobility when technologies are stationary, and an ambiguous effect on moblity when innovations are introduced.

[25] If average output in each period is equal to average consumption, output maximization is the only objective for a risk-neutral VNM welfare maximizer (i.e., $\varepsilon = \rho = \gamma = 0$). If we assume that consumption for each individual is proportional to output, output maximization will be consistent with the maximization of any VNM welfare function.

output. Let δ^p be the value of δ that maximizes W for a given level of output. As discussed in Section 2, δ^p is determined by ε, ρ and γ.

It is possible that δ^t and δ^p will be equal. For example, if maximum origin independence maximizes output then $\delta^t = 1/2$ and if $\varepsilon = \rho > \gamma$ then $\delta^p = 1/2$. Since in this case $\delta^t = \delta^p$, there is no trade-off between the welfare gains from changes in δ based on preferences over mobility and the welfare gains from greater output.

The two values of δ may, however, not be the same, in which case the maximum output does not yield maximum social welfare. For example, suppose that preferences are such that $\delta^p = 1/2$ (for a given level of output, welfare is maximized where there is maximum origin independence) but that output is maximized when there is less than full origin independence. In this case $\delta^t < 1/2$. Starting from $\delta^p = 1/2$ it may be possible to increase W by reducing δ, which increases output. But at some point δ^* (where $\delta^t \leqq \delta^* \leqq \delta^p$) the welfare gain from greater output will be more than offset by the direct loss in social welfare from the decline in origin independence. The resulting δ^* that maximizes W is the efficient δ.

In summary, sections 2 and 3 have provided the welfare basis for considering how mobility could enter preferences. Mobility may also affect production. Together these two aspects determine the constrained optimum. Although a study of the relationship between mobility and production is outside the scope of this paper, the above discussion suggests that the specification of explicit preferences over mobility patterns is an important precondition for a welfare analysis of the potential trade-offs and complementarities involving mobility and productive efficiency. The application of our approach to specific models with endogenous, dynamic links between mobility and production is left for further research.

5. Evaluating Mobility

The framework we have developed can be used to construct social welfare measures of mobility. These are developed in this section and applied to an illustrative example in the following section.

Our starting point is the welfare that would be obtained in a "static society"; i.e., under the assumption that different individuals keep their first-period rank.[26]

[26] The individual with the lowest consumption in the first period has the lowest consumption in the second period, etc.

Denote this hypothetical second period vector of consumption as $\tilde{c}_2$. This is implemented by ranking c_1 and c_2. The c_2 with the same rank as c_1 is assigned as the value of $\tilde{c}_2$. Welfare in the static society is then given by[27]

$$W_s = [E_0 U_{1s}^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{5.1}$$

where

$$U_{1s} = \{\frac{1}{2}c_1^{1-\rho} + \frac{1}{2}\tilde{c}_2{}^{1-\rho}\}^{\frac{1}{1-\rho}}$$

If we normalize this measure of welfare by multiperiod average consumption, defined as

$$E_0\left[\frac{1}{2}c_1 + \frac{1}{2}c_2\right] \equiv \bar{c} \tag{5.2}$$

we obtain a normalized measure of the "welfare loss" associated with a "static society"[28]:

$$I_s \equiv \frac{W_s}{\bar{c}}$$

$\bar{c}$ can be interpreted as the welfare that would be obtained in a society in which consumption is identical across individuals and across periods.[29]

We then measure the welfare that would result with reversal but with early resolution of uncertainty (i.e., under the assumption that each individual at time 1 were to receive complete information about her consumption at time 2), which we label W_e:

$$W_e = [E_0 U_{1e}^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{5.3}$$

[27]In the rest of this paper, for simplicity's sake, we set $\beta = 1/2$.

[28]Clearly, as $\varepsilon \geq 0$ and $\rho \geq 0$, we must have $I_s \leq 1$

[29]In particular, if the marginal distributions are identical across periods, we have that

$$\bar{c} = E_0 c_1 = E_0 c_2$$

and

$$W_s = [E_0 c_1^{1-\varepsilon}]^{\frac{1}{1-''}} = [E_0 c_2^{1-\varepsilon}]^{\frac{1}{1-''}}$$

Then, $I_s = 1 - A$, where A is Atkinson (1970) inequality index for the marginal distribution of consumption.

where

$$U_{1e} = \{\frac{1}{2}c_1^{1-\rho} + \frac{1}{2}c_2{}^{1-\rho}\}^{\frac{1}{1-\rho}}$$

Note that W_e will be larger/equal/smaller than W_s as long as ε is larger/equal/smaller than ρ. When $\varepsilon > \rho$, we like reversal, and the size of W_e relative to W_s captures the "gains" from reversal in a world in which consumption in both periods is known with certainty as soon as we remove the "veil of ignorance". By taking the ratio, we can obtain an index of the "relative gains from reversal"

$$I_r = \frac{W_e}{W_s}$$

The next step is to measure social welfare with later resolution of uncertainty, W. For this measure we calculate expected consumption for period 2 conditional on consumption at time 1 as given in equation (3.5):

$$W = U_0 = [E_0 U_1^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{5.4}$$

where

$$U_1 = \{\frac{1}{2}c_1^{1-\rho} + \frac{1}{2}[(E_1 c_2^{1-\gamma})^{\frac{1}{1-\gamma}}]^{1-\rho}\}^{\frac{1}{1-\rho}}$$

If late resolution of uncertainty is preferred (i.e., if the condition in Proposition 2 is satisfied), W will always be larger or equal to W_e. It will be equal to one only when future consumption is perfectly determined by present consumption (perfect origin dependence). The larger is W relative to W_e, the larger is the welfare value of origin independence. We denote the relative gains from late resolution as

$$I_l \equiv \frac{W}{W_e}.$$

With these building blocks we can now use the following identity

$$W = \bar{c} I_s I_r I_l \tag{5.5}$$

which allows us to identify the impacts of welfare that can be attributed to:
1) the level of average consumption, $\bar{c}$.
2) the maximum potential welfare loss from immobility, I_s.

3) the welfare gain due to "reversal", I_r.

4) the welfare gain due to "late resolution", I_l.

When comparing societies with different levels of average consumption, as is standard practice in the inequality literature, one may consider a "normalized" measure of overall welfare:

$$\frac{W}{\bar{c}} = I_s I_r I_l \tag{5.6}$$

6. Empirical Application

We use data from the Panel Study of Income Dynamics (PSID) to construct our measures of intergenerational earnings mobility for fathers and sons.[30] The PSID is a rich data set for this purpose since it provides direct measures of : 1) earnings of fathers when their children are still living in the parental household, and 2) the adult earnings of these children. Ideally one would obtain lifetime consumption of both fathers and sons; however, like previous studies of intergenerational mobility, we must limit ourselves to earnings (or income) rather than consumption and to a period considerably shorter than a lifetime.[31] Even with a panel covering over twenty years one can obtain only relatively short histories for children who must be young enough to have been in a parental household (0 to 18 years old in our case) at the start of the panel but old enough later in the panel to yield information on adult outcomes such as earnings. The resulting sample includes 1034 father-son pairs (309 black and 725 non-black).[32]

We start by providing our measures for our full sample. We then turn to differences in mobility patterns of blacks and non-blacks.

[30] Since women are less likely to have labor market earnings, we limit our attention in this paper to fathers and sons. While this does not eliminate potential selection issues, focusing on males does reduce this potential sources of selection bias.

[31] c_1 is measured by the average earnings of the father in the first three years of the PSID. c_2 is measured by the average earnings of the son when he was 24 to 26.

[32] Fitzgerald, Gottschalk and Moffitt (1998) find no evidence of biasing attrition on observable characteristics for this sample. We use sample weights throughout this paper since we include the SEO sample. The use of sample weights is particularly important for blacks since they are disproportionately represented in the SEO sample. See Fitzgerald, Gottschalk and Moffitt (1998) for a discussion of the use of sample weights.

6.1. All Persons

The first three rows of Table 1 present the three components of our welfare measure,$W/\bar{c}$, shown in equation 5.5. The first row shows I_s, our measure of welfare in a static society. I_s measures the welfare for our father son pairs if there had been no reversal (if the son with the lowest earnings had been the son of the father with the lowest earnings) and no origin independence (if each son had known his place in the earnings distribution based on his father's rank)[33]. Row 2 shows I_r, the gain in welfare from reversal, and row 3 shows, I_l, the welfare gain from later resolution. The last row shows the resulting composite welfare measure, $W/\bar{c}$, which is the product of the first three rows. Since each of these measures depend on the particular values of ε, ρ and γ chosen, we present results under a variety of parameter values in each column.

To fix ideas we start by showing our measures under the assumption that there is only aversion to inequality by setting $\varepsilon = 6$ and $\gamma = \rho = 0$. Since these parameter values satisfy proposition 2 they also reflect preferences for later resolution of uncertainty (i.e. origin independence) as well as reversal. Under these parameters I_s would be .141. This can be interpreted as showing that welfare is about fourteen percent as high in a static society as in a society with the same average earnings but total equality.

Now consider the impact of reversal and later resolution of uncertainty. Row 2 indicates that the observed amount of reversal nearly triples welfare (i.e. $I_r = 2.93$). This indicates substantial gains from reversal when aversion to inequality (ε) is the only relevant factor[34]. Row 3 shows that later resolution of uncertainty also plays a substantial, though smaller, role. The value for I_l of 1.60 indicates that welfare increases an additional 60 percent if sons do not know their future earnings but can only infer the mean of their expected earnings based on the expected value of sons earnings conditional on father's earnings (as shown in equation 3.5).[35]

[33] This is normalized by the average earnings of our father- son pairs, which is equivalent to the welfare that would have been obtained if all father son pairs had recived the same earnings. I_s can, therefore, be interpreted as the reduction in welfare from going from a society with complete equality to a static society with the same mean earnings.

[34] This step is implemented by matching sons with fathers of the same race and rank and using the resulting values for the matched sons as $\tilde{c}_2$.

[35] We use the kernal smoothed mean earnings of sons, conditional on father's earnings, to obtain conditional means.

Our overall index, $W/\bar{c}$, which is the product of the values in rows 1 to 3, is equal to .661[36]. Thus reversal and the later resolution of uncertainty raises welfare from 14.1 to 66.1 percent of what it would be if multigenerational earnings were equally distributed.

The parameter values in column 1 ($\varepsilon = 6$ and $\gamma = \rho = 0$) were chosen for ease of interpretation. They, however, do not allow for aversion to fluctuations or aversion to second period risk. Columns 2 to 4 allow for aversion to intertemporal fluctuations by letting ρ be non-zero. Columns 3 and 4 also incorporate aversion to second period uncertainty by letting γ be non-zero.

It should come as no surprise that allowing for aversion to intertemporal fluctuations and second period uncertainty reduce the gains from mobility. Since ρ is zero in column 1 there is no trade-off between the welfare gains from lower inequality and the welfare losses from greater intergenerational fluctuations. This is particularly striking in going from column 1 to column 2. Allowing for aversion to intergenerational variability lowers the value of reversal from 2.93 to 1.03 when ρ is raised from 0 to 4. The relatively small impact of reversal (compared to the value of later resolution) holds under a wide variety of parameter values, as shown in columns 2 to 4.

We draw two conclusions from Table 1. First, when we allow for aversion to intertemporal fluctuations (ρ not equal to zero) and for aversion to second period uncertainty (γ not equal to zero) the impact of later resolution is substantially larger than the impact of reversal. Therefore, the role of origin independence is not only of theoretical interest but is also quantitatively important. Second, our measures are robust to the choice of parameter values as long as we allow for aversion to intertemporal fluctuations.[37].

[36]This is identical to the one minus the Atkinson index of inequality for the observed distribution of multigenerational earnings.

[37]Obviously we would show very different patterns if we chose parameter values in which there was an aversion to reversal ($\varepsilon < \rho$) or preference for early resolution of uncertainty (the conditions in propositon 2 were not met) but if either of these were the case there would be no tradeoff. In our simple example the optimal choice of δ would be either 1 or -1 depending on whether $\varepsilon > \rho$ or $\varepsilon < \rho$.

6.2. Measures for Blacks and Non-blacks

The preceding has focused on all races. We now turn to differences in mobility indices for blacks and non-blacks.[38] This allows us to illustrate the use of our measures to compare two distributions. Table 2 shows our measures under the same parameter values shown in columns 2 to 4 in Table 1. The first four rows again show I_s, I_r and I_l and their product, $W/\bar{c}$.

We start by focusing on the first panel of Table 2 (which sets $\varepsilon = 6$, $\rho = 4$, and $\gamma = 0$), though our conclusions based on this panel carry over to a large range of parameter values. Row 1 indicates that the value of I_s are very similar for blacks and non-blacks – (.115 versus .123). This indicates that welfare in a static society (before the benefits of reversal and later resolution) is 11 to 12 percent of what it would be if there were no within race inequality. Note that this does not reflect lower mean earnings of blacks since I_s is normalized by the group specific mean, $\bar{c}$. Rather the similar values of I_s for blacks and non-blacks reflects similar inequality of multigenerational earnings.

The following two rows of Table 2 show the impact of reversal and later resolution for blacks and non-blacks. Again the value of later resolution is considerably larger than the value of reversal. There are, however, differences across races. Blacks gain more than non-blacks from reversal (a 6 percent gain for blacks versus a 2 percent gain for non-blacks). These differences are, however, small compared to differences in the value of later resolution. Both blacks and non-blacks gain substantially more from later resolution than reversal, but non-blacks gain more. Blacks gain 44 percent (I_l is 1.44 in column 1) while non-blacks gain 114 percent.

When we compare $W/\bar{c}$ across the two groups, we find that non-blacks gain considerably more from mobility. Going from a static society to a society with both reversal and later resolution of uncertainty more than doubles the index for non-blacks (from .123 to .268 in column 2) but increases the index for blacks only by roughly fifty percent (from .115 to .176). As we have seen, this is largely a result of non-blacks gaining more from the value of later resolution of uncertainly.

[38]By measuring the expected welfare gains for blacks and non-blacks separately we are treating each dynasty as if they knew their race behind the veil of ignorance but not their earnings.

7. Conclusion

This paper provides an analysis of preferences for economic mobility, based on a social welfare function interpretable as an individualistic utility function "behind a veil of ignorance". In particular, we use a social welfare function à la Kreps-Porteus, which represents a direct extension of expected utility theory to a dynamic setting. With Kreps-Porteus preferences, the only axiom of expected utility that is abandoned is the axiom of compound lotteries. This generalization allows preferences for the timing of resolution of uncertainty.

With our class of social welfare functions, intertemporal patterns generally matter. That is, two societies with the same cross-sectional distributions are not bound to be viewed as equivalent in a welfare sense, as would be the case with a standard Von Neumann-Morgenstern separable utility function.

Our analysis provides a welfare foundation not only for the assessment of "reversal" (which has received most of the attention in the literature), but also for the evaluation of "origin independence". Although the tension between "reversal" and "origin independence" has been discussed in the literature on economic mobility, we provide the first utility-based analysis which explicitly attributes welfare value to both concepts within a unified framework. In particular, we identify the conditions under which late resolution of uncertainty is preferred, and discuss the potential trade-off between "reversal" and "origin independence".

In our framework the resolution of this trade off is determined by three fundamental parameters. These parameters measure (1) aversion to risk behind a veil of ignorance (a measure of aversion to inequality), (2) aversion to risk after the veil of ignorance has been removed and (3) aversion to intertemporal fluctuations (a measure of intertemporal substitutability).

We illustrate our analysis by applying our measures to patterns of intergenerational mobility in the United States. We show that the value of origin independence is quantitatively important. Furthermore, we show that subpopulations experience different mobility patterns of reversal and origin independence: our data indicates that both blacks and non-blacks gain more from origin independence than reversal, but the gains are substantially greater for non-blacks than blacks.

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8. Appendix

8.1. Derivation of Proposition 2

By definition, later resolution of uncertainty is preferred for all marginal distributions of consumption if and only if the following holds for all nondegenerate distributions of c_1 and c_2, (where c_1 and c_2 are strictly positive):

$$\left\{E_0\left[(1-\beta)c_1^{1-\rho}+\beta(E_1c_2^{1-\gamma})^{\frac{1-\rho}{1-\gamma}}\right]^{\frac{1-\varepsilon}{1-\gamma}}\right\}^{\frac{1}{1-\varepsilon}} > \left\{E_0\left[(1-\beta)c_1^{1-\rho}+\beta(c_2^{1-\gamma})^{\frac{1-\rho}{1-\gamma}}\right]^{\frac{1-\varepsilon}{1-\gamma}}\right\}^{\frac{1}{1-\varepsilon}} \tag{8.1}$$

Define

$$G(x)\equiv\left[(1-\beta)c_1^{1-\rho}+\beta x^{\frac{1-\rho}{1-\gamma}}\right]^{\frac{1-\varepsilon}{1-\gamma}} \tag{8.2}$$

where $x\equiv c_2^{1-\gamma}$.

Clearly, the above inequality (8.1) holds if and only if

i) for $\varepsilon<1$, we have that

$$G(E_1x)>E_1G(x) \tag{8.3}$$

for all distributions of c_1 and c_2, that is, if G(x) is concave in x (Jensen's inequality).

ii) for $\varepsilon>1$, we have that

$$G(E_1x)<E_1G(x) \tag{8.4}$$

for all distributions of c_1 and c_2, that is, if G(x) is convex in x (Jensen's inequality).

The conditions under which (8.3) and (8.4) hold can be derived by defining

$$m\equiv(1-\beta)c_1^{1-\rho} \tag{8.5}$$

$$n\equiv\beta x^{\frac{1-\rho}{1-\gamma}} \tag{8.6}$$

$$p\equiv\frac{\beta x^{\frac{1-\rho}{1-\gamma}-2}\left[(1-\beta)c_1^{1-\rho}+\beta x^{\frac{1-\rho}{1-\gamma}}\right]^{\frac{1-\varepsilon}{1-\gamma}-2}}{(1-\gamma)^2} \tag{8.7}$$

Note that m, n and p are all strictly positive for positive values of c_1 and c_2. As

$$G''(x) = (1-\varepsilon)p[(\gamma-\rho)m + (\gamma-\varepsilon)n] \tag{8.8}$$

we have that

i) for $\varepsilon < 1$, $G''(x) < 0$ for all positive values of m and n if and only if $\gamma \leq \rho$ and $\gamma \leq \varepsilon$ (with at least one inequality being strict).

ii) for $\varepsilon > 1$, $G''(x) > 0$ for all positive values of m and n if and only if $\gamma \leq \rho$ and $\gamma \leq \varepsilon$ (with at least one inequality being strict).

QED

8.2. Derivation of Proposition 3

The first derivative of (3.6) with respect to δ can be written as follows

$$W'(\delta) = Q(\delta)S(\delta)$$

where

$$Q(\delta) \equiv \frac{c_H^{1-\gamma} - c_L^{1-\gamma}}{4(1-\gamma)} W^{\varepsilon}$$

and

$$\begin{aligned} S(\delta) \quad \equiv \quad & \{\frac{1}{2}c_L^{1-\rho} + \frac{1}{2}[(1-\delta)c_L^{1-\gamma} + \delta c_H^{1-\gamma}]^{\frac{1-\rho}{1-\gamma}}\}^{\frac{\rho-\varepsilon}{1-\rho}}[(1-\delta)c_L^{1-\gamma} + \delta c_H^{1-\gamma}]^{\frac{\gamma-\rho}{1-\gamma}} + \\ & -\{\frac{1}{2}c_H^{1-\rho} + \frac{1}{2}[(1-\delta)c_H^{1-\gamma} + \delta c_L^{1-\gamma}]^{\frac{1-\rho}{1-\gamma}}\}^{\frac{\rho-\varepsilon}{1-\rho}}[(1-\delta)c_H^{1-\gamma} + \delta c_L^{1-\gamma}]^{\frac{\gamma-\rho}{1-\gamma}} \end{aligned}$$

As $c_H > c_L > 0$, we have that $Q(\delta) > 0$ for every $\delta \in [0,1]$.

Moreover, as one can verify by taking the derivative of $S(\delta)$ with respect to δ, the additional restriction $\gamma < \min\{\varepsilon, \rho\}$ is sufficient to ensure that $S'(\delta) < 0$ for every $\delta \in [0,1]$.

Therefore, we have that

1) If there exists a $\delta^* \in [0,1]$ such that $S(\delta^*) = 0$, $S(\delta)$ is positive (negative) for all δ smaller (larger) than δ^*. As $Q(\delta)$ is always positive, $W'(\delta)$ has the same sign as $S(\delta)$. Henceforth, $W'(\delta)$ is larger/equal/smaller than 0 for δ smaller/equal/larger than δ^*, which implies that W is maximized at $\delta = \delta^*$.

2) If $S(\delta) > 0$ for every $0 \leq \delta \leq 1$, $W'(\delta)$ is always positive, and W is maximized at $\delta = 1$

3) If $S(\delta) < 0$ for every $0 \leq \delta \leq 1, W'(\delta)$ is always negative, and W is maximized at $\delta = 0$

In particular, by substituting in equation (*), we can immediately obtain that:

A) when $\varepsilon = \rho$, $S(1/2) = 0$, and therefore W is maximized at $\delta^* = 1/2$

B) when $\varepsilon > \rho$, $S(1/2) > 0$, which implies either $S(\delta^*) = 0$ at a $\delta^* > 1/2$, or $S(\delta) > 0$ for every $0 \leq \delta \leq 1$. In either case, W is maximized at a δ larger than 1/2.

C) when $\varepsilon < \rho$, $S(1/2) < 0$, which implies either $S(\delta^*) = 0$ at a $\delta^* < 1/2$, or $S(\delta) < 0$ for every $0 \leq \delta \leq 1$. In either case, W is maximized at a δ smaller than 1/2.

QED

Table 1
Welfare Indices -- All Persons

	(1) $\varepsilon=6$ $\rho=0$ $\gamma=0$	(2) $\varepsilon=6$ $\rho=4$ $\gamma=0$	(3) $\varepsilon=6$ $\rho=4$ $\gamma=2$	(4) $\varepsilon=6$ $\rho=6$ $\gamma=2$
I_s	.141	.116	.115	.109
I_r	2.93	1.03	1.03	1.00
I_l	1.60	1.69	1.69	1.69
$\frac{W}{\bar{c}}$	.661	.202	.202	.184

Table 2 - Welfare Indices-- Black and Non-Black

	$\varepsilon=6,\ \rho=4,\ \gamma=0$		$\varepsilon=6,\ \rho=4,\ \gamma=2$		$\varepsilon=6,\ \rho=6,\ \gamma=2$	
	Blacks (1)	Non-black (2)	Blacks (4)	Non-black (5)	Blacks (7)	Non-black (8)
I_s	.115	.123	.115	.123	.112	.114
I_r	1.06	1.02	1.06	1.02	1.00	1.00
I_l	1.44	2.14	1.44	2.14	1.44	2.14
$\frac{W}{\bar{c}}$	.176	.268	.176	.267	.160	.244