Optimal taxation in occupational choice models: simulations for the US economy*

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Preliminary: please, do not circulate

Abstract

Frameworks used to study optimal tax problems are often highly specialized and difficult to simulate in practice. This paper shows that the occupational choice model of Laroque and Pavoni (2017) can be used as a simple and general tool to simulate optimal income tax schedules for individuals and couples in the U.S. economy. The flexibility of the framework allows to compare optimal tax schedules assuming household labor supply on the intensive and extensive margin. Simulated schedules for individual income tax show that extensive margin labor supply leads to negative marginal tax rates at the bottom of the income distribution. Moving to couple taxation, I show that the considered framework can also be employed to recover U.S. government redistributive preferences (inverted optimal tax approach). Given the current governmental preferences I examine how varying redistributive preferences and labor supply elasticities shape optimal couple tax policy.

Keywords: optimal taxation, couple taxation, occupational choice
JEL codes: E2, E6, H2

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1 Introduction

The extensive literature on optimal income taxation has developed a wide range of occupational choice models to explore how income tax systems should be optimally structured. Some papers focus on individual income taxation, carefully modeling individual labor supply responses. Others focus on optimal couple taxation, capturing the labor supply decisions of couples and examining the factors influencing these choices.

This paper takes a different approach by using a unified and highly flexible framework - Laroque and Pavoni (2017) - to simulate optimal income taxation for both individuals and couples in the U.S. setting. The strength of this framework lies in its ability to accommodate different assumptions on occupations' features, agents' labor supply and government redistributive preferences. Notwithstanding its generality, this model can be easily solved to obtain optimal tax schedule simulations in a great variety of settings.

The first part of the paper employs Laroque and Pavoni (2017) framework to perform optimal individual income tax simulations. In particular, I compare optimal tax schedules derived under a model where individuals choose how much to work (intensive margin) versus whether to work at all (extensive margin).

When only the extensive margin is active, the optimal tax schedule features negative marginal tax rates at the bottom of the income distribution[1]. This schedule encourages participation inducing small downward distortions of high income agents' labor supply. In contrast, under the intensive margin model, no negative marginal tax rates emerge and the optimal tax schedule features a traditional subsidy to the unemployed households financed through heavier taxation on top earners.

The second part of the paper employs Laroque and Pavoni (2017) to study optimal couple taxation, assuming both spouses make labor supply decisions at the extensive margin.

Using a simplified setting with four occupational types (no earners, 1-earner-female, 1-earner-male, both earners), I apply the so-called "inverted optimal tax" approach to estimate the implicit social welfare weights consistent with the current U.S. tax system. These capture the actual preferences of US government for redistribution across the four considered occupations. These "revealed" Pareto weights, are then used to simulate optimal tax schedules under varying redistributive preferences and partici-

[1] Cremonini (2020) provides a formal proof of this statement.

pation elasticity scenarios.
When the government has stronger redistributive preferences (with respect to the status-quo) the optimal tax schedule features an increase in subsidies for non-working household and a tax decrease for single-earner-female households. Noticeably, the relative tax burden between one-earner households (men vs female earner) depends on the balance between income levels and labor supply elasticities of these "occupations". When the government strongly values redistribution, poorer one-earner-woman households are taxed less than one-earner-man, due to higher Pareto weights. When the government values little redistribution, the lower labor supply elasticity of 1-earner-women households, leads to optimally set higher tax rates on 1-earner-females than 1-earner-males.

Literature: This paper relates to the long-standing literature on optimal income taxation, which goes back to the seminal contributions of Mirrlees (1971), Diamond (1998), Salanié (1998). In particular this paper contributes to the literature studying optimal taxation in occupational choice models. The works by Rothschild and Scheuer (2013), Ales et al. (2015) study optimal individual income taxation in occupational choice settings where the working decisions of individuals have general equilibrium effects on wages. In this paper I abstract from these general equilibrium effects and allow for occupational choices in occupations characterized by exogenous salaries. To do that I employ the framework of Laroque and Pavoni (2017) which encompasses as particular cases the occupational choice models of Choné and Laroque (2011) (where only the extensive margin of labor supply is active) and Saez (2002) (where both intensive and extensive labor supply margins are active).
This paper also contributes to the literature studying optimal couple income taxation. The frameworks of Kleven et al. (2009) and Immervoll et al. (2011) are closely related to the one in this paper, however they perform optimal tax schedule simulations exogenously assuming the primary earner of each household. In my work I endogenize the decision of becoming primary earner, allowing both female and male workers to become primary earner of the household. The more recent paper by Ales and Sleet (2022) studies optimal couple taxation in a framework which models households' joint occupation choices through a *mixed logit model*. This framework allows them to model rich substitution patterns between different households' work configurations (e.g., male-only, female-only, dual earners, or neither working). Although more simplistic, the framework of Laroque and Pavoni (2017) employed here allows to obtain qualitatively similar result, at much lower computational cost and a more

intuitive mapping between model objects and empirical counterparts.

The paper is structured as follows. Section 2 describes the occupational choice framework of Laroque and Pavoni (2017) which is employed for simulating optimal individual and couple tax schedules. Sections 3 employs the model to study optimal individual income taxation, while in Section 4 the model is employed to study optimal couple taxation. Section 5 concludes.

2 Model

In this Section I present the occupational choice framework of Laroque and Pavoni (2017), which I employ as setting for the optimal tax simulations conducted throughout this paper.

Assume a finite number of occupations indexed by $i \in \{0, 1, ..., I\}$ and a continuum of agents, each characterized by a privately known type $\alpha \in \mathcal{A} \subset \mathbb{R}^I$. Let $F(\alpha)$ indicate the cdf according to which these types are distributed. Each occupation i provides a before tax income w^i which is exogenously given and observed by the government. Income received by the worker in occupation i equals the production of the worker in that occupation. Taxes (or transfers) levied on each occupation i are denoted by t^i and the vector of disposable incomes in the various occupations by $c = (w^0 - t^0, w^1 - t^1, ..., w^I - t^I)$. The government is assumed to be able to observe the occupational decision of each agent but not the type of each individual.
Let u^i be the utility function of an individual with skill α when joining occupation i: $u^i(c^i, \alpha)$. I assume that the utility function is increasing and continuously differentiable in both arguments.
Denote with $A^i(c)$ the set of agents who choose occupation i:

$$A^i(c) := \{\alpha \in \mathcal{A} \mid u^i(c^i, \alpha) > u^j(c^j, \alpha) \, \forall \, j \neq i\} \tag{1}$$

with $\mu(A^i(c))$ indicating the measure of this set. Since each agent chooses one of the available occupations, it holds:

$$\sum_{i=0}^{I} \mu(A^i(c)) = 1 \tag{2}$$

The social planner problem: let's consider the problem of a benevolent planner who chooses the level of disposable income for each occupation:

$$\begin{aligned} \max_{\{c^i\}_{i\in\{0,\ldots,I\}}} \quad & \textstyle\sum_{i=0}^{I} \int_{A^i(c)} \beta(\alpha)\psi(u^i(c^i,\alpha))dF(\alpha) \\ \text{s.t.} \quad & \textstyle\sum_{i=0}^{I} (w^i - c^i)\mu(A^i(c)) = G \end{aligned} \tag{3}$$

where G denotes the exogenous level of government expenditures. The function $\psi(\cdot)$ is assumed to be weakly increasing and captures the redistributive preferences of the government. Furthermore, $\beta(\alpha)$ is a function through which the government can assign different weights to the various types of agents in the economy[2].
The first order conditions of the problem write:

$$\mu(A^i)\left[P(A^i) - 1\right] = -\sum_{j=0}^{I} \frac{\partial \mu(A^j(c))}{\partial c^i} t^j \qquad \forall\, i \in \{0, \ldots, I\} \tag{4}$$

where $P(A^i)$ denotes the Pareto weight, i.e. the average marginal social welfare weight assigned to agents who choose state i:

$$P(A^i) := \frac{1}{\lambda \mu(A^i)} \int_{A^i} \beta(\alpha)\psi'(u^i(c^i,\alpha))u_1^i(c^i,\alpha)dF(\alpha) \tag{5}$$

and λ is the multiplier associated to the government budget constraint. In other terms, $P(A^i)$ represents the value for the government of distributing an extra dollar uniformly to all individuals working in occupation i. It is possible to show that equation (4) can be re-written for differences rather than levels of taxes: for $i = 0, \ldots, I$

$$\mu(A^i)\left[P(A^i) - 1\right] = -\sum_{j\neq i}^{I} \frac{\partial \mu(A^j(c))}{\partial c^i}(t^j - t^i) \tag{6}$$

The left-hand side captures the social value of increasing consumption for individuals in occupation i, net of the associated resource cost. This net benefit is weighted by the number of individuals in occupation i. The right-hand side, by contrast, reflects the budget effect of increasing consumption for occupation i. An increase in c^i may induce individuals from other occupations to switch to occupation i, potentially altering the total tax revenue collected by the government.
Now, consider equation (6) in which the tax differences are written with respect to t^0, this would give the following equation for every $i = 1, \ldots, I$:

[2]The function $\beta(\alpha)$ satisfies the following requirements: $\beta(\alpha) \geq 0$ and $\int \beta(\alpha)dF(\alpha) = 1$

$$\mu(A^i)\left[P(A^i)-1\right] = -\sum_{j=1}^{I}\frac{\partial\mu(A^j(c))}{\partial c^i}(t^j-t^0)$$

Taking as given the measure of sets and the Pareto weights the first order conditions can be re-written as a linear system of I equations in I unknowns:

$$\begin{bmatrix} -\frac{\partial\mu(A^1)}{\partial c^1} & -\frac{\partial\mu(A^2)}{\partial c^1} & \dots & -\frac{\partial\mu(A^I)}{\partial c^1} \\ -\frac{\partial\mu(A^1)}{\partial c^2} & -\frac{\partial\mu(A^2)}{\partial c^2} & \dots & -\frac{\partial\mu(A^I)}{\partial c^2} \\ \dots & \dots & \dots & \dots \\ -\frac{\partial\mu(A^1)}{\partial c^I} & -\frac{\partial\mu(A^2)}{\partial c^I} & \dots & -\frac{\partial\mu(A^I)}{\partial c^I} \end{bmatrix} \begin{bmatrix} t^1-t^0 \\ t^2-t^0 \\ \dots \\ t^I-t^0 \end{bmatrix} = \begin{bmatrix} \mu(A^1)(P(A^1)-1) \\ \mu(A^2)(P(A^2)-1) \\ \dots \\ \mu(A^I)(P(A^I)-1) \end{bmatrix}$$

or, in more compact form:

$$H\Delta t = \mu(P-1) \tag{7}$$

where $\mu(P-1)$ is a $I\times 1$ vector with i^{th} component $\mu(A^i)(P(A^i)-1)$; H is a $I\times I$ matrix with entry $h_{ij} = -\frac{\partial(\mu(A^j))}{\partial c^i}$ for $i=1,...,I$ and $j=1,...,I$ and Δt a $I\times 1$ vector with i^{th} component (t^i-t^0). Now define the "consumption elasticity" of the set A^j as follows:

$$\eta_i^j = -\frac{\partial\mu(A^j)}{\partial(c^i-c^j)}\frac{c^i-c^j}{\mu(A^j)}$$

which captures the percentage change of agents in occupation j in response to a 1% change of disposable income in occupation i. Any element of matrix H can thus be re-written as:

$$h_{ij} = \eta_i^j\frac{\mu(A^j)}{c^i-c^j} \tag{8}$$

Each element of the matrix H, h_{ij}, depends on three components: the elasticity of set A^j with respect to disposable income in occupation i, the measure of set A^j and the difference in disposable income between occupation i and j. Depending on how each occupation is defined these objects will have different empirical counterparts.
If matrix H is invertible the optimal tax schedule (with respect to occupation $i=0$) can be simply obtained by:

$$\Delta t = H^{-1}\mu(P-1) \tag{9}$$

3 Individual income taxation: intensive vs extensive margin

In this section, I use Laroque and Pavoni (2017) framework to simulate optimal individual income tax schedules in different occupational choice settings. First, I consider a model where individuals choose how much to work along the intensive margin only. I then compare the resulting optimal tax schedule to one derived from an occupational choice model where labor supply decisions are instead made exclusively at the extensive margin. I am going to show that shape of the optimal tax schedule differs substantially in the two settings, especially at the bottom of the income distribution.

To derive the optimal tax schedule, I have to solve the system of equations (9). For computational simplicity only, I treat the vector of Pareto weights P as an exogenous object. While this is a simplification, it allows to transform the problem into a linear system that can be simply solved by inverting the matrix H. As outlined in Section 2, calibrating the model requires the following information:

- Data on income and taxes paid by American individuals
- A specification of Pareto weights
- Estimates of labor supply elasticities

The next paragraphs provide an overview of the data sources used to obtain these figures, while more details on the elasticities employed will be reported when performing the optimal tax simulations.

Income and tax data: the unit of reference of these simulations is the individual. To collect information on labor income and average tax rates faced by American households the 2018 American Community Survey is employed. The labor income distribution is discretized into 20 classes of earnings which correspond to "occupations" (see Appendix A), and a density is associated to each of them. The empirical density in our framework provides a way to estimate the measure of the sets A^i for $i = 0, ..., 20$.
To compute the disposable income of each considered occupation, information on average tax rates is needed. Since these simulations focus on individual income taxation the tax rates for single individuals are employed to compute the average disposable

incomes across the 20 occupations. Appendix A summarizes average labor income tax rates faced by American households across the income distribution.

Pareto weights: Pareto weights are computed assuming the following functional (Saez (2002)):

$$P(A^i) = \frac{1}{p(c^i)^\nu} \tag{10}$$

where $p \geq 0$ is a constant which ensures that $\sum_{i=0}^{I} P(A^i)\mu(A^i) = 1$ and $\nu \geq 0$. Notice that this functional form for Pareto weights can simply be obtained by assuming in equation (5) $\beta(\alpha) = 1$ for all $\alpha \in \mathcal{A}$, a standard CRRA utility function for every occupation (solely depending on c^i) and a concave power function $\psi(\cdot)$ for the government redistributive preferences. Notice that, for given occupation specific utility functions, varying ν is equivalent to change the redistributive tastes of the government.

3.1 Extensive margin model: tax simulations

First, I simulate the optimal individual income tax schedule considering the simple case in which only the extensive margin of labor supply is active. In particular, I assume that each individual either works in occupation i corresponding to his type or is unemployed (i.e. he chooses occupation 0). This implies that all entries of the matrix H outside the diagonal are zero, while for the elements on the diagonal the following holds for every $i = 1, ..., I$:

$$h_{ii} = \eta_0^i \frac{\mu(A^i)}{c^i - c^0} \tag{11}$$

The linear system to be solved therefore takes the following form:

$$\begin{bmatrix} h_{11} & 0 & ... & 0 \\ 0 & h_{22} & ... & 0 \\ ... & ... & ... & ... \\ 0 & 0 & ... & h_{II} \end{bmatrix} \begin{bmatrix} t^1 - t^0 \\ t^2 - t^0 \\ ... \\ t^I - t^0 \end{bmatrix} = \begin{bmatrix} \mu(A^1)(P(A^1) - 1) \\ \mu(A^2)(P(A^2) - 1) \\ ... \\ \mu(A^I)(P(A^I) - 1) \end{bmatrix} \tag{12}$$

solving this system delivers the tax differences $t^i - t^0$ for all $i = 1, ..., 20$. To obtain the optimal level of taxes in each occupation the government budget constraint is needed:

$$\sum_{i=0}^{I} t^i \mu(A^i) = T \Rightarrow \quad t^0 = T - \sum_{i=0}^{I} (t^i - t^0)\mu(A^i) \tag{13}$$

where the tax requirement T is chosen to be $T = 10000\$$, which matches the average per-capita income tax revenues net of transfers (TANF, Food stamps) in 2018 (American Community Survey data).

The solution to the optimal tax problem is highly sensitive to the values of the labor supply elasticities, which determine the elements of the matrix H. The empirical literature on labor supply elasticities is extensive, with a wide range of estimation methods and elasticity concepts employed. For the purpose of this simulation, I rely on the extensive margin elasticities reported by Attanasio et al. (2018). In particular, the elasticity that they call "extensive response" perfectly aligns with the concept of participation elasticity (η_0^i) defined in this framework.

Moreover, Attanasio et al. (2018) provide different estimates of these extensive responses across income quartiles, which is crucial for the calibration in this context. Specifically:

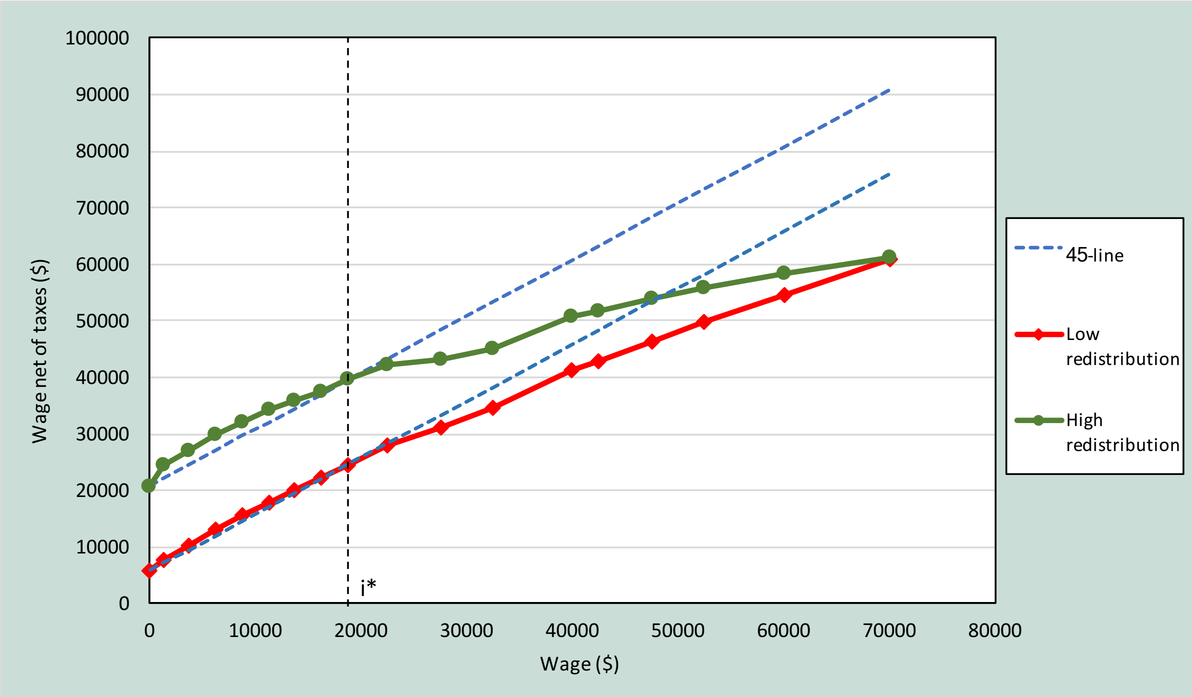
1. for 0p-25p: 1.2
2. for 26p-50p: 0.77
3. for 51p-75p: 0.39
4. for 76p-100p: 0.16

The assumptions made on the elasticities ensure that the linear system (12) admits a unique solution. Specifically, since the matrix H is diagonal with non-zero entries on the diagonal it is possible to show that it is invertible (Cremonini (2020)).

By varying the parameter ν, I also explore how changes in the government's redistributive preferences affect the shape of the optimal tax schedule. The results of these simulations are presented in Figure 1. The red line represents the optimal tax schedule when $\nu = 0.1$ (low redistributive preferences), while the green line represents the optimal tax schedule when the government has higher preferences for redistribution, i.e. when $\nu = 1$.

Figure 1 illustrates that unemployed individuals receive a transfer, which increases as the government's redistributive preferences grow stronger. Notably, the working poor receive a larger transfer than the unemployed. This implies the presence of both a guaranteed minimum income and a negative marginal tax rate at the lower end of the income distribution. Why is it optimal for the working poor to receive more than the unemployed? If they received less (i.e. no negative marginal tax rates), then increasing their transfer would cost one unit of resources while generating a social welfare gain of $P(A^i) > 1$. Additionally, the higher transfer would encourage some unemployed individuals to enter the labor force, increasing total tax revenues. This

FIGURE 1. *Optimal tax schedule when only extensive margin is active*



Notes: *this Figure representes the optimal tax schedule obtained solving the system of equation* (12) *(i.e. extensive margin model). Details on model calibration are reported in Section 3.1. Red line represents the optimal tax schedule when Pareto weights are computed assuming* $\nu = 0.1$*, while the green line when* $\nu = 1$*.*

implies that a scenario with no negative marginal tax rates is suboptimal. Notice that, after the threshold i^*, the negative marginal tax rate turns positive.

The cost of this redistributive scheme is covered by higher taxes on top earners. The structure of the tax schedule is also influenced by the distribution of participation elasticities: high elasticities at the bottom make it relatively inexpensive to incentivize labor market entry, while low elasticities at the top permit heavier taxation on high earners with limited labor supply loss.

Although the simulation uses only four discrete elasticity values (one per earnings quartile), it's plausible that elasticities vary continuously with income. To assess robustness, Appendix B presents a simulation using interpolated elasticity values. The resulting tax schedules are qualitatively unchanged, confirming the consistency of the findings.

3.2 Intensive margin

I now consider the case in which only the intensive margin of labor supply is active. Specifically, I assume that each individual could choose the occupation i which corresponds to his type, occupation $i-1$ or occupation $i+1$. When this is the case it is possible to show that the system (9) takes the form:

The linear system (9) becomes:

$$\begin{bmatrix} h_{11} & h_{12} & 0 & 0 & \dots & 0 \\ h_{21} & h_{22} & h_{23} & 0 & \dots & 0 \\ 0 & h_{31} & h_{32} & h_{33} & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & 0 & h_{I-1I} & h_{II} \end{bmatrix} \begin{bmatrix} t^1 - t^0 \\ t^2 - t^0 \\ t^3 - t^0 \\ \dots \\ t^I - t^0 \end{bmatrix} = \begin{bmatrix} \mu(A^1)(P(A^1) - 1) \\ \mu(A^2)(P(A^2) - 1) \\ \mu(A^3)(P(A^3) - 1) \\ \dots \\ \mu(A^I)(P(A^I) - 1) \end{bmatrix} \tag{14}$$

Using equation (8) it is possible to show that the elements of matrix H take the following form. For each $i = 1, ..., I$:

$$h_{i,i+1} = \eta_i^{i+1} \frac{\mu(A^{i+1})}{c^i - c^{i+1}} \tag{15}$$

$$h_{i,i-1} = \eta_i^{i-1} \frac{\mu(A^{i-1})}{c^{i-1} - c^i} \tag{16}$$

Moreover, by using the fact that for every $i = 0, ..., I$

$$\sum_{j=0}^{I} \frac{\partial \mu(A^j)}{\partial c^i} = 0$$

$$h_{i,i} = \eta_i^{i+1} \frac{\mu(A^{i+1})}{c^{i+1} - c^i} + \eta_i^{i-1} \frac{\mu(A^{i-1})}{c^i - c^{i-1}} \tag{17}$$

The structure of Pareto weights remains the same as in (10) and the budget constraint is the one used in the previous simulation.

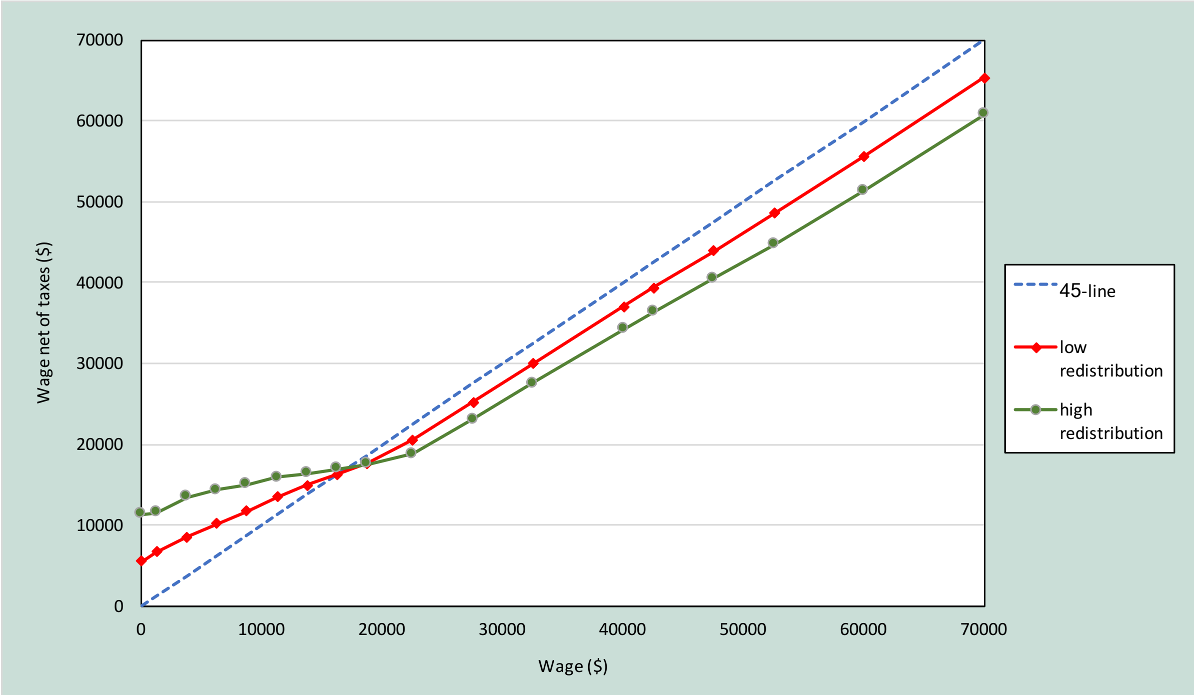
The values of the intensive elasticities used in the following simulation are again taken from the paper by Attanasio et al. (2018). Specifically:

1. for 0p-25p: 0.44
2. for 26p-50p: 0.54
3. for 51p-75p: 0.69
4. for 76p-100p: 1.16

The results of the simulation are presented in the following Figure 2.

The optimal tax schedule here resembles a standard negative income tax (NIT) system, where redistribution occurs through subsidies targeted at the lowest earners and is financed by taxes on higher income brackets. Unlike the case with only the extensive margin active, there is no negative marginal tax rate. The reasoning is as follows:

FIGURE 2. *Optimal tax schedule when only intensive margin is active*



Notes: *this Figure represents the optimal tax schedule obtained solving the system of equation (14) (i.e. intensive margin model). Details on model calibration are reported in Section 3.2. Red line represents the optimal tax schedule when Pareto weights are computed assuming $\nu = 0.1$, while the green line when $\nu = 1$.*

suppose to slightly increase the negative marginal tax rate of occupation i. If there is any reduction in the labor supply in occupation i this would induce those switching to occupation $i-1$ to pay more taxes. Furthermore, the increase in the marginal tax rate would allow the government to raise more resources for redistribution from all agents in occupation higher than i. Thus, the increase in the marginal tax rate would induce an increase in the social welfare, through larger tax collected employed for redistributive purposes. This shows that the negative marginal tax rate was not an optimal solution of the problem.

The shape of the tax schedule is also highly sensitive to the assumed labor supply elasticities. Even if top earners are associated with low Pareto weights, taxing them too heavily is inefficient due to their relatively high labor supply responsiveness, which would lead to reduce the tax revenues collected by the government. This contrasts with the extensive-margin-only case, where high-income individuals have lower participation elasticities and lower Pareto weights, justifying heavier taxation. Appendix B confirms these findings by interpolating the elasticity values provided by Attanasio et al. (2018). This produces a very similar tax schedule, except for a flatter profile at the bottom of the distribution[3].

4 Couple taxation with extensive margin labor choice

The aim of this section is to show how Laroque and Pavoni (2017) model can be applied to derive optimal tax schedules for couples in the United States. First, I employ the so-called "inverted optimal tax approach" to infer social preferences regarding family taxation in the U.S. I then use the information obtained to conduct optimal tax simulations, analyzing how the optimal tax schedule is shaped by the government's redistributive preferences and by households' labor supply elasticities.

Framework and occupations: suppose that each family consists of one man and one woman, and that each individual decides whether to work or not, that is only the extensive margin of labor supply is active for each family member. In the framework of Laroque and Pavoni (2017), the work status of household members can be represented using the following occupations: $i = 0$ if neither spouse works, $i = 1$ if only the woman works, $i = 2$ if only the man works and $i = 3$ if both spouses work. In cases where only one spouse is employed, that individual is referred to as the primary earner.

To simplify the analysis I rule out the possibility of "double deviations", that is the "primary earner" exiting the labor market and the "secondary earner" entering the labor market or both exiting (or entering) the labor market jointly. Although restrictive, this is a common assumption in the optimal couple taxation literature (e.g. Kleven et al. (2009), Immervoll et al. (2011)). Under these assumptions the system of FOCs (7) can be re-written as:

$$\begin{bmatrix} -\frac{\partial\mu(A^0)}{\partial c^0} & -\frac{\partial\mu(A^1)}{\partial c^0} & -\frac{\partial\mu(A^2)}{\partial c^0} \\ -\frac{\partial\mu(A^0)}{\partial c^1} & -\frac{\partial\mu(A^1)}{\partial c^1} & 0 \\ -\frac{\partial\mu(A^0)}{\partial c^2} & 0 & -\frac{\partial\mu(A^2)}{\partial c^2} \end{bmatrix} \begin{bmatrix} t^0 - t^3 \\ t^1 - t^3 \\ t^2 - t^3 \end{bmatrix} = \begin{bmatrix} \mu(A^0)(P(A^0) - 1) \\ \mu(A^1)(P(A^1) - 1) \\ \mu(A^2)(P(A^2) - 1) \end{bmatrix} \tag{18}$$

notice that, in this case, tax differences are written with respect to occupation 3.

[3]Notice that in the high-redistribution scenario with only an extensive margin (see Figure B3.1), marginal tax rates go above 100% for income larger than, 40,000 USD (thus implying re-ranking of income when moving from pre-tax incomes to post-tax incomes). This seems to indicate that a model with just an extensive margin appears to be too much an oversimplifcation to generate meaningful tax results.

Matrix H properties: to compute the optimal couple tax schedule (taking as given the Pareto weights) the key challenge is to link the elements of matrix H to their (estimable) empirical counterparts. Let's proceed step by step.
Consider the first row of matrix H, whose elements capture the changes in the measures of all occupations when disposable income in occupation $i = 0$ varies. It holds:

$$\frac{\partial \mu(A^1)}{\partial c^0} = -\eta_0^1 \frac{\mu(A^1)}{c_1 - c_0} \qquad \frac{\partial \mu(A^2)}{\partial c^0} = -\eta_0^2 \frac{\mu(A^2)}{c_2 - c_0}$$

where η_0^1 corresponds to the participation elasticity of a woman conditional on his spouse not working, and η_0^2 corresponds to the participation elasticity of a man conditional on his spouse not working. Furthermore, given the assumption: $-\frac{\partial \mu(A^3)}{\partial c^0} = 0$ we have $-\frac{\partial \mu(A^0)}{\partial c^0} = \frac{\partial \mu(A^1)}{\partial c^0} + \frac{\partial \mu(A^2)}{\partial c^0}$.

Consider now the second row of H which captures the occupational effects of an increase in c^1, the disposable income of an household where the woman is the only earner. In this case in some families in which both spouses are not working, the woman may find convenient to start working. Alternatively, in households where both family members are working the increase in c^1 may lead male workers to quit their job. These movements are captured by:

$$\frac{\partial \mu(A^0)}{\partial c^1} = -\eta_0^1 \frac{\mu(A^0)}{c_1 - c_0} \qquad \frac{\partial \mu(A^3)}{\partial c^1} = -\eta_1^3 \frac{\mu(A^3)}{c_3 - c_1}$$

where η_0^1 is the participation elasticity of women conditional on her spouse not working, while η_1^3 is the participation elasticity of men conditional on his spouse to be working. Furthermore, given the assumption of no double deviations the following holds: $-\frac{\partial \mu(A^1)}{\partial c^1} = \frac{\partial \mu(A^0)}{\partial c^1} + \frac{\partial \mu(A^3)}{\partial c^1}$.

An analogous reasoning can be employed to re-write the entries of the third row of the matrix H. Let's assume an increase c^2: men of some couples in which both members are not working may start working. Furthermore, women in couples in which both members are working may decide to quit their job. These movements are captured by:

$$\frac{\partial \mu(A^0)}{\partial c^2} = -\eta_0^2 \frac{\mu(A^2)}{c_2 - c_0} \qquad \frac{\partial \mu(A^3)}{\partial c^2} = -\eta_2^3 \frac{\mu(A^3)}{c_3 - c_2}$$

where η_0^2 is the participation elasticity of men conditional on his spouse not working, while η_2^3 is the participation elasticity of women conditional on his spouse to be working. Furthermore: $-\frac{\partial\mu(A^2)}{\partial c^2} = \frac{\partial\mu(A^0)}{\partial c^2} + \frac{\partial\mu(A^3)}{\partial c^2}$

To sum up, to calibrate this occupational choice model four elasticities are needed: the participation elasticity of women and men conditional on the spouse not working (η_0^1 and η_0^2) or working (η_1^3 and η_2^3). If we assume that all the four mentioned elasticities mentioned are non-zero, it is possible to show that the matrix H in this setting is invertible.

Differently from Section 3, the presented model will be first employed to estimate the vector of Pareto weights P, assuming that the existing tax system is optimal (inverted optimal tax approach).

Then, the observed Pareto weights will be suitably altered so to simulate how the optimal couple tax schedule would change under different governmental redistributive preferences and different elasticity scenarios.

These exercises require data on the disposable incomes and taxes paid by American households, as well as information about the employment status of household members. The following Section summarizes these information and describes the calibration of matrix H.

4.1 Data and matrix H calibration

The reference unit in this analysis is the household as a whole. Since the model focuses on determining optimal tax schedules based solely on the labor supply decisions of couples, the relevant income considered is exclusively labor income, excluding any income from capital or investments. Accordingly, taxes are defined as labor income taxes, imposed by both central and local governments, minus any benefits received (e.g. guaranteed minimum income, unemployment benefits, family-related government transfers).

Labor income and labor income taxes: the reference year for this analysis is 2018. Data on the number of unemployed households, single-earner households, and dual-earner households in the United States are drawn from the American Current Population Survey. These figures are used to calculate the shares of each defined occupation category and are presented in the first column of Table 1. The second column of Table 1 displays the average gross labor income for each household type, based on data from the 2018 American Community Survey. Given the complexity and variability of tax and benefit systems across U.S. states, estimating average tax liabilities and benefits

TABLE 1. *Calibration data*

	$\mu(A^i)$	w^i	c^i
$i = 0$	0.2012	0	22844
$i = 1$	0.0727	48623	42934
$i = 2$	0.2042	57204	50511
$i = 3$	0.5219	91768	75543

Notes: *Measures of column 1 are taken from 2018 Current Population Survey provided by US Bureau of Labor Statistics. Column 2 represents the median income of each "occupation": they are taken from 2018 American Community Survey and they are gross of taxes. In the third column the income tax rate faced by each occupation, according to the income values of column 2, are presented. Finally, the net value of consumption for each occupation is provided in the fourth column. All values are in inflation-adjusted dollars.*

by occupation is challenging. To address this, I use the OECD tax-benefit calculator. Specifically, I simulate taxes and benefits for U.S. households in which both adults are 50 years old and have two children aged 16 and 12 (figures that reflect the average household composition in the U.S). The resulting disposable incomes are reported in Table 1, column 3.

Participation elasticities: The literature on participation elasticities is extensive, with estimates varying widely depending on the methodological approach and context in which they are derived. Labor force participation elasticities are generally modest and vary across groups. On average, women, low-income individuals, and secondary earners tend to respond more to tax and benefit changes than men or primary earners.

Bartels and Shupe (2023) calculate participation elasticities for primary and secondary earners of both genders in couples for several EU countries between 2008 and 2014 using EUROMOD data. They find that the average elasticity is 0.08 for men and 0.14 for women. However, when distinguishing by their role in the household, the primary earner range is 0.02-0.08 for men and -0.03-0.15 for women whereas the secondary earner range is 0.05-0.2 for men and 0.09-0.22 for women.

Bargain et al. (2014) compute labor supply elasticities not only for EU countries but also for the US., using TAXBEN and EUROMOD programs. Notably, the average participation elasticities reported by Bartels and Shupe (2023) for the EU (0.08 for men and 0.14 for women) fall well within the ranges estimated by Bargain et al. (2014) for the U.S. (which are 0.05-0.15 for men and 0.1-0.2 for women).

Additional studies report similar elasticity estimates. For instance, Lin and Tong (2017) use IRS administrative data from 2000-2009 and the TAXSIM model to estimate slightly lower participation elasticities (0.03 for married men and 0.10 for married women). These will constitute lower bounds in our simulations. Eissa and Hoynes

(2004), using 1984-1996 U.S. data and a Probit model, estimate participation elasticities of 0.03 for men and 0.27 for women in response to EITC expansions, highlighting the program's role in encouraging mothers to stay home. While these estimates are broadly consistent with our range, we adopt more conservative elasticity values for women, given that the Eissa and Hoynes (2004) data are dated and gender elasticities have converged over time as women's labor force participation increased Bargain et al. (2014). This discussions leads to deem reasonable the scenarios that are considered in Table 2.

TABLE 2. *Values for the extensive elasticities employed in simulations*

	Male 1^{st} earner	Male 2^{nd} earner	Fem. 1^{st} earner	Fem. 2^{nd} earner
Scenario 1	0.05	0.1	0.05	0.15
Scenario 2	0.05	0.1	0.05	0.18
Scenario 3	0.05	0.1	0.07	0.18
Scenario 4	0.03	0.09	0.03	0.13

Notes: Participation elasticity values have been chosen consistently with the literature findings summarized in this paragraph. Specifically, scenario (2) considers slightly larger elasticities for female as a secondary earner, scenario (3) consider larger elasticities for female in general, scenario (4) is the lower bound case.

4.2 Inverted optimal tax approach

The optimal taxation literature has traditionally focused on deriving the efficient tax schedule given the government's redistributive preferences. However, a more recent strand of research, beginning with Bourguignon and Spadaro (2012), adopts a reverse approach. Rather than assuming specific social preferences, this approach starts by assuming the existing tax schedule in a country as optimal and then asks which set of Pareto weights would be consistent with that optimal tax system. In Laroque and Pavoni (2017) this means to solve the system $H\Delta t = \mu(P-1)$ for the vector of Pareto weights P (taking as given Δt) rather than for Δt (taking as given P).

Once retrieved the "revealed Pareto weights" I study whether they are consistent with the properties of Pareto weights derived under standard assumptions for the social welfare function.

Denote with $\hat{P}(A^i)$ the revealed Pareto weight for occupation i. Equation (18) allows to estimate the reveled Pareto weights for $i = 1, 2, 3$:

$$\hat{P}(A^i) = 1 + \frac{1}{\mu(A^i)}\Bigg(- \frac{\partial \mu(A^1)}{\partial c^i}(t^1 - t^0) - \frac{\partial \mu(A^2)}{\partial c^i}(t^2 - t^0) - \frac{\partial \mu(A^3)}{\partial c^i}(t^3 - t^0)\Bigg) \quad (19)$$

Together with: $\sum_{i=0}^{3} \hat{P}(A^i)\mu(A^i) = 1$ which allows to retrieve $\hat{P}(A^0)$.

Revealed Pareto weights properties: let's recall the definition of Pareto weight (5):

$$P(A^i) := \frac{1}{\lambda\mu(A^i)} \int_{A^i} \beta(\alpha)\psi'(u^i(c^i, \alpha))u_1^i(c^i, \alpha)dF(\alpha)$$

they represent the average marginal social welfare weight associated to individuals (or in this case couples) who choose occupation i.

Denote by $G(c) = \int_{A_i} \beta(\alpha)\psi(u^i(c^i, \alpha)))dF(\alpha)$ the social welfare function faced by the planner. If the functions $\psi(\cdot)$ and $u^i(c^i, \cdot)$ are weakly increasing, then the social welfare function $G(c)$ is weakly increasing in c^i, for all $i = 0, ...3$.

Definition 1 (Paretian Social Welfare function)**.** *A Social Welfare function $G(c^1, ..., c^I)$ is said to be Paretian if $\partial G(c)/\partial c^i \geq 0$ for all $i = 0, ..., I$. Otherwise G is non-Paretian.*

Therefore, if the social welfare function of our couple taxation problem is Paretian, it holds: $\int_{A^i} \beta(\alpha)\psi'(u^i(c^i, \alpha))u_1^i(c^i, \alpha)dF(\alpha) \geq 0$ for all $i = 0, ..., 3$, hence $P(A^i) \geq 0$. In other words, only positive Pareto weights could be associated to a Paretian Social Welfare function. I then check whether the estimated "revealed" Pareto weights are consistent with the minimal requirement of a Paretian social welfare function.

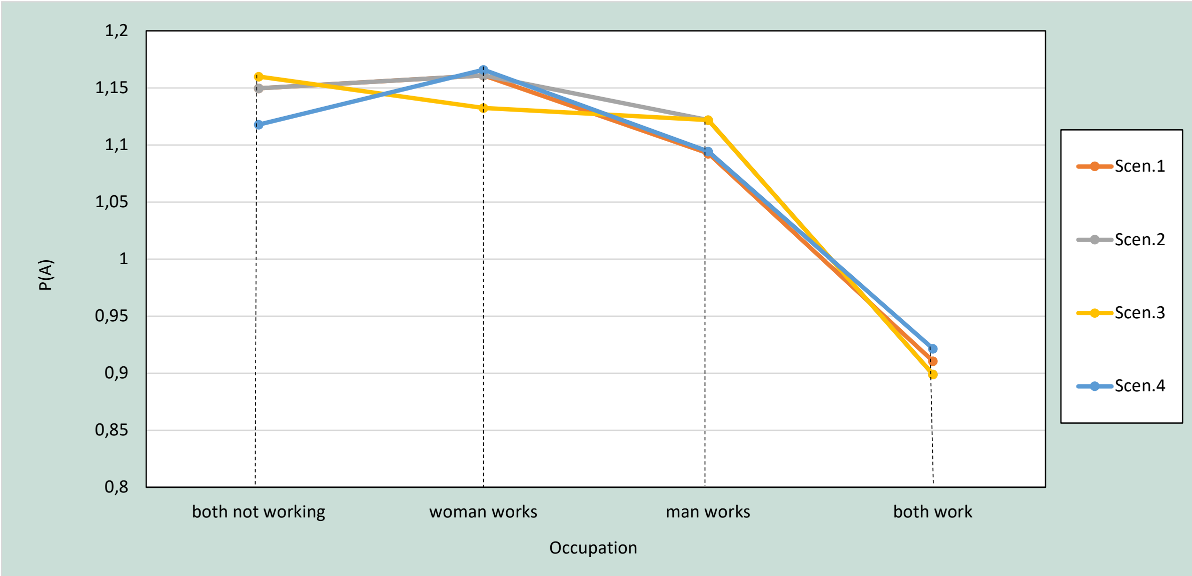
Revealed Pareto weights estimates: Figure 3 represents the "revealed" Pareto weights computed using equation (19). The different colored lines correspond to the revealed Pareto weights estimated employing the four participation elasticity scenarios described in Table 2.

First, note that the Pareto weights are significantly different from zero across all scenarios, indicating that the estimated revealed Pareto weights are consistent with a Paretian social welfare function.

The next step is to assess whether Pareto weights are decreasing in household disposable income. That would be the case under the standard assumption of concave utility functions for agents in each occupation and linear or concave function $\psi(\cdot)$ (reflecting utilitarian or inequality averse planner).

Revealed Pareto weights decrease with disposable income for occupations $i = 1, 2, 3$ as expected. However, in some scenarios, the weight assigned to the poorest house-

FIGURE 3. *Revealed Pareto Weights for US couples*



Notes: *Revealed Pareto Weights for US couples. The scenarios correspond to the values of the participation elasticities of Table 2. The considered couples are: couples in which both members are not working, one-earner couple with woman working, one-earner couple with man working, two earners couple. Computation by the author, data and simulation method presented in the present section.*

holds (those with no earners) is lower than that of households where only the female spouse works, who have larger disposable income. Why is that the case? Among the possible explanations Saez and Stantcheva (2016) highlight that weights $P(A^i)$ could be not only a function of $c = (c^0, c^1, c^2, c^3)$ but also of net taxes. In fact, assuming that $P(A^i)$ increases with $t = (t^0, t^1, t^2, t^3)$ captures the idea that taxpayers contributing more to the society are more deserving of additional consumption. This perspective helps to explain the observed shape of the revealed Pareto weights: Pareto weights in occupations $i = 1, 2, 3$ mostly reflect government redistributive preferences and concavity of the utility functions. For non-working households, instead, lower weights reflect a political reluctance to allocate significant resources toward those not contributing to the tax system.

An alternative explanation could be the following. Suppose the observed tax system does reflect the government solving the same the planner's optimization problem I have analyzed. As previously noted, estimating participation elasticities is highly contentious and results can vary significantly depending on the methodology and data used. Therefore, the elasticities I used to compute the revealed Pareto weights may differ from those assumed by policymakers when designing the tax schedule. Furthermore, since comprehensive tax reforms are not implemented each year the elasticities used by the government to determine the optimal tax schedule may be based on older data with respect to mine. There is evidence, in fact, that participation elasticities have decreased over time (Lundberg and Norell (2020)), and simply assuming a female participation elasticity (conditional on the spouse not working) of 0.07 (scenario 3) rather than 0.05 or lower delivers a set of Pareto weights strictly decreasing in disposable income. The intuition is very simple: with females more responsive to changes in taxation, given redistributive preferences, female should be taxed less. Therefore, to keep the current tax scheme as optimal with a larger female participation elasticity the government should decrease the weight associated to occupation $i = 1$ and increase the weight associated to $i = 0$.

4.3 Couple tax simulation

In this section I use the previously derived information on governmental preferences to simulate optimal tax schedules under varying assumptions. Specifically, I conduct a series of comparative statics exercises to examine how changes in redistributive preferences or in the assumed participation elasticities affect the resulting optimal tax schedules.
To find the optimal couple tax schedule I need to solve the system of equations (18). Notice that, both the Pareto weights $P(A^i(c))$ and the measures of the sets $\mu(A^i(c))$ are endogenous objects depending on the vector of disposable incomes. In Section 3, just for computational simplicity I took these objects as given, now I consider them as *endogenous*. Under this assumption the system is no longer linear and it can only be solved numerically.

Similarly to the approach taken in Section 3, I am going to assume a functional form for the Pareto weights which directly depend on disposable incomes, without specifying the primitives of the social welfare function: $\beta(\alpha)$, $u^i(\cdot,\cdot)$ and $\psi(\cdot)$. I stick to the functional form employed for the individual optimal tax simulations of Section 3:

$$P(A^i) = \frac{1}{p(c^i)^\nu} \tag{20}$$

This functional form is particularly useful because it allows to model preferences of the government with the use of a single parameter ν: for example, if $\nu = +\infty$ preferences correspond to the Rawlsian case, while if $\nu = 0$ the government displays Utilitarian preferences. More in general, ν can be interpreted in the following way: when disposable income is multiplied by N, the government values N^ν times less

marginal consumption.
Furthermore, this simple functional form choice makes it possible to solve the non-linear system of equations (18), without treating the Pareto weights as given.
Notice, however, that not only the Pareto weights are endogenous objects, but also the measure of each occupation set, $\mu(A^i)$, which so far have been taken as given. To take that into account the endogeneity of occupation measures when computing the optimal tax schedule the following procedure is employed:

1. Start from the existing occupational distribution and disposable income scheme. Given governmental preferences (which amounts to choose ν) the optimal tax schedule could be computed;

2. Compute the new distribution of households across the various occupations under the new tax schedule.

3. The new disposable income and the new $\mu(A^i)$ could be used as the starting point in order to repeat 1. and 2.

4. This procedure has to be iterated up to point of convergence which is the desired solution of the optimal taxation problem

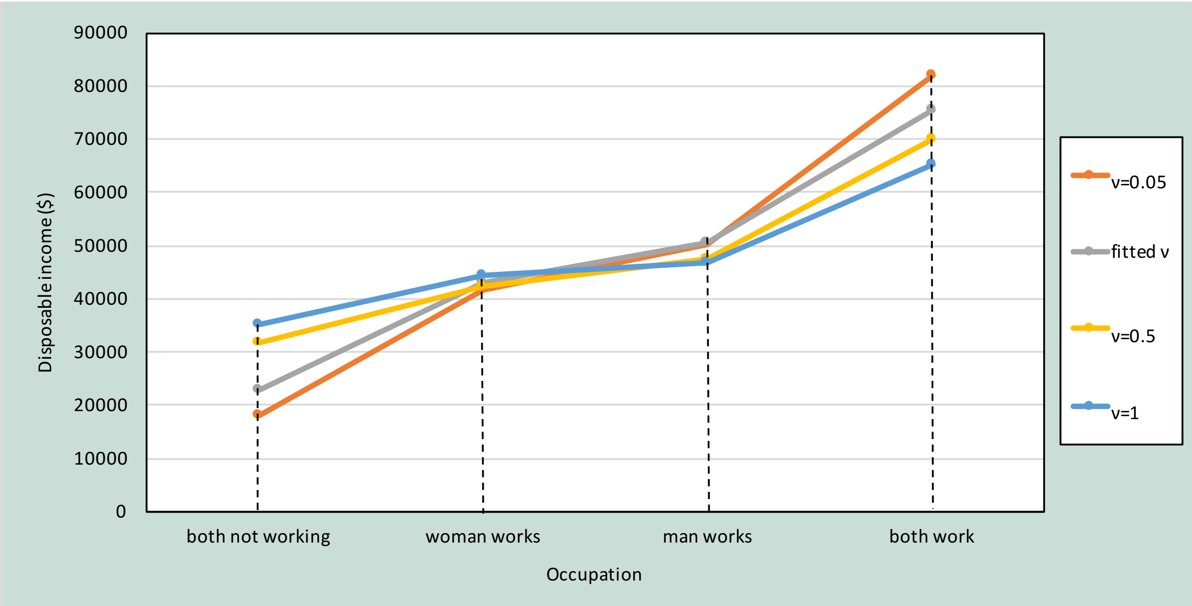
In particular, to compute the new household distribution across occupations in 2., the following relationship is employed:

$$\Delta\mu(A^i) = \sum_{j \neq i} \frac{\partial \mu(A^i)}{\partial c^j}(\Delta c^j - \Delta c^i) \tag{21}$$

which tell that the change in the measure of occupation i depends on how the disposable income in occupation i changes with respect to that in any other occupations, weighted for a term that positively depends on the elasticity between the two occupations. Given these behavioral responses the new measures of the occupation sets will be $\mu^{'}(A^i) = \mu(A^i) + \Delta\mu(A^i)$. Notice that the structure of this procedure does not guarantee a priori convergence of the algorithm. This issue is discussed in the Appendix C.

To perform simulations with values of Pareto weights that are comparable with actual redistributive preferences of American government, I am going to use the following procedure. By assuming the functional form (20) and using the "revealed" Pareto weights computed in the previous paragraph I estimate the ν which best fits their observed shape[4]. In this way, when the ν employed is the fitted one the optimal tax schedule is the existing one. Then, perturbing the chosen value for ν allows me to study how the optimal shape of the income tax schedule changes when varying the government redistributive preferences.

FIGURE 4. Simulation of disposable income for US couples

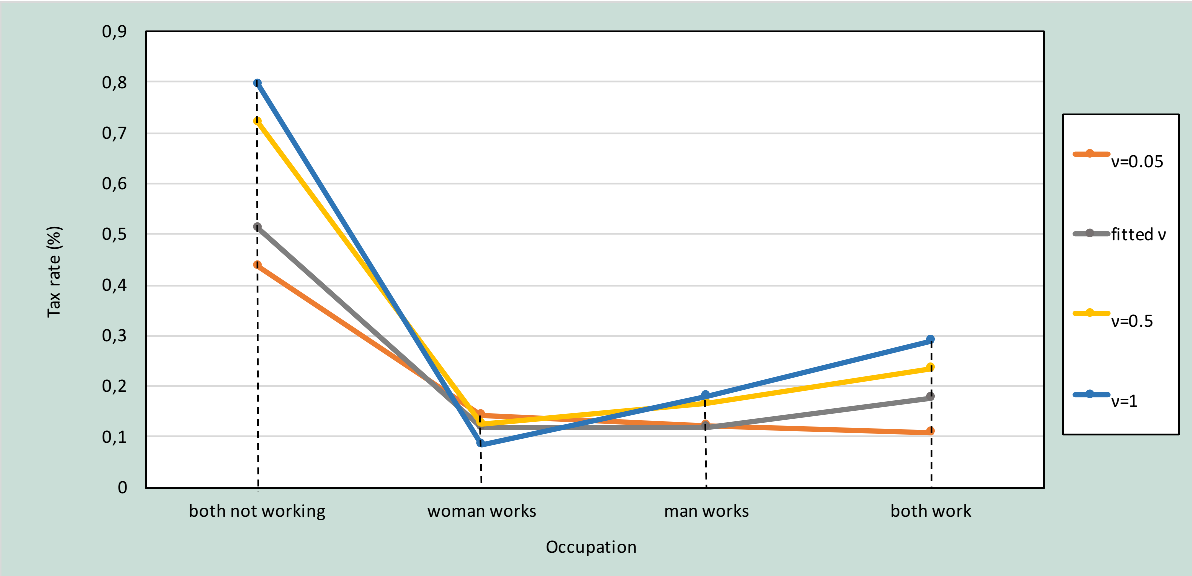


Notes: *Simulation of disposable income for US couples for different governmental redistributive preferences employing the participation elasticities of Table 2, Scenario 1. Fitted $\nu = 0.1412$. The considered couples are: couples in which both members are not working, one-earner couple with woman working, one-earner couple with man working, two earners couple. Computation by the author, data and simulation method presented in the present section.*

Results Figure 4 shows the disposable incomes associated to the optimal tax schedule computed solving the (non-linear) system (18). The different colored lines correspond to the optimal disposable incomes under various government redistributive preferences. Figure 5, instead, reports the optimal tax rates associated to the different occupations considered. Notice that in Figure 5, the tax rate associated to occupation $i = 0$ corresponds to the *average participation tax rate* which is computed as follows. First I calculate the participation tax rate for each spouse (conditional on his partner not working), defined as: (benefits of non working + taxes when working) / wage, and then I take the average between men and women participation tax rates. Notice the participation tax rate is inversely proportional to the average financial gain of an household member to enter the labor market (conditional on his/her partner

[4]The fitted value is $\nu = 0.1412$, which is obtained by averaging the results of the MSE minimization problem across the four elasticity scenarios considered.

FIGURE 5. Simulation of optimal tax rates for US couples



Notes: *Simulation of tax rates for US couples for different governmental redistributive preferences employing the participation elasticities of Table 2, Scenario 1. Fitted* $\nu = 0.1412$*. Tax rates are average tax rates, except for the couples in which both are not working, in this case the Participation Tax Rate is presented. The considered couples are: couples in which both members are not working, one-earner couple with woman working, one-earner couple with man working, two earners couple. Computation by the author, data and simulation method presented in the present section.*

not working). The other tax rates are instead the average tax rates associated to each occupation.

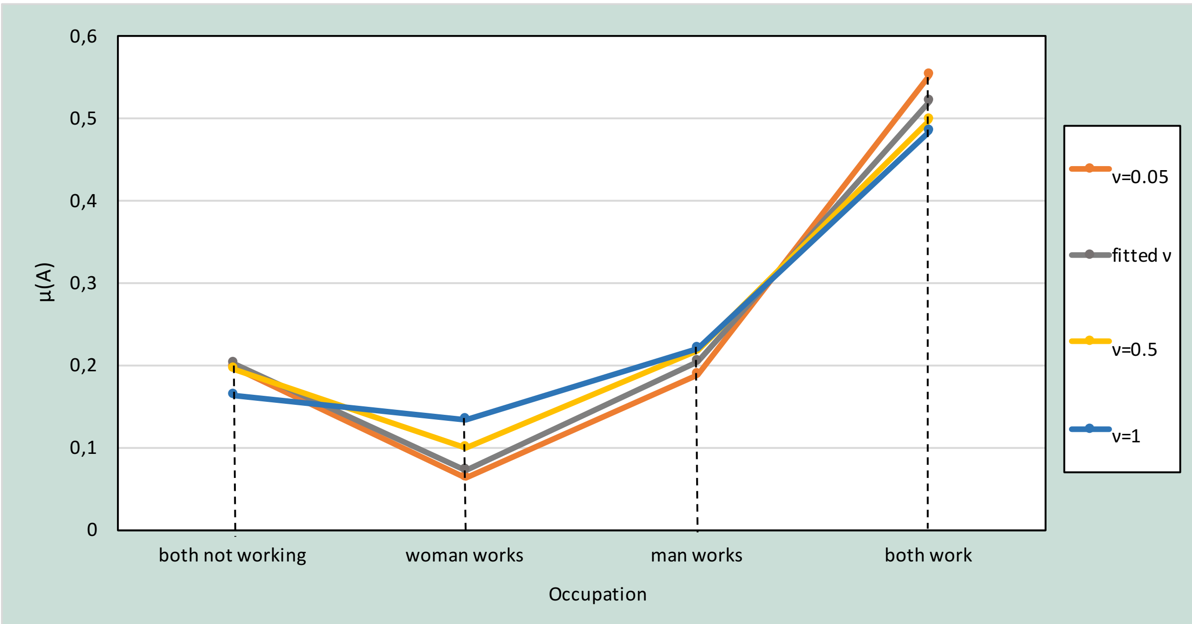
Notice that the gray line closely approximates the existing tax schedule for American households, since it's computed employing the "revealed" Pareto weights estimated in this Section.

The simulation shows that when increasing the redistributive tastes of the government (with respect to the actual preferences, gray line) the greatest variation in tax rates is associated to the non-working and the two-earners families: specifically, more redistribution implies higher subsidies to the non-working families that are taxed away from the two-earners families.

Now, notice that when redistributive preferences of the government are low (orange line) the average tax rate faced by household where only the woman is working is larger than the average tax rate faced by household where only the man is working.

Two contrasting forces determine this effect. One the one hand household with one-earner-woman are poorer, hence associated with a larger Pareto weight. However, the elasticity $\partial\mu(A^i)/\partial c^i$ is larger for the occupation with 1-earner-man with respect to the occupation with 1-earner-women[5]. Thus, when the government highly values redistribution the redistributive effect induced by the Pareto weight dominates, hence the average tax rate is larger for the occupation with 1-earner-man. Instead, when the redistributive preferences of the government are lower the elasticity effect dominates and the tax rate face by 1-earner-woman household is larger than that faced by 1-earner-man. This is exactly what we can observe in Figure 5: when $\nu = 1$ (that is when government has high preferences for redistribution) we observe a strictly increasing average tax schedule (apart from occupation $i = 0$), instead when governmental preferences for redistribution decrease ($\nu = 0.05$) the tax schedule is strictly decreasing.

FIGURE 6. Equilibrium occupational distribution for US simulation



Notes: *Equilibrium occupational distribution for US couples for different governmental redistributive preferences given the following participation elasticities:* $\eta_1^0 = 0.05$, $\eta_2^0 = 0.05$, $\tilde{\eta}_1^0 = 0.1$, $\tilde{\eta}_2^0 = 0.15$. *Fitted* $\nu = 0.1412$. *The considered couples are: couples in which both members are not working, one-earner couple with woman working, one-earner couple with man working, two earners couple. Computation by the author, data and simulation method presented in the present section.*

Finally, consider the equilibrium occupational distribution. First, notice that the measure of families in which both members work decreases when government preference for redistribution is higher. This is representative of the distortion of labor supply associated with higher taxation for 2-earners couples, which induces in some couples either the man or the woman to stop working. This increases the measure of

[5]Notice that in Scenario 1 (see Table 2) the participation elasticity of male and female as a first earner is the same. Instead, the participation elasticity of female as a second earner is larger than the elasticity of a male as a second earner. This explains why the elasticity of occupation $i = 1$ (only woman working) is lower than the elasticity of occupation 2 (only man working)

the sets A^1 and A^2. Lastly, notice that the number of families in which no members are working remains almost constant, only slightly affected by the size of the transfer these households receive. This is due to the low participation elasticity of primary earners. Only in case of $\nu = 1$ the number of families in which nobody works is significantly lower than in the other cases. This is essentially due to a particularly favorable taxation for one-earner families in which the woman is working, inducing many unemployed couples to switch to this occupation.

5 Conclusion

In this paper I used the general occupational choice framework of Laroque and Pavoni (2017) to simulate optimal income tax schedules for both individuals and couples in the U.S. economy. The flexibility of the framework has allowed to show how different assumptions about labor supply behavior (in particular whether agents respond on the intensive or extensive margin) lead to markedly different optimal tax structures.
In the case of individual taxation, simulations reveal that when only the extensive margin is active, the optimal tax system features negative marginal tax rates at the bottom of the income distribution to encourage participation. In contrast, under intensive-margin labor supply, the optimal schedule features a subsidy for unemployed individuals and positive marginal tax rates.
In the case of couple taxation, I specify the model so to account for joint labor supply decisions of couple members at the extensive margin. Using this framework, I recover the Pareto weights implicitly embedded in the current U.S. couple tax system. First, I show that they are consistent with a standard social welfare function (increasing in households' utility) and then use them to simulate optimal tax schedules varying government redistributive preferences. The results reveal how the interaction between Pareto weights and participation elasticities shapes the relative tax burden across household types. Noticeably, 1-earner-female households should receive a more favorable tax treatment then 1-earner-man households when government highly values redistribution, with the opposite result holding when preferences for redistribution are low.
Overall, this work has illustrated the flexibility of Laroque and Pavoni (2017) model to simulate and compare optimal tax schedules across different household structures and labor supply assumptions. Furthermore, the simplicity of the framework makes it especially useful for exploring the key trade-offs in tax design while enabling straight-

forward simulation of optimal policies across a broad set of economic environments.

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Appendices

A Data

TABLE 3. Empirical earning distribution calibration US 2018

Earnings level	Density weights	Cumulative distribution
0$	16,38%	16,38%
$1 to $2499	4,55%	20,93%
$2500 to $4999	3,16%	24,09%
$5000 to $7499	3,30%	27,39%
$7500 to $9999	2,27%	29,66%
$10000 to $12499	3,86%	33,52%
$12500 to $14999	1,86%	35,39%
$15000 to $17499	3,16%	38,55%
$17500 to $19999	2,04%	40,59%
$20000 to $24999	6,28%	46,87%
$25000 to $29999	5,23%	52,09%
$30000 to $34999	5,74%	57,84%
$35000 to $39999	4,54%	62,38%
$40000 to $44999	4,65%	67,03%
$45000 to $49999	3,45%	70,47%
$50000 to $54999	4,13%	74,61%
$55000 to $64999	5,45%	80,06%
$65000 to $74999	4,12%	84,18%
$75000 to $99999	6,44%	90,63%
$100000 or more	9,37%	100,00%

Notes: Earnings in year 2018 for working age population. Data taken from U.S. Census Bureau, 2018 American Community Survey 1-Year Estimates. Data are expressed in 2018 inflation adjusted dollars. Column 2-3 represent the density and the cumulative distribution, respectively, of each earning class. The classes have been chosen to be as consistent as possible with Saez (2002).

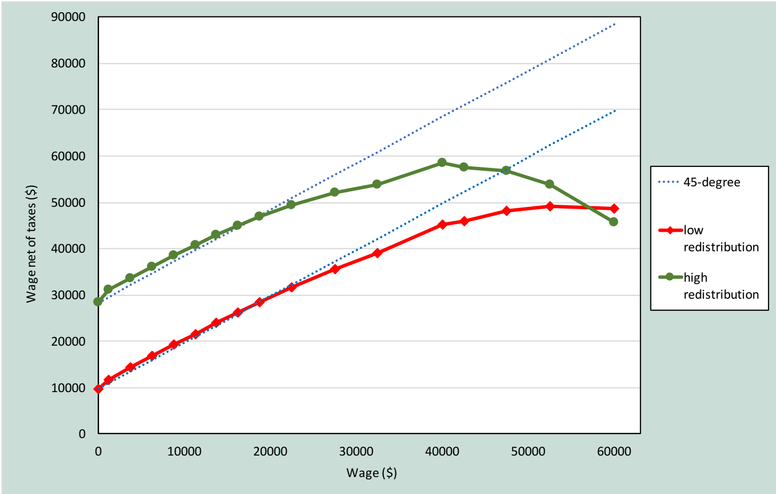
TABLE 4. US Marginal tax rates for 2018

Marg. Tax	Single	Married	Married Filing Separately	Head of Household
10%	0 - 9525	0 - 19050	0 - 9525	0 - 13600
12%	9526 - 38700	19051 - 77400	9526 - 38700	13601 - 51800
22%	38701 - 82500	77401 - 165000	38701 - 82500	51801 - 82500
24%	82501 - 157500	165001 - 315000	82501 - 157500	82501 - 157500
32%	157501 - 200000	315001 - 400000	157501 - 200000	157501 - 200000
35%	200001 - 500000	400001 - 600000	200001 - 300000	200001 - 500000
37%	500001+	600001+	300001+	500001+

Notes: 2018 marginal tax rates schedules, source: Department of the Treasury - your federal income tax for individuals. All tax brackets are expressed in dollars.

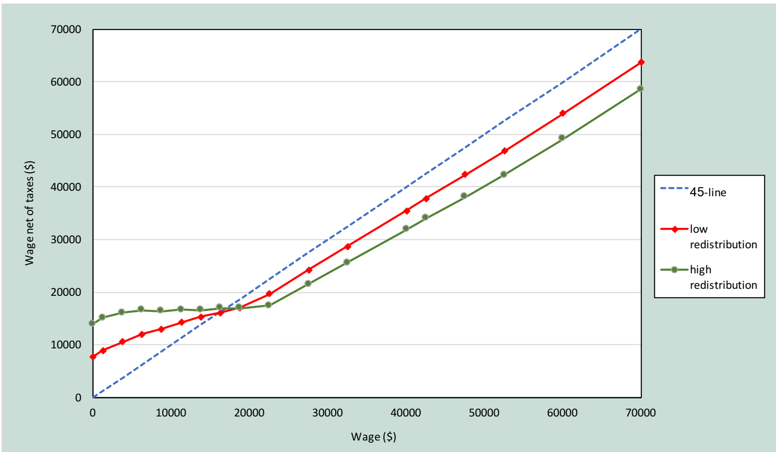
B Additional simulations

FIGURE 7. Optimal tax schedule with only extensive margin active - with interpolated elasticities



Notes: The simulation is carried on with the assumptions of Section 3.1 with the only difference that the elasticities are interpolated. Specifically, in order to determine the elasticities the following interpolating equation has been computed imposing a third degree polynomial on the participation elasticities provided by Ottaviano (2018): $1.07 \times 10^{-6}x^3 - 8 \times 10^{-5}x^2 - 0.0153x + 1.4025$ where x is the average cumulated density of each earning bracket.

FIGURE 8. Optimal tax schedule with only intensive margin active - with interpolated elasticities



Notes: The simulation is carried on with the assumptions of Section 3.2 with the only difference that the elasticities are interpolated. Specifically, in order to determine the elasticities the following interpolating equation has been computed imposing a third degree polynomial on the participation elasticities provided by Ottaviano (2018): $2.88 \times 10^{-6}x^3 - 2.84 \times 10^{-4}x^2 - 0.0123x + 0.3244$ where x is the average cumulated density of each earning bracket.

C Convergence of the algorithm for couple taxation simulations

The issue of convergence of the presented algorithm is not trivial and needs to be ad-

dressed. Consider the first iteration of the algorithm: the result of Step 1 is the optimal tax schedule given elasticities, redistributive preferences of the government and the initial distribution of couples into occupations. Especially when elasticities are very low (as in our case) for the government it is optimal to impose a lot of taxes on the the occupations associated with the lowest Pareto weights and to give a huge subsidy to those associated with the highest Pareto weights. This may determine as a result of Step 1 negative disposable incomes which do not make sense both from a theoretical point of view (the government cannot tax couples more than their labor gross income) and also from the point of view of the algorithm (it will deliver an error). The solution which is used to solve this problem is the following: the starting point of Step 2 is a weighted average of the solution of Step 1 and the values of the initial tax schedule, where the weights are chosen in order to assigned the maximum weight possible to the solution of Step 1 and to guarantee convergence of the algorithm. Some robustness checks have been performed in order to assess the results when choosing weights capable of ensuring the convergence of the algorithm and close to the optimal ones: this does not alter significantly the results of the procedure.
However, this procedure has a precise economic interpretation: it allows to implicitly include the constraints of non negativity of disposable income and to avoid negative measures of the sets A^i (which arise when the algorithm starts to diverge).