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Taxation behind the veil of ignorance

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TAXATION BEHIND THE VEIL OF IGNORANCE

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ABSTRACT. We explore the design of impartial tax schemes in a simple setup where agents' incomes are completely determined by their inborn talents. Building on Harsanyi's veil-of-ignorance approach, we conceptualize an impartial observer who chooses a tax scheme without knowing her own preferences and the distribution of talents, and whose vNM preferences behind the veil obey Harsanyi's principle of acceptance and are independent, in terms of utility-scale, of the distribution of talents. Our results in the resulting framework provide three main messages: (i) the veil of ignorance implies anonymity of tax schemes; (ii) the veil of ignorance generically rejects utilitarian tax schemes; (iii) the veil of ignorance endorses the (Rawlsian) leveling tax scheme.

JEL: *D63, D71, H24.*
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1. INTRODUCTION

Income tax schemes, when properly designed, are essential tools for the enhancement of distributive justice. Our aim in this paper is to design an "impartial" income tax scheme for a group of agents when their incomes are completely determined by their inborn talents, which are "morally arbitrary" (e.g., Rawls, 1971). We take Harsanyi's veil-of-ignorance approach (e.g., Harsanyi, 1953; 1955; 1977) to conceptualize an impartial viewpoint. An impartial observer, briefly IO, contemplates becoming, with equal probability, one of the agents in the group, for whom the tax burden is going to be allocated, and obtaining one of the possible taxable incomes (or talents) under an income distribution with equal probability too. The decision by such an IO is considered as being impartial because it would not represent the interests of a particular person only, or a particular income group only.

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The veil of ignorance necessitates the IO to reflect the interests of all agents (and all income groups) equally well.

The "basic structure of society" (the subject of justice) here is how society should "determine the division of advantages from social cooperation" (Rawls, 1999, p.6) in the form of tax allocations. The principles of justice govern the way taxes are allocated across different income groups.[1] We investigate the principles, or tax schemes, over which agents agree when they make their decisions rationally through a "fair procedure" (a unanimous decision behind the veil of ignorance). In order to "nullify the effects of specific contingencies which put men at odds and temp them to exploit social and natural circumstances to their own advantage" (Rawls, 1999, p.118), the veil of ignorance hides each person's "fortune in the distribution of natural assets and abilities... his aversion to risk" (Rawls, 1999, p.118). In our model, this takes the form of uncertainties with regard to both incomes (indicating talents) and risk preferences. The major difference with respect to the original approach by Harsanyi is the added fortune in the distribution of talents, and our focus on the basic structure of society that is not sensitive to risk preferences (tax schemes do not take into account risk preferences; they take into account income distributions).

Our main findings can be summarized in two parts. On the one hand, and contrary to the utilitarian connotation of Harsanyi's approach, we show that the IO's rational decision in our context rejects utilitarian tax schemes that maximize a weighted sum of individual utilities. This is due to a fundamental conflict with impartiality that utilitarian schemes exhibit. More precisely, we show that, under a mild condition, all utilitarian tax schemes violate a specific form of anonymity, which turns out to be a necessary condition for the IO's rational decision. The IO's rational decision, as we define it, is interim optimal (no incentive for revision after knowing her private identity) and is optimal among all interim optimal decisions.

On the other hand, we find that the rational scheme for the IO coincides with the most egalitarian tax scheme, the leveling tax, which is a natural formulation of the *Rawlsian* difference principle in our simple taxation model. This might be interpreted as rationale for the veil of ignorance as a tool for recommending what justice requires, with respect to the distribution of income. This has been recently challenged due to a systematic conflict between the veil of ignorance and a weak version of egalitarianism, in the context of resource allocation based on "human functioning disabilities" (e.g., Roemer, 2002; Moreno-Ternero and Roemer, 2008). We show in this

[1]"These principles primarily apply, as I have said, to the basic structure of society and govern the assignment of rights and duties and regulate the distribution of social and economic advantages." (Rawls, 1999, p.53).

paper that one can escape from that disturbing conflict, at least in our model, provided one is willing to thicken the veil in a natural way and to obey the fundamental constraints imposed in the basic structure of society.

These findings convey another important message from our work, which had not been highlighted in the sizable existing literature on the veil of ignorance; namely, that the veil of ignorance, when properly thickened, generically implies anonymity of allocation rules (tax schemes, in our context).

The rest of the paper is organized as follows. In Section 2, we present the model. The results are gathered in Section 3. Section 4 concludes with some remarks and further insights.

2. Model

Consider a group N of n agents; for ease of notation, let $N \equiv \{1,\dots,n\}$. Each agent $i \in N$ is born with a certain level of talent, which is the sole determinant of his pre-tax income.[2] Thus, agents have no moral responsibility for their incomes. Throughout the paper, we use talent and pre-tax income interchangeably. For each agent $i \in N$, let y_i denote i's talent or pre-tax income. A fixed amount of revenue $R > 0$ needs to be collected through a tax scheme. The tax revenue is used to supply a pure public good that provides uniform benefits to all agents, and so the only distributional concern here is with regard to post-tax incomes or tax allocations. Assume that the total income is not short of collecting the revenue R, i.e., $\sum_{i\in N} y_i \geq R$. Seminal normative investigation on such tax problems can be found, for instance, in Young (1987, 1988).[3] The profile of incomes $y = (y_1,\dots,y_n)$ and the revenue R constitute a tax problem. Let $\mathscr{D}$ be the collection of all tax problems we are interested in solving and call it the domain of tax problems. *Throughout the paper, we assume that for all tax problems $(y,R) \in \mathscr{D}$, there is at least an agent with zero income.*

A *tax allocation* for a problem $(y,R) \in \mathscr{D}$ is a profile of tax payments $t = (t_1,\dots,t_n)$ such that $\sum_{i=1}^{n} t_i = R$ (balancedness) and $0 \leq t_i \leq y_i$ for each $i \in N$ (boundedness).[4] We say that $t = (t_1,\dots,t_n)$ is an *interior* tax profile if $0 < t_i < y_i$ for each $i \in N$. A *tax scheme* is a function f associating with each problem in $\mathscr{D}$ a *tax allocation* $t = f(y,R)$. Well-known tax schemes are the *head tax*; which distributes the tax burden equally subject to no

[2] In other words, we assume that labor is perfectly inelastically supplied.

[3] O'Neill (1982) used earlier the same mathematical framework to analyze the problem of adjudicating conflicting claims. Readers are referred to Moulin (2002) or Thomson (2003, 2015, 2019) for extensive treatments of diverse problems (such as taxation, conflicting claims, bankruptcy, cost sharing, and surplus sharing) fitting this framework.

[4] Thus, we rule out subsidies as means of redistribution.

agent paying more than his income; the *leveling tax*, which equalizes post-tax income across agents subject to no agent being subsidized; and the *flat tax*, which equalizes tax rates across agents. Formally, under the head tax, $t_i = \min\{-1/\lambda, y_i\}$ for some $\lambda \in \mathbb{R}_-$ with $\sum_{i\in N} \min\{-1/\lambda, y_i\} = R$; under the leveling tax, $t_i = \max\{y_i - 1/\lambda, 0\}$ for some $\lambda \in \mathbb{R}_+$ with $\sum_{i\in N} \max\{y_i - 1/\lambda, 0\} = R$; under the flat tax, $t_i = \lambda y_i$ for some $\lambda \in [0,1]$ with $\sum_{i\in N} \lambda y_i = R$. The flat tax always yields interior tax profiles whenever $\sum_{i\in N} y_i > R$. This is, however, not the case with the other two schemes. Note that, under the leveling tax, exempted agents end up with lower post-tax incomes than the other agents: for each i, j, k with $t_i, t_j > 0$ and $t_k = 0$, $y_k \leq y_i - t_i = y_j - t_j$. In our simple model, income can be considered as an index of primary goods. Then, the leveling tax allows us to achieve the maximum possible index (post-tax income) of worst-off agents.[5] Hence, the leveling tax here formalizes the Rawlsian difference principle.

Assume that each agent possesses von Neumann-Morgenstern (vNM) preferences over income lotteries (probability distributions over income levels). Denote agent i's vNM utility function on income by $u_i \colon \mathbb{R}_+ \to \mathbb{R}$. Throughout the paper, we assume that all agents are *strictly risk averse*, i.e., $u_i(\cdot)$ is strictly concave for each $i \in N$. A (weighted) *utilitarian tax scheme* selects tax profiles maximizing the weighted average of (post-tax income) utilities, i.e., $(t_i)_{i\in N}$ maximizes

$$\sum_{i=1}^{n} \alpha_i u_i(y_i - t_i),$$

where $(\alpha_i)_{i\in N} \in \mathbb{R}^N_{++}$ is the vector of weights on individual utilities.

Anonymity. In the literature on fair allocation, impartiality is formalized as various axioms of (social choice) rules. The most basic one is *anonymity*, the requirement that the tax payment of each agent should not depend on who the tax payer is but solely on her income level and the income distribution. This will require that switching the incomes of agents i and j should only switch their tax payments without changing the tax payments of anyone else. Formally, let Π denote the set of bijections from the set of agents N into itself. For each $\pi \in \Pi$, let y_π denote the resulting income profile after permuting N via π; that is, for all $i \in N$, $y_\pi \equiv (y_{\pi(i)})_{i\in N}$. A tax scheme $f(\cdot)$ is *anonymous* if $f_{\pi(i)}(y,R) = f_i(y_\pi, R)$, for each $(y,R) \in \mathscr{D}$, $\pi \in \Pi$ and $i \in N$. Thus, if f is anonymous, we write, for ease of notation, $t_\pi \equiv f(y_\pi, R)$, when $t = f(y,R)$. If R remains fixed, and no confusion is possible, we skip it while referring to a scheme.

[5] This holds under the constraint of claims-boundedness. It is straightforward to show that, in our model, the leveling tax profile is the best one under the lexicographic extension of the Rawlsian maximin principle.

Anonymity requires first that when there occurs a reshuffling of agents' income positions, all those agents whose positions remain fixed should not experience any change in their tax burdens. It also requires that reshuffled agents' tax burdens should also be reshuffled in the same order; tax burdens should be "covariant" with the reshuffling. Formally,

Invariance-Anonymity: For each $\pi \in \Pi$ and $i \in N$ with $\pi(i) = i$, $f_i(y_\pi, R) = f_i(y, R)$.

Covariance-Anonymity: For each $\pi \in \Pi$ and $i, j \in N$ with $i \neq j$ and $\pi(i) = j$, $f_i(y_\pi, R) = f_j(y, R)$.

It is evident that *anonymity* is equivalent to the combination of these two partial anonymity axioms.[6]

Utilitarian tax schemes violate anonymity when agents have different utility functions. They violate both *invariance-anonymity* and *covariance-anonymity*. As we shall see later, violation of *invariance-anonymity* is actually quite widespread among utilitarian schemes.

In the contractarian tradition, impartiality of moral norms (tax schemes, here) comes out from the impartial nature of the original position of the social contract. The most rigorous and effective development in the 20th century of this issue is characterized by the "veil of ignorance" (Harsanyi, 1953, 1955, 1977; Rawls, 1963, 1971).[7]

The Veil of Ignorance. The veil of ignorance conceptualizes an impartial viewpoint where tax profiles can be decided without any influence of morally arbitrary characteristics such as risk preferences or talent. A decision maker behind the veil of ignorance is referred to as the *impartial observer*, or briefly *IO*. The IO aims to select "optimal" tax schemes (i.e., schemes benefiting her most) within the domain $\mathscr{D}$. As a necessary condition to deliver impartiality, the domain should be closed with respect to any name permutation, that is, if $y \in \mathscr{D}$, then for each $\pi \in \Pi$, $y_\pi \in \mathscr{D}$.

The IO faces uncertainties with regard to whom she might be (her utility function and her position in the income profile) and what income profile might prevail. A *state* is thus composed by the realization of these two variables. Namely, the state $(i, y) \in N \times \mathscr{D}$, means that the IO is endowed with the utility function $u_i(\cdot)$ and takes the i-th component y_i in the income profile y. The space of states is therefore given by $N \times \mathscr{D}$. A state is realized under a given probability distribution $P \colon N \times \mathscr{D} \to [0, 1]$. If the two

[6]The equivalence also holds if covariance-anonymity is replaced with *weak covariance-anonymity*, i.e., for each $\pi \in \Pi$ and each pair $i, j \in N$ with $i \neq j$ and $\pi(i) = j$, whenever $\pi(h) = h$, for all $h \in N$, $f_h(y_\pi, R) = f_h(y, R)$, then $f_i(y_\pi, R) = f_j(y, R)$.

[7]A somewhat related, albeit different, alternative is the so-called notion of probabilistic egalitarianism (e.g., Lerner, 1944, Sen, 1971) that we shall not treat here.

variables of the state are realized independently, we say that the distribution satisfies independence. Formally,

Independent Probability: There exist probability distributions $P_N : N \to [0,1]$ and $P_{\mathscr{D}} : \mathscr{D} \to [0,1]$ such that, for each state $(i,y) \in N \times \mathscr{D}$,

$$P(i,y) = P_N(i) \times P_{\mathscr{D}}(y).$$

The next assumption, which will be used in one of our main results, says that for a given distribution of income $y \in \mathscr{D}$, the chance of agent i's taking agent j's position in the distribution equals to the chance of her taking agent k's position. Thus, the positions of any pair of agents would occur with equal probability. Formally:

Equi-Probability over Talent: For each $y \in \mathscr{D}$ and each triple $i, j, k \in N$,

$$\sum_{\pi \in \Pi:\ \pi(i)=j} P(i, y_\pi) = \sum_{\pi \in \Pi:\ \pi(i)=k} P(i, y_\pi).$$

When a type is defined by a combination of a utility function and income, the distribution of types is not fixed because agent i (with utility function $u_i(\cdot)$) may take any position in the income distribution. In other words, as becoming person i is independent from taking a certain position in the income distribution (due to the condition of independent probability), there is no correlation between utility functions and the positions in an income distribution, which plays a critical role for deriving our main results.[8]

A crucial dimension for human development is the freedom from the adverse or inadverse shock of natural lotteries. Incomes in our model represent in-born talents and utility functions represent risk attitudes of individual decision makers. Independence of the two characteristics presumes an ideal social domain where individuals have the full freedom of developing their risk attitudes independently of their in-born advantage or disadvantage. For example, society allows any individual with walking disability to access most social opportunities by getting rid of the hurdles she may experience (due to the walking disability). Her disability, then, will not prevent her to develop, by the direction of her free will, any risk preferences available for other non-disabled individuals. We believe that such an ideal social domain, as well as the other impartial nature of the veil of ignorance (equi-probability over talent) serves as a proper basis of distributive justice.

When there is a perfect correlation between utility functions and incomes and the distribution of types is fixed, agents face uncertainty about which position in this distribution they will take. Our main results do not hold

[8]The correlation between talent (cognitive ability) and risk aversion has been long studied. Recent evidence indicates that it is domain specific and not as strong as suggested by some previous studies (e.g., Lilleholt, 2019).

under this perfect correlation case, as we explain in Remark 1. Is it desirable to assume this perfect correlation to be a characteristic for the veil of ignorance, or the original position, a la John Rawls? We think not necessarily. In order to conceptualize an impartial ground, where the agreement on the principles of justice (here a fair taxation scheme) is to be made, it seems natural to admit the full freedom to develop tastes, or risk attitudes, independently from in-born talents.

The Impartial Observer. In what follows, for the sake of simplicity, we fix a distribution of incomes (talents) at profile $y \in \mathbb{R}^n_+$ and a revenue R and restrict the domain of tax problems so that it only comprises those problems that have the same income distribution and revenue as the problem (y,R). That is, we assume $\mathscr{D} \equiv \{(y_\pi, R) : \pi \in \Pi\}$. Then, our state space can be simply written as $\mathscr{S} \equiv N \times \Pi$, and each state $(i,\pi) \in N \times \Pi$ will be representing the state in which the IO is in the position of agent i and faces the problem (y_π, R). That is, at state (i,π), she has i's income $y_{\pi(i)}$ at problem y_π and i's utility function $u_i(\cdot)$.[9] Under this simplification, the assumption of independent probability reduces to $P(i, y_\pi) = P_N(i) \times P_\Pi(y_\pi)$, for each $(i,\pi) \in \mathscr{S}$. Then, equi-probability over talent means that $\sum_{\pi\in\Pi:\ \pi(i)=j} P_\Pi(y_\pi) = \sum_{\pi\in\Pi:\ \pi(i)=k} P_\Pi(y_\pi)$, for all $j,k \in N$. It follows from there, and

$$\sum_{j\in N} \sum_{\pi\in\Pi:\pi(i)=j} P_\Pi(y_\pi) = \sum_{\pi\in\Pi} P_\Pi(y_\pi) = 1,$$

that, for each $j \in N$,

$$\sum_{\pi\in\Pi:\ \pi(i)=j} P_\Pi(y_\pi) = 1/n.$$

An *extended prospect* for the IO $((i,\pi),W) \in \mathscr{S} \times \mathbb{R}_+$ specifies the realized state $(i,\pi) \in \mathscr{S}$ and the level of post-tax income $W \in \mathbb{R}_+$. A *lottery* is a probability distribution over the set of all extended prospects, $\mathscr{S} \times \mathbb{R}_+$. Let $\mathscr{L}$ be the set of lotteries. A *simple lottery* is a profile of probability-income pairs at all states; that is, $L \equiv (p_{i,\pi}, W_{i,\pi})_{(i,\pi)\in\mathscr{S}}$, (a sure income at each state). With a slight abuse, we call a probability distribution over income an *income lottery*.[10] Then, a *lottery* can be described by the composition of state-probabilities $(p_{i,\pi})_{(i,\pi)\in\mathscr{S}}$ and a profile of income lotteries at all states.

The IO's preferences over lotteries follow the vNM axioms. Thus, there is a utility index function $U : \mathscr{S} \times \mathbb{R}_+ \to \mathbb{R}$ for which the IO's preferences over lotteries are represented by the expected value of $U(\cdot)$. The decision

[9]Note that any domain that is closed with respect to name permutations can be expressed as the union of our simple domains. Our simplification, which is only intended for ease of exposition, will not imply any loss of generality. All results apply to the general framework.

[10]Income lotteries are the lotteries for the IO after a state (i,π) is realized.

problem of the IO behind the veil of ignorance is then to find the tax scheme that maximizes the expected value of the utility index function U. In order to determine, at least partially, what the function U is, we follow Harsanyi's first step and assume what he calls:

Principle of Acceptance: For each $i \in N$ and $\pi \in \Pi$, $U(i,\pi,\cdot)$ represents the same vNM preferences over income lotteries as $u_i(\cdot)$ represents.

In other words, once the IO takes the position of person i, the IO's preferences over income lotteries coincide with i's preferences. This axiom also implies that the IO's vNM preferences over income lotteries do not depend on the distribution of talents.

The veil of ignorance provides an ideal social domain where talents (incomes) do not provide any constraint in the distribution of utility functions. One may be born with disabilities but enjoy equal freedom of developing any utility function (or risk preferences) available for non-disabled individuals. In this ideal social domain, the IO has no reason to exhibit different risk attitudes across different talents. More precisely, we require that the IO's talent, as well as the distribution of talents, do not affect her utility scale either.

Talent Irrelevance: For each $i \in N$ and each pair $\pi,\pi' \in \Pi$, $U(i,\pi,\cdot) = U(i,\pi',\cdot)+c$ for some constant $c \in \mathbb{R}$.

By the principle of acceptance, and the vNM theorem, it follows that, for each $(i,\pi) \in \mathscr{S}$, there exist $a_{i\pi} > 0$ and $b_{i\pi}$ such that, for each $W \in \mathbb{R}_+$,

$$U(i,\pi,W) = a_{i\pi} \cdot u_i(W) + b_{i\pi}.$$

Then, by talent irrelevance, for each i, there exists $a_i > 0$ such that $a_i \equiv a_{i\pi}$ for each $\pi \in \Pi$. Hence, for each $(i,\pi) \in \mathscr{S}$ and each $W \in \mathbb{R}_+$,

$$U(i,\pi,W) = a_i \cdot u_i(W) + b_{i\pi}.$$

If a tax scheme $f\colon \mathscr{D} \to \mathbb{R}^N$ is chosen, then the IO faces a simple lottery $L_f \equiv (P(i,\pi), y_{\pi(i)} - f_i(y_\pi,R))_{(i,\pi)\in\mathscr{S}}$. Thus, f yields the following expected utility for the IO:

$$\begin{aligned} U(L_f) &= \sum_{(i,\pi)\in N\times\Pi} P(i,\pi)U(i,\pi,y_{\pi(i)} - f_i(y_\pi,R)) \\ &= \sum_{(i,\pi)\in N\times\Pi} P(i,\pi)[a_i u_i(y_{\pi(i)} - f_i(y_\pi,R)) + b_{i\pi}]. \end{aligned}$$

In summary, we have the following statement regarding the choice of the impartial observer in our setting.

Lemma 1. *Under the principle of acceptance and talent irrelevance, the IO's preferences over tax schemes f are represented by the following expected utility function*

$$\sum_{(i,\pi)\in N\times\Pi} P(i,\pi)[a_i u_i(y_{\pi(i)} - f_i(y_\pi, R)) + b_{i\pi}],$$

for some $a_1,\ldots,a_n \geq 0$ and $b_{1\pi},\ldots,b_{n\pi} \in \mathbb{R}$.

Rational Tax Scheme. We will restrict our attention to tax schemes that are optimal for the IO behind the veil with "interim information" of her identity and talent. A tax scheme f is *interim optimal* if for any realization of the IO's identity and talent, the IO, after being informed of her own identity and talent, has no incentive to revise the tax scheme. Among these interim optimal tax schemes, the IO chooses the one that is optimal behind the veil of ignorance. We say that a tax scheme is *rational* if it is interim optimal and is preferred by the IO behind the veil to any other interim optimal tax schemes.

3. Results

3.1. **The veil of ignorance implies anonymity of tax schemes.** We start this section with a result that provides a necessary condition for optimal tax schemes.

Proposition 1. *All interim optimal tax schemes satisfy invariance-anonymity.*

Proof. Let $f\colon \mathscr{D} \to \mathbb{R}^N$ be an (interim) optimal scheme for the IO. Let $i^* \in N$ and $\bar{\pi} \in \Pi$ be such that $\bar{\pi}(i^*) = i^*$. Suppose, by contradiction, that $f_{i^*}(y_{\bar{\pi}}, R) \neq f_{i^*}(y, R)$. For each $h \in N$, let $\bar{t}_h \equiv \sum_{\pi\in\Pi:\pi(i^*)=i^*} \frac{1}{(n-1)!} f_{\pi^{-1}(h)}(y_\pi, R)$ be the mean of all tax payments by the person with h's talent at all problems y_π with $\pi(i^*) = i^*$. In particular, $\bar{t}_{i^*} \equiv \sum_{\pi\in\Pi:\pi(i^*)=i^*} \frac{1}{(n-1)!} f_{i^*}(y_\pi, R)$. Note that for each $\pi \in \Pi$ with $\pi(i^*) = i^*$, $(\bar{t}_{\pi(h)})_{h\in N}$ is a feasible tax profile at tax problem y_π. By Lemma 1, the IO's expected utility from tax scheme f can be written as

$$U(L_f) = \sum_{i\in N} a_i \sum_{j\in N} \sum_{\pi\in\Pi:\pi(i)=j} P(i,\pi) u_i(y_j - f_i(y_\pi, R)).$$

Then, by strict risk aversion of agent i^*, i.e., strict concavity of $u_{i^*}(\cdot)$,

$$u_{i^*}(y_{i^*} - \bar{t}_{i^*}) > \sum_{\pi\in\Pi:\pi(i^*)=i^*} \frac{P(i^*,\pi) u_{i^*}(y_{i^*} - f_{i^*}(y_\pi, R))}{\sum_{\pi\in\Pi:\pi(i^*)=i^*} P(i^*,\pi)}.$$

Thus, by replacing $f(y_\pi, R)$ with $\bar{t}_\pi$ for each $\pi \in \Pi$ with $\pi(i^*) = i^*$, and keeping the rest of the values of $f(\cdot)$, we can define another tax scheme that yields the IO with the position of i^* and income level y_{i^*}, a higher expected utility than $f(\cdot)$ does, contradicting interim optimality.

□

Invariance-anonymity says that if the IO becomes agent i and has agent j's talent, her tax payment is fixed independently of what talents the other agents have. That is, the IO's tax payment T_{ij} when she becomes agent i and has agent j's talent is well-defined. Therefore, the tax scheme has the matrix representation for the IO.

Lemma 2. *A tax scheme f satisfies invariance-anonymity if and only if for each $(y,R) \in \mathscr{D}$, there is a tax matrix $T \equiv (T_{ij})_{(i,j)\in N\times N}$ such that, for each $i, j \in N$,* (i) $0 \leq T_{ij} \leq y_j$; (ii) $\sum_{j\in N} T_{ij} = R$, *and for each $\pi \in \Pi$,* (iii) $f_i(y_\pi, R) = T_{i\pi(i)}$.

In words, the third statement of the previous lemma says that the (i, j)'s entry of the tax matrix yields the IO's tax payment when she becomes i and is endowed with j's talent. It follows from there that if the tax scheme also satisfies (weak) covariance-anonymity, and hence it is fully anonymous, all row vectors of T are identical.

A straightforward consequence of Proposition 1 is that, if an interim optimal tax scheme satisfies *covariance-anonymity* then it is fully *anonymous*. Moreover, we show that when there is an agent with zero income (as we assumed earlier that it happens), *invariance-anonymity* implies *covariance-anonymity*.

Proposition 2. *Invariance-anonymity implies covariance-anonymity.*

Proof. Let $(y,R) \in \mathscr{D}$ and $x \equiv f(y,R)$. Let $h \in N$ be such that $y_h = 0$ (we assumed that there is at least one agent with zero income). Let $i, j \in N$, $i \neq j$, and $R' \equiv x_i + x_j$. Let $\pi^{ij} \in \Pi$ be the transposition of i and j.

By *invariance-anonymity*, $f_k(y_{\pi^{ih}}, R) = x_k$, for each $k \in N\backslash\{i,h\}$. By claims-boundedness, $f_i(y_{\pi^{ih}}, R) = 0 = f_h(y,R)$. Hence, by efficiency, $f_h(y_{\pi^{ih}}, R) = x_i$. If $j = h$, the proof is complete.

Suppose otherwise, i.e., $j \neq h$. Let $y' \equiv y_{\pi^{ih}}$. Again, by invariance-anonymity, $f_k(y'_{\pi^{ij}}, R) = f_k(y', R)$, for each $k \in N\backslash\{i, j\}$, which implies that $f_h(y'_{\pi^{ij}}, R) = x_i$ and, for each $k \in N\backslash\{i, j, h\}$, $f_k(y'_{\pi^{ij}}, R) = x_k$. By boundedness, $f_j(y'_{\pi^{ij}}, R) = 0$. Hence, by balancedness, $f_i(y'_{\pi^{ij}}, R) = x_j$.

Finally, let $y^* \equiv y'_{\pi^{ij}}$. Clearly, $y^*_{\pi^{jh}} = y_{\pi^{ij}}$. Again, by invariance-anonymity, $f_k(y^*_{\pi^{jh}}, R) = f_k(y^*, R)$, for each $k \in N\backslash\{j,h\}$, which implies that $f_i(y^*_{\pi^{jh}}, R) = x_j$ and, for each $k \in N\backslash\{i, j, h\}$, $f_k(y^*_{\pi^{jh}}, R) = x_k$. By boundedness, $f_h(y^*_{\pi^{jh}}, R) = 0$. Hence, by balancedness, $f_j(y^*_{\pi^{jh}}, R) = x_i$.

Therefore, $f(y_{\pi^{ij}}, R) = x_{\pi^{ij}}$.

The result then follows from the fact that all permutations $\pi \in \Pi$ can be represented by a composition of a finite sequence of transpositions. □

The following result, which is a straightforward consequence of Propositions 1 and 2, conveys our first message in this paper, as stated in the title of this subsection; namely, that the veil of ignorance implies anonymity of tax schemes.

Theorem 1. *If a tax scheme is rational, then it is anonymous.*

3.2. **The veil of ignorance rejects utilitarian tax schemes.** Proposition 1 shows that a rational decision behind the veil of ignorance implies *invariance-anonymity*. As mentioned earlier, utilitarian tax schemes violate *anonymity* quite often. In fact, violation of *invariance-anonymity* occurs under the following mild condition for tax schemes, which says that an agent's income is lower than another agent's post-tax income for some interior tax profile. Formally,

Minimal Difference: There exist $\pi \in \Pi$ and $y \in \mathscr{D}$ such that, for each $i \in N$, $0 < f_i(y_\pi, R) < y_{\pi(i)}$ and, for some $j,k \in N$, $y_{\pi(j)} < y_{\pi(k)} - f_k(y_\pi, R)$.

Proposition 3. *Assume $n \geq 3$. If minimal difference holds, utilitarian tax schemes violate invariance-anonymity.*

Proof. Let f be a utilitarian tax scheme and assume that *minimal difference* holds. Let $\pi \in \Pi$ and $y \in \mathscr{D}$ be such that, for each $i \in N$, $0 < f_i(y_\pi, R) < y_{\pi(i)}$ and, for some $j,k \in N$, $y_{\pi(j)} < y_{\pi(k)} - f_k(y_\pi, R)$. Let π' be such that $\pi'(k) = \pi(j)$, $\pi'(j) = \pi(k)$, and for each $h \neq k, j$, $\pi'(h) = \pi(h)$. By the interiority assumption, marginal utilities at π-post-tax incomes must be equal, i.e., $u'_1(y_{\pi(1)} - f_1(y_\pi)) = \cdots = u'_n(y_{\pi(n)} - f_n(y_\pi)) \equiv \lambda$.

Claim: For each $h \neq k$, $u'_h(y_{\pi'(h)} - f_h(y_{\pi'}, R)) < \lambda$.

Proof of the claim. We first show that $u'_j(y_{\pi'(j)} - f_j(y_{\pi'}, R)) < \lambda$. Suppose otherwise. Then, $y_{\pi'(j)} - f_j(y_{\pi'}, R) \leq y_{\pi(j)} - f_j(y_\pi, R)$. As both j and k have lower post-tax income, there must be another agent $h \neq j,k$ whose post-tax income is higher, i.e., $y_{\pi'(h)} - f_h(y_{\pi'}, R) > y_{\pi(h)} - f_h(y_\pi, R)$. Then, by the strict concavity of u_h, $u'_h(y_{\pi'(h)} - f_h(y_{\pi'})) < u'_h(y_{\pi(h)} - f_h(y_\pi)) = \lambda$. Therefore, $u'_h(y_{\pi'(h)} - f_h(y_{\pi'})) < u'_j(y_{\pi'(j)} - f_j(y_{\pi'}))$. Note that $y_{\pi'(h)} - f_h(y_{\pi'}) > 0$ and $y_{\pi'(j)} - f_j(y_{\pi'}, R) < y_{\pi'(j)}$ (because $y_{\pi'(j)} - f_j(y_{\pi'}, R) \leq y_{\pi(j)} - f_j(y_\pi, R)$ and $f_j(y_\pi, R) > 0$). Thus, it is possible to reduce h's post-tax income and increase j 's post-tax income simultaneously, which leads to a higher aggregate utility level (for j has a higher marginal utility than h), contradicting that $f(y_{\pi'}, R)$ maximizes the aggregate utility.

Now, suppose that, for some $h \neq j,k$, $u'_h(y_{\pi'(h)} - f_h(y_{\pi'}, R)) \geq \lambda$. Then $y_{\pi'(h)} - f_h(y_{\pi'}, R) \leq y_{\pi(h)} - f_h(y_\pi, R)$. Note that $y_{\pi'(j)} - f_j(y_{\pi'}, R) > y_{\pi(j)} -$

$f_j(y_\pi, R) > 0$ and that, by assumption, $y_{\pi(h)} - f_h(y_\pi, R) < y_{\pi(h)}$ and so $y_{\pi'(h)} - f_h(y_{\pi'}, R) < y_{\pi(h)}$. Thus, it is possible to increase h's post-tax income and reduce j 's post-tax income simultaneously, which leads to a higher aggregate utility level, (for h has a higher marginal utility than j) contradicting that $f(y_{\pi'}, R)$ maximizes the aggregate utility. $\Diamond$

Hence, for each $h \neq k, j$, $u'_h(y_{\pi'(h)} - f_h(y_{\pi'}, R)) < \lambda = u'_h(y_{\pi(h)} - f_h(y_\pi, R))$, which implies $y_{\pi'(h)} - f_h(y_{\pi'}, R) > y_{\pi(h)} - f_h(y_\pi, R)$. Therefore, as $\pi'(h) = \pi(h)$, we get $f_h(y_{\pi'}, R) < f_h(y_\pi, R)$, contrary to what invariance-anonymity requires. $\square$

Combining Propositions 1 and 3 we reach the conclusion that utilitarian tax schemes are typically rejected by the IO (the second message we wanted to convey from this work).

Theorem 2. *If a utilitarian tax scheme satisfies minimal difference, then it is not rational.*

3.3. **The veil of ignorance endorses the (Rawlsian) leveling tax scheme.**

In this section, we show that, under the premises of independence and equi-probability over incomes, the most egalitarian tax scheme -the leveling tax- which is a natural formulation of the *Rawlsian* difference principle in our simple taxation model, is the only rational tax scheme for the IO. Formally,

Theorem 3. *If the probability distribution satisfies independence and equi-probability over incomes, then the leveling tax is the only rational tax scheme.*

Proof. By Theorem 1, a rational tax scheme for the IO is anonymous. Then, by Lemma 2, it is represented by a tax matrix and, by anonymity, the matrix is composed of a constant row vector $t \equiv (t_i)_{i \in N}$. Consequently, the IO's problem can be expressed as follows:

$$\max_t \left\{ \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{\pi(i)=j} P(i, y_\pi) a_i \cdot u_i(y_j - t_j) : 0 \leq t_j \leq y_j, \sum_{j \in N} t_j = R \right\}. \tag{3.1}$$

By independence, the objective function can be transformed into

$$\sum_{i=1}^{n} P_N(i) \sum_{j=1}^{n} \sum_{\pi(i)=j} P_\Pi(y_\pi) a_i \cdot u_i(y_j - t_j) \tag{3.2}$$

By equi-probability over incomes, $\sum_{\pi(i)=j} P_\Pi(y_\pi) = \frac{1}{n}$, and, thus, the objective can be transformed further into

$$\sum_{i=1}^{n} P_N(i) \cdot \sum_{j=1}^{n} \frac{1}{n} \cdot a_i \cdot u_i(y_j - t_j) = \sum_{j=1}^{n} \frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i(y_j - t_j). \tag{3.3}$$

In the remaining part of the proof, we assume, for simplicity, that individual utility index functions $u_i(\cdot)$ are differentiable. The Lagrangian associated with (3.1) is given by

$$\mathscr{L}(\cdot) = \sum_{j=1}^{n} \frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i(y_j - t_j) + \lambda \left(R - \sum_{j=1}^{n} t_j \right) + \sum_{j=1}^{n} \mu_j (y_j - t_j) + \sum_{j=1}^{n} \gamma_j t_j.$$

As all agents are strictly risk averse, $\sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i(y_j - t_j)$ is strictly concave, and the above program can be solved by the Kuhn-Tucker Theorem (e.g., Mas-Colell et al., 1995). We consider two types of solutions to (3.1) for which the first constraint binds, i.e., solutions t such that $\sum_{j=1}^{n} t_j = R$. The first type refers to interior solutions (i.e., those for which $0 < t_j < y_j$ for each $j \in N$) and the second one to corner solutions (i.e., those for which either $t_j = 0$ or $t_j = y_j$ for some $j \in N$).

Formally,

Case 1. $\mu_j = \gamma_j = 0$ for each $j \in N$ (the interior solutions).

In this case, we would have to solve the following system of equations:

$$-\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_j - t_j) = \lambda \text{ for all } j \in N.$$

Let $j, k \in N$. Then,

$$\sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_j - t_j) = \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_k - t_k).$$

As $\sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i(\cdot)$ is strictly concave, it follows that

$$y_j - t_j = y_k - t_k.$$

In other words, post-tax incomes are equalized across agents.

Case 2. $\mu_j \neq 0$ or $\gamma_j \neq 0$ for some $j \in N$ (the corner solutions).

In this case, we would have to solve the following system of equations:

$$-\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_j - t_j) - \lambda - \mu_j + \gamma_j = 0 \text{ for all } j \in N.$$

Thus, it is clear that for each of those agents $j \in N$ with interior solutions, i.e., $\mu_j = \gamma_j = 0$, then we have $-\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_j - t_j) = \lambda$. Then, Case 1 concludes that these agents will have equal post-tax incomes. Let now $j \in N$ be such that $\mu_j > 0$. Then, $t_j = y_j$, which implies that $0 \geq -\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(0) = \lambda + \mu_j > 0$, a contradiction. Finally, let $j \in N$ be such that $\gamma_j \neq 0$. Then, $t_j = 0$ and, therefore, $-\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_j) = \lambda - \gamma_j$. As $-\frac{1}{n} \sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i'(y_k - t_k) = \lambda$, for each k such that $t_k > 0$, it follows that $y_j = y_j - t_j \leq y_k - t_k$ for each j, k such that $t_k > 0 = t_j$. □

A close examination of the above proof tells us that it is not necessary to assume that all agents are "strictly" risk averse. The result would also hold assuming that only one agent is "strictly" risk averse (as this would be enough to guarantee the strict concavity of $\sum_{i \in N} P_N(i) \cdot a_i \cdot u_i(\cdot)$). "Strict" concavity of all individual utility functions, however, is needed to obtain invariance-anonymity in the proof of Theorem 1, as well as for the proof of Proposition 3.

Remark 1. A close examination of the proof also allows to infer that, with perfect correlation between income and utility (i.e., when , $P(i, y_\pi) = 0$ for each $i \in N$ and each non-identity permutation π), the IO's objective function becomes

$$\sum_{i=1}^{n} P_N(i) \cdot a_i \cdot u_i(y_i - t_i),$$

from where the *anti-prioritarian* result derived in Roemer (2002) and Moreno-Ternero and Roemer (2008) would also be obtained. We conjecture that a similar result may be established when there is imperfect yet partial correlation between income and utility. The formal proof is left for future research.[11]

4. Concluding Remarks

The veil of ignorance has been an influential concept in political philosophy during most of the last century. Many prominent authors have employed it in different forms as a tool to guarantee impartiality in resource allocation, albeit with no clear consensus on how thick the veil should be (e.g., Harsanyi, 1953; 1955; 1977; Rawls, 1971; Dworkin, 1981a; 1981b). One of the early contributions on the veil of ignorance is due to John Harsanyi, which we have partially endorsed here. In Harsanyi's original framework, an impartial observer engages in a thought experiment in which she imagines having an equal chance of being any individual, complete with that individual's tastes and objective circumstances. Harsanyi obtains that lotteries on the set of social alternatives should be ranked according to the average of the individual utilities, for suitably chosen vNM utility representations of the individual preferences.[12] There is a broad agreement about adopting Harsanyi's original framework and his principle of acceptance. Nevertheless, beyond such an agreement on his first step, there are different

[11] A case with correlated income-utility occurs when $\mathscr{D} = \{y_\pi : \pi \in \Pi\}$, $y_1 > \cdots > y_n$, and, for each $i \in N$ and each $\pi \in \Pi$, $P(i, y_\pi) > 0$ if $\pi(i) = i$, and $P(i, y_\pi) = 0$ otherwise.

[12] Karni and Weymark (1998) provide an extension of this theorem to an informationally parsimonious context in which the IO is only assumed to have preferences on the extended lotteries in which there is an equal chance of being any person in society.

options in the literature to complete it.[13] Some of these options (e.g., Karni, 1998) arise from challenging Harsanyi's formalization of impartiality, or the interpretation of his result as a justification for average utilitarianism.[14]

In this paper, we have explored the selection of optimal and impartial tax schemes in a slight modification of Harsanyi's original framework to impose a thicker veil of ignorance. In our model, agents' incomes are completely determined by their talents. The IO contemplates becoming, with equal probability, one of the agents in the group for whom the tax burden is going to be allocated, and also obtaining one of the possible talents with equal probability. Following Harsanyi's first step, we impose the principle of acceptance but, due to the thickness of our veil of ignorance, we also impose an additional axiom (talent irrelevance), according to which the distribution of talents does not make any scale-difference in the IO's vNM utility index function. We then scrutinize the role of impartiality by means of two partial anonymity axioms and obtain the main result. The first result amounts to obtain anonymity of tax schemes as a byproduct of the veil-of-ignorance approach. The second result is the rejection of utilitarian tax schemes based on impartiality. The third result amounts to the IO's endorsement of the leveling tax. Thus, the IO is in line with giving *priority* to the worst-off.[15] Actually, the IO selects the most extreme version of priority, as it advocates for the most preferred taxation scheme for the worst-off individual. In other words, we provide a veil-of-ignorance argument to endorse a Rawlsian recommendation in our context. This is in line with Rawls (1971) himself, who put forth an argument for the difference principle invoking the veil of ignorance and the original position.

For ease of exposition, we considered in our model of tax schemes the boundedness assumption implying that no subsidies were allowed. But this assumption may be weakened to allow for subsidies below a certain upper bound. More precisely, we may assume that there exists $B \geq 0$ such that $-B \leq t_i \leq y_i$ for each $i \in N$, which seems to be a reasonable assumption. In the resulting new scenario, the leveling tax could be defined accordingly, upon assuming that all agents end up with the same post-tax income, under the proviso that no agent is subsidized by more than B. Formally, $t_i = \max\{y_i - 1/\lambda, -B\}$ for some $\lambda_B \in \mathbb{R}_+$ with $\sum_{i \in N} \max\{y_i - 1/\lambda_B, -B\} = R$; The current proof of Theorem 3 could also be modified accordingly, so that

[13] See, for instance, Moreno-Ternero and Roemer (2008) and the literature cited therein. More recently, see Grant et al., (2012) or Fleurbaey and Mongin (2016).

[14] See, for instance, Weymark (1991) for an elaborated critique against this interpretation.

[15] See Moreno-Ternero and Roemer (2006, 2012) or Chun et al., (2014) for recent instances of the powerful implications of this notion in resource allocation.

the result would also hold in the resulting setting. Without such a common bound for subsidies, full equality would instead be obtained.

Throughout the paper, we assumed that there is an agent with zero income. This plays a critical role in Proposition 2, which is used in all our main results. However, we may drop this assumption when the model is extended to allow for population changes and we consider tax schemes that satisfy a weak consistency axiom known as "null-consistency"(which states that an agent with zero income does not make any change in the tax payments of the others), and non-negativity.[16]

Tax schemes in our model do not rely on the profile of utility functions. They only depend on the profile of incomes. The model can be extended to incorporate utility functions so that a tax problem may be defined by both profiles of incomes and utility functions. If so, the axiom of anonymity we consider in our simple model can be stated as follows: given a profile of utility functions, when the profile of incomes is permuted according to π, the tax allocation should also be permuted according to π. This is not a usual notion of anonymity in the extended model, but would still be a necessary condition for a rational tax scheme, as in our simple model. All our main results would also hold in the outlined extended model.

We believe our results might have implications for the political economy of taxation and the current public debate on taxes and inequality, with the growing popularity of flat taxes, despite the rising inequality. Mirrlees (1971) pioneered an extensive (primarily normative) literature on redistributive income taxation. Earlier than that, Foley (1967) analyzed the problem of voting over taxes in an endowment economy.[17] He focused on the case of flat taxes (with or without exemption; and allowing or excluding for the existence of negative taxes) and showed that, for such a class, there always exists a majority voting equilibrium, i.e., a (flat) tax method that cannot be overturned by any other member of the class through majority rule. This can be extended to a rich family of piece-wise linear tax methods too (e.g., Moreno-Ternero, 2011). Voting over (selfishly) optimal tax schedules has also been analyzed by Meltzer and Richard (1981), Snyder and Kramer (1988), Marhuenda and Ortuno-Ortin (1995, 1998), De Donder and Hindricks (2003), and Brett and Weymark (2017, 2020) among others. These investigations deal with taxpayers' self-centered (selfish) decisions on tax schemes. The veil of ignorance in our investigation enforces tax payers to make impartial decisions, which leads to a unanimous consensus,

[16] We would need to assume the domain is rich enough to admit adding or deleting agents with zero income.

[17] See also Gouveia and Oliver (1996).

as claimed by Rawls (1971), at the leveling tax (the most egalitarian tax scheme).

Finally, our main goal is to identify just tax schemes that are selected from the veil of ignorance and to investigate the characteristics of tax schemes that originates purely from "rationality (regarding the choice of tax schemes) of the IO and the veil of ignorance", which are the two critical conditions imposed by both John Rawls and John Harsanyi. It seems reasonable to pursue this research goal in an environment where no other constraints such as incentive compatibility arise (as we do in our model or its extended version adding utility variables to the problems). This is the main reason we assume in the model that labor supply is fixed and so independent of taxation, which allows us to avoid the complication arising from disincentive effect (concerning labor supply) of taxation as well as incentive compatibilities. It is a nice research question to further our investigation in a more complex model where disincentive effect exists and incentive compatibilities are binding constraints for taxation as in the Mirrlees framework. This is, however, beyond the scope of our current investigation.

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