Optimal Taxation and Tax Complexity with Taxpayers Misperceptions*

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`Work in progress - Comments welcome`

Abstract

Complexity is a decisive feature of tax systems and a recent body of evidence reveals that it prompts taxpayers to underestimate taxes. Extending Mirrlees (1971) seminal optimal taxation model to allow for misperceptions, we investigate whether tax complexity may be a desirable policy tool in this environment. We think of tax complexity as the obfuscating features of the tax system and model it as an information cost. The higher the complexity, the more taxpayers prefer to rely on their priors about the tax scheme and the less elastic is their labor supply. We characterize the optimal policy – namely the optimal tax schedule and the optimal tax complexity – and show that complexity may be strictly positive at the optimum. This appears to be particularly relevant when priors are downward biased, a common result in most empirical studies.

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Introduction

May complexity be a desirable feature of tax systems? Though unanimously lamented by both taxpayers[1], economists and politicians, tax complexity is a common and decisive feature of tax systems. In particular, tax systems tend to feature a large number of overlapping tax instruments with intricate links. One may imagine several explanations as to why such complexity is observed. However, regardless of its origin, an important by-product of this complexity is that it confuses taxpayers and generates misperceptions of taxes (e.g. Abeler and Jäger (2015), Feldman et al. (2016)).

Building on these empirical findings, this paper develops a model of optimal income taxation with misperceptions in which we introduce tax complexity as a policy instrument to influence taxpayers' perceptions. We think of tax complexity as the obfuscating features of the tax system. Formally, we model tax complexity as information frictions rending the collection of information costly for taxpayers. These costs stand for taxpayers' time, attention and cognitive efforts to internalize taxes when making economic decisions. An increase in complexity will ultimately prompt agents to rely more on their priors about the tax schedule than on the true tax schedule thereby changing their labor supply decisions and reducing labor supply elasticities with respect to actual marginal tax rates.

For any well-defined distribution of priors, we characterize the optimal level of tax complexity as well as the optimal tax schedule. We show that these two policy instruments are intrinsically connected at the optimum and we observe deviations from standard optimal tax formulas when accounting for tax complexity. To build up the intuition, we first characterize the optimal policy assuming the tax schedule is linear, and then extend our analysis to non-linear tax schedules. While offering a first interesting setup to discuss the conditions for optimal complexity to be strictly positive, the non-linear setup turns out to be more interesting as it allows the government to implement more sophisticated strategies to exploit the potential gains from complexity.

Building on the seminal contribution of Mirrlees (1971), optimal redistributive taxation is determined as the solution to an equity-efficiency trade-off. On the one hand, when the government is inequality averse redistribution raises social welfare by reducing inequalities. On the other hand, because it reduces the gains from work, redistribution has a detrimental effect on incentives and is a source of inefficiency.

The introduction of misperceptions in this setup radically changes the equity-efficiency trade-off as it reduces the impact of taxes on taxpayers' labor supply. We assume agents

[1]In France, a recent survey indicates that 88 percent of taxpayers perceive the tax and transfer system as being complex (Ifop, March 2017).

act upon a perceived tax schedule. Without additional information, taxpayers have to rely on their priors about the tax schedule when deciding how much to work and consume. However, agents may have access to additional information to improve their belief about taxes and better internalize their impact on economic choices. Our preferred interpretation is a rational inattention model in which information collection – attention to the tax schedule – is an endogenous choice resulting from an arbitrage between the time, energy and monetary costs devoted to learn about the tax schedule and the utility costs from misoptimization. This offers a natural channel through which tax complexity may affect perceptions: attention costs. Hence, tax complexity is proxied by a monetary equivalent that corresponds to the attention cost of being fully aware of all the fiscal laws that potentially affect one's economic choices.

We characterize the optimal policy in this environment assuming that the government may effectively choose tax complexity through tax implementation. We show that the optimal policy, and in particular the desirability of tax complexity greatly depends on agents' priors of their marginal tax rates. It turns out that when priors are downward biased, a high level of complexity is desirable as it helps alleviating inefficiencies associated to taxes. On the other hand, when priors are upward biased, complexity is an undesirable feature of tax systems as the government would like perceived marginal tax rates to adjust downward in order to reduce the inefficiencies. Empirical evidence suggest that economic agents tend to underestimate marginal tax rates (e.g. Rees-Jones and Taubinsky (2016)) . Hence, according to our results, governments should implement complex tax schedule to maximize social welfare – even when accounting for misallocation and attention costs.

Our canonical application to a rational inattention setup takes priors as exogenous and then endogenously predicts the intensity of taxpayers' attention to the endogenous tax schedule. By imposing coherent assumptions on priors, it may thus be robust to the rational expectation critics raised to behavioral models with naive expectations. To illustrate how, we study an example where we consider that priors are uniformly distributed and unbiased on average. With such priors, the government is not willing to increase the tax rate as, otherwise, agent's priors would account for such increase and lead them to work less. Nevertheless, even without the tax rate channel – from which stem the first order gains to implementing a complex tax system – we report that a revenue maximizing and a Ralwsian government have an incentive to implement a strictly positive level of tax complexity. This is a consequence of the asymmetric willingness to observe the effective marginal tax rate as overestimating the marginal tax rate is relatively more distortive than underestimating it. As a result, complexity may prove to be useful even when taxpayers' priors are unbiased on average.

Related Literature. This paper relates to at least two strands of the literature. First, the salience literature shows that agents' response to tax instruments depends on how visible these instruments are. Chetty et al. (2009) provide evidence that consumers underreact to sales taxes that are not included in posted prices, even though consumers seem well informed about these taxes. Similarly, Finkelstein (2009) establishes that automatic toll payment system reduces the elasticity of driving with respect to the amount of the toll, although agents do not systematically underestimate this amount. On the theory side, Goldin (2015) analyses optimal sales taxes in a representative agent model when the government objective is to raise revenue. He shows that the optimal balance between a salient tax and a non-salient tax may allow the government to attain the first-best outcome (lump-sum taxation). Using an online shopping experiment, Taubinsky and Rees-Jones (2016) provide additional evidence on the heterogeneity of underreaction to non-salient sales taxes. In particular they show that rich individuals are less likely to underreact than poor individuals which increases the regressivity of the tax burden. Moreover, their results indicate that the degree of underreaction is decreasing in the tax rate which is consistent with the predictions of rational inattention models. The present paper contributes to this literature by studying optimal income taxation in a rational inattention setting where taxpayer perceptions of taxes come from exogenous priors and endogenous attention to taxes. Moreover, our model may reproduce most of the above stated empirical observation[2].

Second, is the strand of the literature concerned with agents' use of heuristic representations of complex tax schedules. In an early contribution, Liebman and Zeckhauser (2004) document the use of two simple heuristics, *ironing* -linearizing the tax schedule based on one's average tax rate- and *spotlighting* -linearizing the tax schedule based on one's marginal tax rate- and study their impact in a Mirrlees optimal income tax model. Using experimental data on predictions of amounts due for the US federal income tax, Rees-Jones and Taubinsky (2016) provide strong evidence of *ironing*, no evidence of *spotlighting* and a systematic tendency to underestimate marginal tax rates. The estimated misperceptions are welfare increasing as they reduce the efficiency cost of taxation and enhance redistribution. In a lab experiment, Abeler and Jäger (2015) analyse individual reactions to simple and complex tax systems. They show that in complex tax environments individuals do not make optimal choices and tend to underreact to the introduction of new taxes. Moreover, the degree of underreaction in their setting appears to be related with cognitive abilities but surprisingly not with the size of the incentive change. Finally, and closer to our paper, Farhi and Gabaix (2015) analyze optimal income taxation

[2] e.g. under-reaction to taxes, heterogeneity of misperceptions, richer individuals being more attentive to the tax schedule, a decreasing degree of underreaction when the tax increases.

problem with behavioral agents.[3] More precisely, they study a Mirrlees optimal income taxation problem in which agents' perception of their marginal tax rates depends on the marginal tax rates of others. In this setting, the choice of a non-linear tax schedule by the government generates misperceptions and thus optimization mistakes. Our contribution to this literature is to make normative recommendations on tax schedules and tax systems. In particular, a key contribution is to explicitly model tax complexity as a policy instrument for the government. To the best of our knowledge, this is the first paper to treat tax complexity as a policy instrument in the taxation literature. A however related contribution is that of Kleven and Kopczuk (2011) who study the optimal design of transfer programs where transfer complexity is modeled as a screening device for potential recipients and shown to be part of the optimal policy.

The paper is organized as follows. The first section extends the standard labor supply model to allow for the misperception of taxes. The second section characterizes optimal policy when the government uses a linear tax schedule and provides numerical simulations to illustrate the theoretical results. The third section derives the optimal policy when the government may use an unconstrained non-linear tax schedule. The last section concludes.

1 Labor Supply with Misperceptions

Labor supply is central to any discussion of the equity-efficiency trade-off. In this section we extend the standard static labor supply model to economic agents who imperfectly observe the tax schedule.

We consider an economy in which taxpayers differ in terms of productivity w. Productivities are distributed from a cumulative distribution function $F(.)$ and the population size is normalized to one. Each agent has a utility function $\mathcal{U}(c, y, w) = u(c) - v(y, w)$ where c is consumption, y earnings, w productivity and $v(y, w)$ represents disutility to work. We assume utility is increasing in consumption ($u' > 0$) and decreasing in effort ($v_y > 0$, $v_w < 0$).

An agent chooses its consumption and labor supply to maximize its utility subject to a budget constraint where its earnings are subject to the tax schedule $T(y) : \mathbb{R}^+ \mapsto \mathbb{R}$ implemented by the government. We assume taxpayers misperceive the tax schedule and are thus going to act upon a perceived tax schedule $\tilde{T}(y)$. To construct this perceived tax

[3]Gerritsen (2015) and Lockwood (2016) are other treatments of optimal income taxation with behavioral agents less closely related to our setup.

schedule, agents are going to rely on their priors about the tax schedule and on additional information they may collect.

A taxpayer of productivity w holds priors about the tax schedule, here assumed exogenous. These priors consist of a finite sequence of coefficients $\{\hat{p}_n\}_{n=1}^N$ such that, without additional information, an agent perceived tax schedule is $\hat{T}(y) = \mathcal{T}(y; (\{\hat{p}_n\}_{n=1}^N)_i)$ where $\mathcal{T} : \mathbb{R}^+ \mapsto \mathbb{R}^+$ is a function that maps the finite sequence of parameters to a continuous function of y. We impose that the perceived marginal tax rates must be less than one by making the assumption that the priors are such that $\mathcal{T}'(y; (\{\hat{p}_n\}_{n=1}^N)_i) \leq 1 \ \forall y \in \mathbb{R}^+$. Priors are distributed according to a well-defined conditional probability distribution function $f(\{\hat{p}_n\}_{n=1}^N | w)$. In the paper, we further assume that $\mathcal{T}(y; (\{\hat{p}_n\}_{n=1}^N)_i)$ is a linear approximation of the tax schedule. While restrictive, linearization of the tax schedule has been largely used in the taxation literature and remains a good approximation of most real life tax systems. Moreover, it allows to restrict the set of priors to $N = 2$ where $\hat{p}_1$ represents the intercept of the tax schedule r and $\hat{p}_2$ its slope τ.

In addition, we assume agents have access to a costly technology allowing them to sharpen their approximation of the tax system. This technology stands for the time, money and cognitive costs devoted by taxpayers to understand fiscal laws. Agents have an incentive to use it to reduce utility misallocation costs from misperceptions. Formally, the perceived tax schedule after collecting information is $\tilde{T}(y) = \mathcal{T}(y; (\{\tilde{p}_n\}_{n=1}^2 | y^*)_i)$ where $(\{\tilde{p}_n\}_{n=1}^N | y^*)_i$ are the updated parameters given the information collected by the agent. These coefficients are updated given the following rule

$$\tilde{p}_n = \theta p_n(y^*) + (1 - \theta)\hat{p}_n \qquad \forall n \in \{1, \ldots, N\} \tag{1}$$

where $\theta \in [0, 1]$ is a measure of information collection and $p_n(y^*)$ is the n^{th} coefficient associated to the *best* local approximation $\mathcal{T}(y; \{p_n\}_{n=1}^N | y^*)$ of the true tax schedule. We assume that this *best* local approximation $\mathcal{T}(y; \{p_n\}_{n=1}^N | y^*)$ is such that $\mathcal{T}(y^*; \{p_n\}_{n=1}^N | y^*) = T(y^*)$ and $\mathcal{T}_y(y^*; \{p_n\}_{n=1}^N | y^*) = T'(y^*)$, namely it has to be exact in level and slope at y^*. These two constraints exactly identify the parameters $\{p_n\}_{n=1}^2 | y^*$. Specification (1) may be interpreted as the expected result from a signal extraction where the weights $\{\theta_n\}_{n=1}^N$ are a decreasing function of the signal variance (i.e. the information content of the signal as measured by the reduction in Shanon entropy before and after receiving a signal). In line with the rational inattention literature, we model attention as an agent's choice resulting from the following optimization program:

$$\max_{\{\theta_n\}_{n=1}^N \in [0,1]^N} V(w, r, T(y)) - \Phi_U(\{\theta_n\}_{n=1}^N; \kappa) \tag{2}$$

where $V(y, r, T(y))$ is an agent's indirect utility and $\Phi_U(\{\theta_n\}_{n=1}^N; \kappa)$ denotes the utility cost of collecting and understanding information on the tax schedule. We assume these perceptions costs are increasing with respect to choice variables $\{\theta_n\}_{n=1}^N$ and increasing with the complexity of the tax system parametrized by κ.

To the best of our knowledge, this paper is the first one to examine the consequences of endogenous attention allocation within a taxation framework; a novelty that will prove to be essential when it comes to understanding the government incentives to optimally set the complexity of the tax system.

To sum up, taxpayers' behavior results from solving an outer and an inner problems. The outer problem consists in choosing how much attention to pay to the tax schedule following equation (2) in order to update their perception of the tax schedule. Then, the inner problem is to choose consumption and labor to maximize utility given agent's perceived budget constraint featuring agent's perceived tax schedule.

We use the concept of misperception equilibriums formalized in Rees-Jones and Taubinsky (2016) as our definition of equilibrium in this static environment. Formally, y^* is a misperception equilibrium if $y^* \in \arg\max_y \mathcal{U}(y - \tilde{T}(y|y^*) -, y, w)$ where $\tilde{T}(y|y^*) = \mathcal{T}(y; \{\{\tilde{p}_n\}_{n=1}^N\}_i|y^*)$. Alternatively saying, it means that taxpayers budget constraint holds with the true tax liability $T(y^*)$ in equilibrium. In the setup developed in this paper, a necessary and sufficient condition for misperception equilibria is that the perceived tax schedule is such that $\tilde{T}(y^*|y^*) = T(y^*)$, i.e. the perceived tax schedule is exact in level at y^*. While restrictive, these equilibria are the only stable equilibria in a dynamic environment where taxpayers have to pay $T(y^*)$ at the end of each period, regardless of their ex ante perception of taxes. Rees-Jones and Taubinsky (2016) show the existence and uniqueness of a misperception equilibrium when the tax schedule $T(y)$ is convex.

The misperception model developed in this section remains quite general and allows to consider multiple forms of misperceptions. More specifically, through the distribution of priors, one may easily introduce ironing behaviors ($\hat{\tau}$ equal to agent's *average* tax rate) or study the effect from introducing a non-salient tax ($\hat{\tau}$ equal to zero); two types of misperceptions that have been widely identified as good representations of agents' misunderstanding of the tax system (see Rees-Jones and Taubinsky (2017) for a review).

Canonical Application. We conclude this section by providing a self-contained illustration of taxpayers' problem in a model of rational inattention. Rational inattention has at least two appealing features in this context.

First, it implies that rich agents are more attentive to the tax schedule than poor agents as they have higher incentives to do so. This is intuitively appealing, in line with the empirical evidence provided by Taubinsky and Rees-Jones (2016) and is potentially important for redistributive concerns in complex tax systems.

Second, rational inattention endogenously generates a downward bias of perceived marginal tax rates – as long as the priors are not too upward biased – which seems to be the empirically relevant case. While this result is trivial when priors are downward biased, it also holds when priors are unbiased – or when the upward bias is small enough –. Indeed, the convexity of work disutility $v(y, w)$ prompts agents to pay more attention to the tax system when they hold high priors about marginal tax rates than when they hold low ones. Hence if priors are ex-ante unbiased, they will be ex-post biased downwards which will have important implications for the desirability of tax complexity.

Assume taxpayers' priors about the tax system are such that $\hat{T}(y) = \hat{r} + \hat{\tau} y$. Taxpayers' inner problem writes

$$\max_{c,y} \quad \mathcal{U}(c, y, w) = u(c) - v(y, w)$$
$$s.t. c \leq y - \tilde{T}(y|y)$$

where $\tilde{T}(y|y) = T(y)$ and $\tilde{T}'(y|y) = \theta_2 T'(y) + (1-\theta_2)\hat{\tau}_i$. The first order condition of this problem is:

$$\frac{\partial \mathcal{U}}{\partial c}[1 - (\theta_2 T'(y) + (1-\theta_2)\hat{\tau}_i)] + \frac{\partial \mathcal{U}}{\partial y} = 0$$

Taxpayers' outer problem is to allocate attention rationally by solving the following

$$\begin{aligned} \{\theta_n^*\}_{n=1}^2 \quad &= \quad \arg \sup_{\{\theta_n^*\}_{n=1}^2} \mathcal{U}(y - T(y), y, w) - \Phi_U(\{\theta_n\}_{n=1}^2; \kappa) \\ \text{s.t.} \quad & \quad \frac{\partial \mathcal{U}}{\partial c}[1 - (\theta_2 T'(y) + (1-\theta_2)\hat{\tau})] + \frac{\partial \mathcal{U}}{\partial y} = 0 \\ & \quad 0 \leq \theta_n \leq 1 \qquad \forall n \in \{1, 2\} \end{aligned}$$

where $\Phi_U(\kappa(y)) = \kappa(\theta_1^\alpha + \theta_2^\alpha)$ is the utility cost of attention and $\alpha \geq 1$. Assuming utility is quasi linear – i.e. $\mathcal{U}(c, y, w) = c - (y/w)^{1+\epsilon}/(1+\epsilon)$ – as in the simulations reported along the paper, there is no income effect and one can show that $\theta_1 = 0$ as consumption and thus the level of tax liability does not enter in agent's labor supply choice. Hence we center our discussion on priors about marginal tax rates $\{\hat{\tau}\}$ – which are of first-order importance – and disregard priors about the intercept $\{\hat{r}\}$ although they would play a role in the general case with income effects.

2 Illustration: Optimal Policy with Linear Taxes

In this section, we provide an illustration of our main findings when the government uses a linear tax schedule. This allows us to highlight the mechanisms at work without introducing the heavy formalism required to deal with non-linear tax schedules which we turn to in the next section. We write the government problem and then derive formulas for the optimal tax rate and the optimal complexity that we interpret and illustrate by providing numerical simulations.

Government Problem. In this setting, the government has two policy instruments: the tax schedule and tax complexity. Assuming the tax schedule is linear, we write $T(y) = r + \tau y$ where r is a lump-sum amount (demogrant) and τ is the marginal tax rate in the economy. The government chooses (r, τ) and the complexity parameter κ governing agents attention costs to maximize a social welfare function subject to its resource constraint with an exogenous spending requirement E:

$$\max_{r,\tau,\kappa} \quad \int_0^\infty G\Big(\mathcal{U}(c + (1-\tau)y^*(.), y^*(.), w) - \Phi_U(\theta^*(.); \kappa)\Big) f(w)dw$$
$$s.t \int_0^\infty \tau y^*(.)) f(w)dw \geq r + E$$

The associated Lagrangian writes

$$\mathcal{L} \;=\; \int_0^\infty \Big[G\Big(\mathcal{U}(r + (1-\tau)y^*(.), y^*(.), w) - \Phi_U(.)\Big) + p\Big(\tau y^*(.) - r - E\Big)\Big] f(w)dw$$

Note that writing the problem in this way implicitly assumes that individuals priors $\{\hat{\tau}(w)\}_w$, utility perception costs $\Phi_U(\theta;\kappa)$ and the formation process of perceived marginal tax rates $\{\tilde{\tau}(w)\}_w$ are known to the government. While this assumption is not straightforward, we adopt it as a benchmark case to determine the optimal policy of a benevolent government. The optimal policy would naturally be different if these elements were imperfectly observed by the government or subject to uncertainty.

Following custom in the taxation literature, we capture the government redistributive tastes through (endogenous) social marginal welfare weights $g(w) = \frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c}$. Given this objective, we now characterize the optimal schedule and the optimal complexity of the tax system through three propositions that formally correspond to the three first order conditions of the government problem.

Optimal Tax Formulas. To highlight the intuitions and the economic mechanisms behind the propositions, we derive proofs using a tax reform approach.

Proposition 1. *The optimal linear tax rate τ is such that*

$$\frac{\tau}{1-\tau} = \frac{1 - \bar{g}_{y^*} - \bar{g}_{\frac{\tilde{\tau}-\tau}{1-\tau}y^*\xi} - \bar{g}_{d\Phi}}{\xi_{Y^*}}$$

with

$$
\begin{aligned}
Y^* &= \int_0^\infty y^*(w)f(w)dw \\
\bar{g}_{y^*} &= \frac{1}{Y^*}\int_0^\infty g(w)y^*(w)f(w)dw \\
\bar{g}_{\frac{\tilde{\tau}-\tau}{1-\tau}y^*\xi} &= \frac{1}{Y^*}\int_0^\infty g(w)(\tilde{\tau}-\tau)\frac{y^*(w)}{1-\tau}\xi(.)f(w)dw \\
\bar{g}_{d\Phi} &= \frac{1}{Y^*}\int_0^\infty g(w)\frac{\partial\Phi}{\partial\theta}\left[\frac{\partial\theta^*}{\partial\tau} - \frac{\partial\theta^*}{\partial y}\frac{y^*(w)}{1-\tau}\xi(w)\right] f(w)dw \\
\xi(w) &:= \frac{1-\tau}{y^*(w)}\frac{dy^*}{d(1-\tau)} = -\frac{\frac{\partial y^*}{\partial\theta}\frac{\partial\theta^*}{\partial\tau}+\frac{\partial y^*}{\partial\tau}}{1-\frac{\partial y^*}{\partial\theta}\frac{\partial\theta^*}{\partial y}}\frac{1-\tau}{y^*(w)} \\
\xi_{Y^*} &:= \frac{1-\tau}{Y^*}\frac{dY^*}{d(1-\tau)} = \frac{1}{Y^*}\int_0^\infty y^*(w)\xi(w)f(w)dw
\end{aligned}
$$

where the elasticity of labor supply with respect to the marginal net-of-tax rate $\xi(w)$ depends on perceptions of taxes and encapsulates the circularity effect stemming from the endogeneity of these perceptions.

Proof. Let consider the Lagrangian associated with the objective of the government and a reform that consists in an increase $\Delta\tau$ of the marginal tax rate. The impact of this reform on the Lagrangian is given by

$$
\frac{d\mathcal{L}}{p} = \int_0^\infty \left\{\frac{G'(V)}{p}dV + y^*(.)d\tau + \tau dy^*\right\} f(w)dw
$$

where the terms correspond respectively to a welfare effect, a mechanical revenue increase and a behavioral response that reduces revenue. We show that the welfare effect can be decomposed into a mechanical consumption loss, a component related to the misallocation induced by the misperception ($\tilde{\tau} \neq \tau$) and the change in perceptions costs

$$
dV = -\frac{\partial\mathcal{U}}{\partial c}y^*(.)d\tau + \frac{\partial\mathcal{U}}{\partial c}(\tilde{\tau}-\tau)dy^* - \frac{\partial\mathcal{U}}{\partial c}\frac{\partial\Phi}{\partial\theta}d\theta^*
$$

We thus have to characterize the changes dy^*, $d\theta^*$ induced by the reform $d\tau = \Delta\tau$. Since $y^*(\theta,\tau,\hat{\tau},w)$ and $\theta^*(y,\tau,\hat{\tau},\kappa,w)$ are implicitly defined as functions of one another, a reform induces a circularity effect in the sense that it induces a change in labor supply, thus a change in perceptions and thus a subsequent change in labor supply followed by a subsequent change in perceptions, etc. The total change in labor and perceptions thus solve the following fixed-point problem

$$
\begin{aligned}
dy^* &= \frac{\partial y^*}{\partial\theta}d\theta^* + \frac{\partial y^*}{\partial\tau}\Delta\tau \\
d\theta^* &= \frac{\partial\theta^*}{\partial y}dy^* + \frac{\partial\theta^*}{\partial\tau}\Delta\tau
\end{aligned}
$$

where we use the fact that $d\hat{\tau} = 0$ due to our assumption that priors are exogenous and thereby not affected by the reform. This yields

$$\begin{aligned} dy^* &= \frac{\frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial \tau} + \frac{\partial y^*}{\partial \tau}}{1 - \frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial y}}\Delta\tau := -\frac{y^*(.)}{1-\tau}\xi(.)\Delta\tau \\ d\theta^* &= \left[\frac{\partial \theta^*}{\partial \tau} - \frac{\partial \theta^*}{\partial y}\frac{y^*(.)}{1-\tau}\xi(.)\right]\Delta\tau \end{aligned}$$

where the elasticity of labour supply with respect to the marginal net-of-tax rate $\xi(.)$ features, by definition, this circularity effect stemming from the endogeneity of perceptions. We can now fully characterize the impact of the reform

$$\begin{aligned} \frac{d\mathcal{L}}{p} &= \int_0^\infty \Big\{ \frac{G'(V)}{p}\left(-\frac{\partial \mathcal{U}}{\partial c}y^*(.)d\tau + \frac{\partial \mathcal{U}}{\partial c}(\tilde{\tau}-\tau)dy^* - \frac{\partial \mathcal{U}}{\partial c}\frac{\partial \Phi}{\partial \theta}d\theta^*\right) \\ &\quad + y^*(.)d\tau + \tau dy^* \Big\} f(w)dw \end{aligned}$$

Introducing social welfare weights $g(w) = \frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c}$ and plugging-in previous expressions we get

$$\begin{aligned} \frac{d\mathcal{L}}{p} &= \int_0^\infty \Big\{ -g(w)\left(y^*(.) + (\tilde{\tau}-\tau)\frac{y^*(.)}{1-\tau}\xi(.) + \frac{\partial \Phi}{\partial \theta}\left[\frac{\partial \theta^*}{\partial \tau} - \frac{\partial \theta^*}{\partial y}\frac{y^*(.)}{1-\tau}\xi(.)\right]\right)\Delta\tau \\ &\quad + y^*(.)\Delta\tau - \tau\frac{y^*(.)}{1-\tau}\xi(.)\Delta\tau \Big\} f(w)dw \end{aligned}$$

Characterizing the optimal linear tax rate by the optimality condition $d\mathcal{L} = 0$ yields

$$\frac{\tau}{1-\tau} = \frac{\int_0^\infty \left\{ y^*(.) - g(w)\left(y^*(.) + (\tilde{\tau}-\tau)\frac{y^*(.)}{1-\tau}\xi(.) + \frac{\partial \Phi}{\partial \theta}\left[\frac{\partial \theta^*}{\partial \tau} - \frac{\partial \theta^*}{\partial y}\frac{y^*(.)}{1-\tau}\xi(.)\right]\right)\right\} f(w)dw}{\int_0^\infty y^*(.)\xi(.)f(w)dw}$$

Dividing the numerator and the denominator by $Y^* = \int_0^\infty y^*(.)f(w)dw$ gives the proposition since

$$\xi_{Y^*} := \frac{1-\tau}{Y^*}\frac{dY^*}{d(1-\tau)} = \frac{1-\tau}{Y^*}\int_0^\infty \frac{dy^*}{d(1-\tau)}f(w)dw = \frac{1}{Y^*}\int_0^\infty y^*(w)\xi(w)f(w)dw$$

□

In a standard framework (e.g. Mirrlees (1971), Saez (2001)), the optimal linear tax rate is determined by the trade-off between the distortionary effect of taxes (ξ_{Y^*}) and the redistributive effects ($1 - \bar{g}_{y^*}$). This trade-off is still the dominant force in our formula, however with quantities that embody misperceptions of the tax schedule. In particular, the more complex the tax system, the more individuals rely on their priors, the less elastic the labor supply and *ceteris paribus* the higher the tax rate. This constitutes the basic appeal of tax complexity.

In addition, two new correction terms corresponding to two new welfare effects appear. The first term ($\bar{g}_{\frac{\tilde{\tau}-\tau}{1-\tau}y^*\xi}$) corresponds to a utility misallocation cost whenever individuals suffer from misperceptions ($\tilde{\tau} \neq \tau$). Absent misperceptions the change in behavior induced by the reform does not have a first-order effect on welfare by a standard envelope argument. This argument is no longer valid since misperceptions imply imperfect optimization and a failure of the envelope theorem. Suppose an individual overperceives marginal tax rates ($\tilde{\tau} \geq \tau$) and thus supplies a too low quantity of labor from an allocation perspective. Then this correction term is positive and accordingly pushes the optimal tax rate downwards. Indeed, by setting a lower marginal tax rate, the government induces this individual to work more which increases his utility by getting him closer to his optimal allocation. Conversely, if an individual underperceives marginal tax rates ($\tilde{\tau} \leq \tau$), this pushes optimal tax rate upwards. Hence, this correction term pushes for a divergence of optimal tax rates away from individuals' priors.

In contrast, the second term ($\bar{g}_{d\Phi}$) which relates to utility perception costs pushes for a convergence of optimal tax rates towards individuals' priors. In a rational inattention framework the intuition is straightforward: the wider the gap between τ and $\tilde{\tau}$ the higher the incentives to pay attention to the true tax schedule and thereby the higher the attention and the associated utility perception costs. This first-order effect is accompanied by a more subtle, and in general second-order, effect that occurs through the endogeneity of perceptions. A higher level of labor supply prompts higher incentives to pay attention to the true tax schedule. This complementary effect thus pushes, regardless of priors' level, for higher tax rates as a mean to reduce labor supply.

Note that the strength and quantitative importance of these two correction terms naturally depend on the parametrization of individuals' utility functions, their priors and on the level of tax complexity implemented by the government.

The previous proposition fully characterizes the optimal tax rate τ given social welfare weights $g(w)$ defined up to a normalization by the social marginal costs of public funds p – the Lagrange multiplier of the budget constraint – which we now pin down. Note that, as the proof shows, this normalization is derived from the first-order condition in r to the government problem. The level of the lump-sum transfer r is itself determined by the equilibrium of the government budget constraint.

Proposition 2. *At the optimum, the marginal cost of public funds p is given by*

$$p = \int_0^\infty G'(V(w))\frac{\partial \mathcal{U}}{\partial c} f(w)dw \iff \int_0^\infty g(w)f(w)dw = 1$$

Proof. Let consider a reform that consists in a uniform lump-sum increase in taxes Δr. Absent income effects, there are no behavioral reactions and the impact of the reform simply amounts to a mechanical welfare (consumption) loss and a mechanical revenue gain

$$d\mathcal{L} = \int_0^\infty \left[-G'(V(w)) \frac{\partial \mathcal{U}}{\partial c} \Delta r + p \Delta r \right] f(w) dw$$

Characterizing the optimum by the optimality condition $d\mathcal{L} = 0$ yields the result. □

We next characterize the optimal complexity for the tax system

Proposition 3. *Suppose κ may take values in $[0, \bar{\kappa}]$. If the optimal level of complexity belongs to the interior of this set, it is characterized by*

$$\frac{1}{\kappa} = -\frac{\bar{g}_{(\tilde{\tau}-\tau)\frac{y^*}{\kappa}\xi^\kappa} - \bar{g}_{d\Phi}}{\tau \xi^\kappa_{Y^*}}$$

with

$$\begin{aligned}
\bar{g}_{(\tilde{\tau}-\tau)\frac{y^*}{\kappa}\xi^\kappa} &= \frac{1}{Y^*} \int_0^\infty g(w) (\tilde{\tau} - \tau) \frac{y^*}{\kappa} \xi^\kappa(.) f(w) dw \\
\bar{g}_{d\Phi} &= \frac{1}{Y^*} \int_0^\infty g(w) \left[\frac{\partial \Phi}{\partial \theta} \left(\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \theta^*}{\partial y} \frac{y^*}{\kappa} \xi^\kappa(.) \right) + \frac{\partial \Phi}{\partial \kappa} \right] f(w) dw \\
\xi^\kappa_{Y^*} &:= \frac{\kappa}{Y^*} \frac{dY^*}{d\kappa} = \frac{1}{Y^*} \int_0^\infty y^* \xi^\kappa(w) f(w) dw
\end{aligned}$$

Proof. Let again consider the Lagrangian associated to the government problem

$$\mathcal{L} = \int_0^\infty \left[G\Big(\mathcal{U}(r + (1-\tau) y^*(.), y^*(.), w) - \Phi_U(\theta^*(.), \kappa) \Big) + p\Big(\tau y^*(.) - r - E \Big) \right] f(w) dw$$

and a reform that consists in an increase in complexity $\Delta\kappa$. This reform induces a revenue effect and a welfare effect that can be decomposed into a misallocation term ($\tilde{\tau} \neq \tau$) and a perception costs term. Formally, the impact of this reform on the Lagrangian is given by

$$\frac{d\mathcal{L}}{p} = \int_0^\infty \left\{ \frac{G'(V)}{p} \left[\frac{\partial \mathcal{U}}{\partial c} (\tilde{\tau} - \tau) dy^* - \frac{\partial \mathcal{U}}{\partial c} \left(\frac{\partial \Phi}{\partial \theta} d\theta^* + \frac{\partial \Phi}{\partial \kappa} d\kappa \right) \right] + \tau dy^* \right\} f(w) dw$$

We thus have to characterize the changes dy^*, $d\theta^*$ induced by the reform $d\kappa = \Delta\kappa$. Since $y^*(\theta, \tau, \hat{\tau}, w)$ and $\theta^*(y, \tau, \hat{\tau}, \kappa, w)$ are implicitly defined as functions of one another, they solve the following fixed-point problem

$$\begin{aligned}
dy^* &= \frac{\partial y^*}{\partial \theta} d\theta^* \\
d\theta^* &= \frac{\partial \theta^*}{\partial y} dy^* + \frac{\partial \theta^*}{\partial \kappa} \Delta\kappa
\end{aligned}$$

where we use the fact that $d\hat{\tau} = 0$ due to our assumption that priors are exogenous and not affected by the complexity of the tax system. This yields

$$\begin{aligned}
dy^* &= \frac{\frac{\partial y^*}{\partial \theta} \frac{\partial \theta^*}{\partial \kappa}}{1 - \frac{\partial y^*}{\partial \theta} \frac{\partial \theta^*}{\partial y}} \Delta\kappa := \frac{y^*}{\kappa} \xi^\kappa(.) \Delta\kappa \\
d\theta^* &= \left[\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \theta^*}{\partial y} \frac{y^*}{\kappa} \xi^\kappa(.) \right] \Delta\kappa
\end{aligned}$$

which allows us to get the following expression for the impact of a reform

$$\frac{d\mathcal{L}}{p} = \int_0^{\infty} \left\{ g(w)(\tilde{\tau} - \tau)\frac{y^*}{\kappa}\xi^{\kappa}(.) - g(w)\left[\frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \theta^*}{\partial y}\frac{y^*}{\kappa}\xi^{\kappa}(.)\right) + \frac{\partial \Phi}{\partial \kappa}\right] + \tau\frac{y^*}{\kappa}\xi^{\kappa}(.)\right\} \Delta\kappa \, dF(w)$$

Characterizing the optimum by the optimality condition $d\mathcal{L} = 0$ yields

$$\frac{1}{\kappa} = -\frac{\int_0^{\infty} \left\{ g(w)(\tilde{\tau} - \tau)\frac{y^*}{\kappa}\xi^{\kappa}(.) - g(w)\left[\frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \theta^*}{\partial y}\frac{y^*}{\kappa}\xi^{\kappa}(.)\right) + \frac{\partial \Phi}{\partial \kappa}\right] + \right\} \; dF(w)}{\tau \int_0^{\infty} y^* \xi^{\kappa}(w) f(w) dw}$$

□

An increase in complexity generate three effects: a revenue effect ($\tau \xi^{\kappa}_{Y^*}$), a welfare effect linked to misallocation ($\bar{g}_{(\tilde{\tau}-\tau)\frac{y^*}{\kappa}\xi^{\kappa}}$) and a welfare effect related to perceptions costs ($\bar{g}_{d\Phi}$). The optimal level of complexity trades-off these three effects.

The revenue effect is a revenue gain if priors about the marginal tax rates are on average downward biased. Indeed, an increase in complexity induces agents to rely more heavily on their priors, which in this case induces a decrease in perceived marginal tax rates. This prompts agents to work more and thus generates a revenue gain. Again, this is the basic appeal of tax complexity. In contrast, if priors are on average upward biased, an increase in complexity will trigger an undesirable revenue loss. Numerical simulations below suggest that this is the dominant effect when setting tax complexity.

The welfare effect linked to misallocation unambiguously pushes towards low levels of complexity since an increase in complexity always induce a higher reliance on priors and thus larger misallocations. Formally, when on average $\tilde{\tau} > \tau$ then on average $\xi^{\kappa} < 0$ and $\bar{g}_{(\tilde{\tau}-\tau)\frac{y^*}{\kappa}\xi^{\kappa}} < 0$. Conversely, when on average on average $\tilde{\tau} < \tau$ then on average $\xi^{\kappa} > 0$ such that again $\bar{g}_{(\tilde{\tau}-\tau)\frac{y^*}{\kappa}\xi^{\kappa}} < 0$.

The welfare effect related to perceptions costs pushes towards low levels of complexity to the first-order since the direct effect of an increase in complexity is to increase perceptions costs. Naturally, a counteracting second-order effect is at work since an increase in complexity induces individuals to pay less attention to the tax schedule as incentives to do so are reduced. Moreover, it prompts to the third-order a change in individual labor supply which again prompts a change in attention. However the direction of this change depends on the direction of the labor supply reaction which depends again on the upward or downward bias of the priors.

Numerical Simulations. We now turn to numerical simulations to characterize optimal policy in benchmark cases and emphasize the main economic mechanisms at the heart of the government arbitrage. These illustrative simulations are realized in our canonical application with rational inattention and a quasi-linear utility function. While the optimal policy of the government will ultimately be affected by the introduction of a non-linear tax schedule, understanding the model predictions for linear taxes is a natural step.

The discussion is articulated around the role of taxpayers' priors. We consider two benchmarks for priors: (i) when taxpayers' beliefs are homogenous and potentially biased and (ii) when taxpayers' priors about the tax system are uniformly distributed and unbiased on average. The problem of the government is then to choose the welfare maximizing tax rate τ^* and complexity κ^* given taxpayers' priors and an attention cost function $\Phi(\theta, \kappa)$.

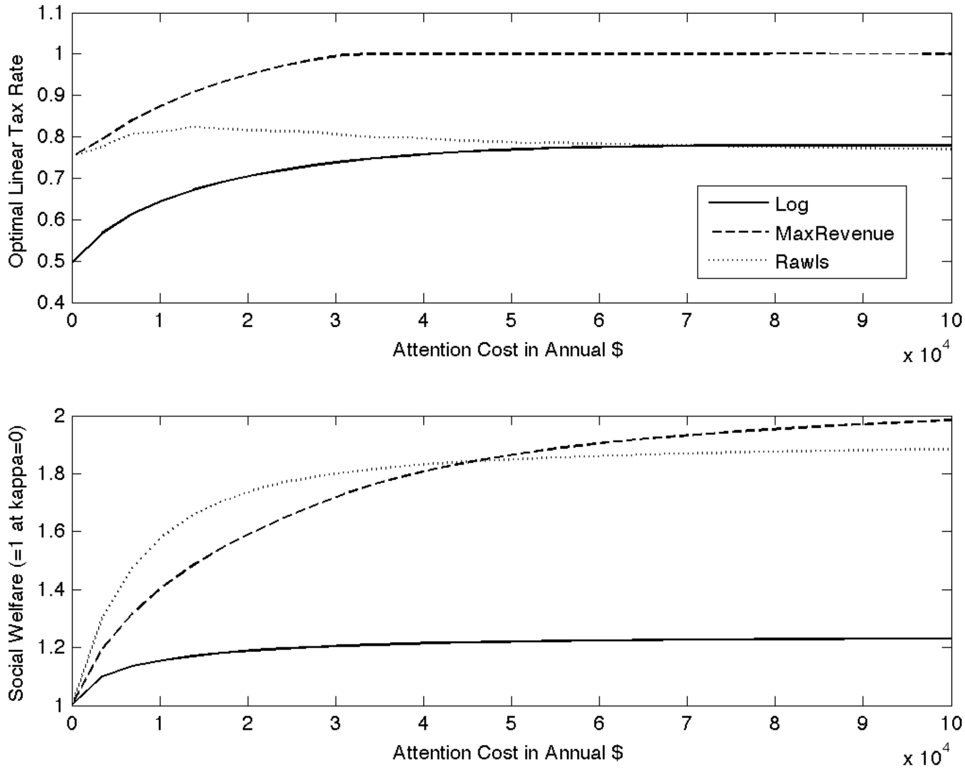
When priors are exogenous and identical across taxpayers, the government optimal policy depends on agents' priors position compared to the optimal policy *absent complexity*. If priors about marginal tax rates[4] are higher than the optimal marginal tax rate *absent complexity*, the government wants to implement as much complexity as possible. Conversely the government prefers to implement the simplest tax schedule when priors about marginal tax rates are lower than the optimal marginal tax rate *absent complexity*.

To understand this statement, consider an economy where each taxpayer's prior is set to zero. This trivial example may be rationalized by the fact that taxpayers may believe taxes are lump-sum before getting any information about the tax system, by the fact that taxes are not salient or that taxpayers solve a sparse max problem à la Gabaix (2014). With such priors, an inequality averse government always implements as much complexity as possible. This intuition is as follows: starting from an equilibrium without complexity, an increase in complexity will lower the perceived marginal rate as understanding fiscal laws gets more difficult. Therefore, the government may increase the tax rate while keeping elasticities to the true tax constant. Hence, the more productive workers will not decrease their labor supply, so that the social welfare is ultimately an increasing function of the tax complexity. Nevertheless, it is interesting to note that the marginal gains from complexity on social welfare are decreasing. Indeed, when κ is already high, taxpayers' attention to the tax schedule is low so that an increase in complexity has little effect. As a result, the social welfare gain from complexity is asymptotically bounded.

Simulations show that the optimal tax rate is asymptotically bounded as well and, strangely enough, that it doesn't necessarily converge to a confiscatory tax equal to 100%. This is because when agents do not observe the tax system, their labor choice is far from optimal. Thus, if the social welfare is a weighted integral of taxpayers' well-being, the government has an incentive to limit utility misallocation costs. Therefore, it lowers the tax rate to ensure that the distance between taxpayers' priors and the actual tax rate is not too important. As a result, we observe that the welfare maximizing tax rate is lower

[4] Again, with a quasi-linear utility function, there is no income effects and priors about the intercept of the tax system does not play a role in the choices made by the agent.

Figure 1: Optimal Tax and Complexity when Priors are Downward Biased



Note: The exogenous priors are set to $\hat{\tau} = 0$ for all taxpayers. The model is calibrated using 2016 CPS data and a quasi-linear iso-elastic utility with an elasticity of 0.33. These simulations are preliminary and presented only to illustrate the government's arbitrage.

than 100% whenever the social welfare function accounts for taxpayers utility i.e. for a Log or Rawlsian social welfare function but not for a revenue maximizing government.

Hence an interesting and surprising feature of optimal taxation with complex tax schedules is that a revenue maximizing government and a Rawlsian government have different incentives. While the former increases taxes as much as possible given taxpayers' sensitivity to the true tax rate, there exists a threshold complexity such that the latter prefers to decrease taxes in order to lower the utility cost from misperceptions of the worst-off taxpayer. As we argued, this last result is the consequence of the existence of utility misallocation costs related to misperceptions. Our simulations indicate a somehow even more surprising result: as the tax schedule becomes more and more complex, the optimal tax rate of a Rawlsian government converges to the optimal tax rate of a government with a Log social welfare function. This is due to the fact that when taxpayer's prior are set to zero, the first-best allocation is attained as complexity converges to infinity, meaning that all utility levels are equalized.

These illustrative simulations thus suggest that the complexity of the tax schedule is important when setting the optimal tax rate. Hence, fiscal policy recommendations must account for real-life complexity of tax schedules as it might radically affect optimal policies.

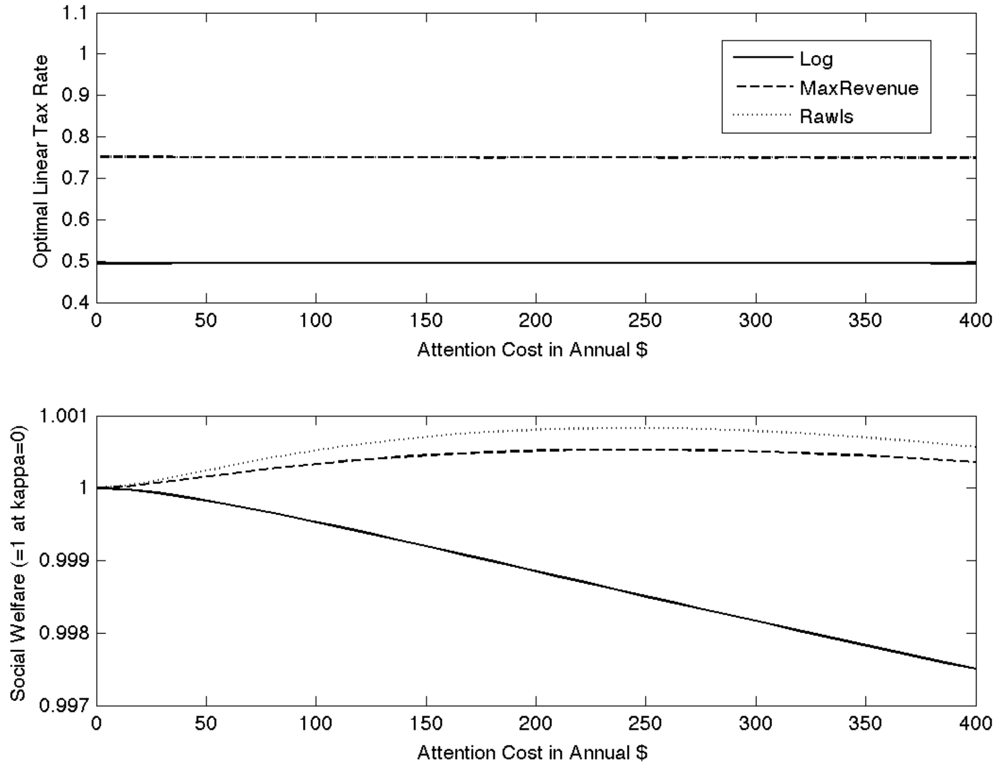
Symmetrically, one may show that complexity is an undesirable feature of the tax system when priors are upward biased with respect to the optimal policy *absent complexity*. Moreover, when priors are unbiased and identical across consumers, we are back to the standard taxation model and the complexity of the economy has no impact on agents' behavior. Although the assumption of homogenous biased priors simplifies the problem and allows us to emphasize the role of tax complexity in the economy and the new arbitrage of the government, it seems largely unrealistic. More specifically, these priors are for example not robust to the introduction of dynamic learning. We therefore turn to the study of an unbiased distribution of priors to assess its impact for optimal taxation.

Our canonical rational inattention misperception model is also well-suited to account for heterogenous priors across taxpayers. A case of special interest is when taxpayers' beliefs are unbiased and distributed from a uniform distribution around the true tax. Unbiased priors lead the government to set the optimal tax rate close to the optimal one without complexity since distortions of taxpayers's labor choice will not all go in the desired direction. Hence, the channel through which complexity may be an optimal feature of tax systems is more subtle here. Consider two taxpayers A and B with the same productivity w_i but different priors $\hat{\tau}_A = \tau^* + \Delta$ and $\hat{\tau}_B = \tau^* - \Delta$. The convexity of work disutility $v(y, w)$ implies that the marginal cost from misoptimization is larger for A than for B. Thus, A will be willing to devote more time and attention to understand fiscal laws. As a result, the average perceived tax rate after collecting information is lower than the actual tax rate, while priors were unbiased a priori. There might be a gain from complexity as long as the average optimal labor choice of agents A and B is larger than the labor choice of an agent who observes the tax rate perfectly. Alternatively saying, the government may have an incentive to implement a complex tax system if and only if it increases aggregate income sufficiently to cover the induced welfare costs.

Figure 2 reports the optimal tax rate and complexity with such priors. As explained above, optimal tax rates are almost constant. The social welfare functions are however affected by the tax complexity and the model predicts the existence of an optimal positive level of tax complexity. For a Ralwsian social welfare and a revenue maximizing government, the optimal level of complexity is strictly positive. This is not the case anymore with a log social welfare that accounts for the utility costs from misoptimization[5].

[5]If the government's objective was to maximize a weighted integral of log consumptions, then it

Figure 2: Optimal Tax and Complexity with Unbiased Heterogenous Priors



Note: Priors are heterogenous and such that $\int_{\mathbb{R}+} \hat{\tau}_i dF(i) = \tau^\star$ where $\tau^\star$ is the government optimal tax rate. The model is calibrated using 2016 CPS data and a quasi-linear iso-elastic utility with an elasticity of 0.33. These simulations are preliminary and presented only to illustrate the government's arbitrage.

The estimated welfare gains from complexity seem low, about 0.1%. This is however not surprising knowing that we are implicitly studying the worst-case scenario as regards to the conditions under which complexity may be optimal. Namely, we are assuming that priors are unbiased ex-ante, thus eliminating the main channel through which complexity may be a desirable feature of tax systems. Though not consistent with empirical evidence about the perceptions about taxes that suggest priors are biased downward this example leads to a major conclusion: the optimal tax complexity may be strictly positive in a world with rational taxpayers who on average correctly observe the tax scheme.

From the above examples one may conjecture the following implications: (i) if priors are unbiased and negatively correlated with productivities, then there exists an optimal positive level of complexity, (ii) if taxpayers's priors are the result of ironing, then the government has an incentive to implement a progressive and complex tax system.

These first simulations were introduced to provide insights on how complexity may

would be optimal to implement a positive level of complexity.

affect the predictions of standard taxation models. They show that, according to the distribution of priors, complexity may lead to tremendous variations in optimal tax rates. Moreover, we saw that even in a rational world where economic agents observe correctly the true tax rate on average, the optimal level of tax complexity might be positive depending on the government's objective. In this section, we only considered a linear tax system. Allowing the government to implement a non-linear tax schedule will prove to be essential as it offers new instruments to potentially increase the gains from tax complexity. Moreover, it will be a natural setup to introduce more realistic forms of beliefs such as *ironing*. Hence, the next section derives the optimal behavior of the government when taxes are potentially non-linear.

3 Optimal Non-Linear Taxation and Tax Complexity

The problem of the government is to choose a non-linear tax schedule $\{T(y)\}_{y\geq 0}$ with complexity κ to maximize a social welfare function subject to its resource constraint with an exogenous spending requirement E:

$$\max_{\{T(y)\}_{y\geq 0};\ \kappa} \quad \int_0^\infty G\Big(\mathcal{U}(y^*(.) - T(y^*(.)), y^*(.), w) - \Phi_U(.)\Big) f(w)dw$$
$$s.t \int_0^\infty T(y^*(.))f(w)dw \geq E$$

Following custom in the taxation literature, we capture the government redistributive tastes through (endogenous) social marginal welfare weights $g(w) = \frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c}$. Given this objective, we now characterize the optimal schedule and the optimal complexity of the tax system.

Proposition 4. *Assuming that there exists an increasing mapping $y|_w : w \to y^*(\theta^*(., w), w)$ between skills w and income y, the optimal non-linear tax schedule verifies at each income $y = y^*(w^r)$*[6]

$$\begin{aligned}
\frac{T'(y^*(w^r))}{1 - T'(y^*(w^r))} &= \frac{1}{\xi(.)}\frac{\frac{dy|_w}{dw}(w^r)}{y^*(w^r)}\frac{1 - F(w^r)}{f(w^r)}\int_{w=w^r}^\infty (1 - g(w))\frac{f(w)}{1 - F(w^r)}dw \\
&+ g(w^r)\frac{T'(y^*(w^r)) - \tilde{T}'(y^*(w^r))}{1 - T'(y^*(w^r))} \\
&+ g(w^r)\left(\frac{\frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau}T''\right)}{1 - T'(y^*(w^r))} - \frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \tau}\right)
\end{aligned}$$

[6] Je réalise qu'il y a deux fonctions $y^*(.)$ différentes. $y^*(.) = y^*(\theta, \tau, \hat{\tau}, w)$ et $y^*(.) = y|_w := w \mapsto y^*(\theta^*(., w), \tau, \hat{\tau}, w)$. Je vais régler ça demain !

where $\xi(.)$ denotes the total elasticity of labor supply encapsulating all circularity effects and $\Phi(.)$ is the perception cost function associated to the perception of $\tilde{T}'(y^*(w^r))$.

Proof. Let consider the Lagrangian associated with the objective of the government

$$\mathcal{L} = \int_0^\infty \left[G\Big(\mathcal{U}(y^*(.) - T(y^*(.)), y^*(.), w) - \Phi_U(.)\Big) + p\Big(T(y^*(.)) - E\Big)\right] f(w)dw$$

and a reform that consists in a uniform increase $\Delta\tau^r$ of marginal tax rate in $[y^r - \Delta y^r, y^r]$. As long as $y^*|_w : w \to y^*(\theta^*(., w), \tau, \hat{\tau}, w)$ is strictly increasing[7] we can map this interval of income to an interval of skills $[w^r - \Delta w^r, w^r]$ with $\Delta y^r \approx \frac{dy^*|_w}{dw}(w^*)\Delta w^r$. The change in the Lagrangian associated to the reform is

$$\frac{d\mathcal{L}}{p} = \int_{w=0}^{w=w^r-\Delta w^r} \frac{dL_1(w)}{p} f(w)dw + \int_{w=w^r-\Delta w^r}^{w=w^r} \frac{dL_2(w)}{p} f(w)dw + \int_{w=w^r}^{\infty} \frac{dL_3(w)}{p} f(w)dw$$

Assuming their perceived marginal tax rate does not change after the reform, agents below $w^r - \Delta^r w$ are not affected:

$$dL_1(w) = 0$$

Assuming their perceived marginal tax rate does not change after the reform, agents above w^r are only affected by a lump-sum increase in tax liability $\Delta\rho^r = \Delta\tau^r\Delta y^r$ to which they do not react absent income effects:

$$\frac{dL_3(w)}{p} = \left(1 - \frac{G'(V(.))}{p}\frac{\partial\mathcal{U}}{\partial c}\right)\Delta\tau^r\Delta y^r$$

The key difficulty is to characterize $dL_2(w)$

$$\frac{dL_2(w)}{p} = \frac{G'(V(w))}{p} dV + \tau dy^*$$

We show

$$dV = \frac{\partial\mathcal{U}}{\partial c}(\tilde{\tau} - \tau)dy^* - \frac{\partial\mathcal{U}}{\partial c}\frac{\partial\Phi}{\partial\theta}d\theta^*$$

We thus have to characterize dy^* and $d\theta^*$ induced by the reform $\Delta\tau^r$. Since $y^*(\theta, \tau, \hat{\tau}, w)$ and $\theta^*(y, \tau, \hat{\tau}, \kappa, w)$ are implicitly defined as fixed-point solutions, they are jointly deter-

[7] This standard monotonicity assumption usually follows from a Spence-Mirrlees single-crossing condition and imposes a restriction on the tax schedule chosen by the government. Here we directly impose this assumption which puts restrictions on both utilities, priors and the tax schedule chosen by the government.

mined by the system

$$\begin{aligned}
dy^* &= \frac{\partial y^*}{\partial \theta} d\theta + \frac{\partial y^*}{\partial \tau} d\tau \\
d\theta^* &= \frac{\partial \theta^*}{\partial y} dy^* + \frac{\partial \theta^*}{\partial \tau} d\tau \\
d\tau &= \Delta\tau^r + T''(y^*)dy^*
\end{aligned}$$

where the last equality follows from the fact that with a non-linear tax system the effective marginal tax rate $\tau = T'(y^*)$ changes both exogenously with the reform by $\Delta\tau^r$ and endogenously through labor supply adjustments by $T''(y^*)dy^*$. This system yields

$$\begin{aligned}
dy^* &= \frac{\frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial \tau} + \frac{\partial y^*}{\partial \tau}}{1 - \left(\frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial \tau} + \frac{\partial y^*}{\partial \tau}\right) T'' - \frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial y}} \Delta\tau^r := -\frac{y}{1-\tau}\xi(.)\Delta\tau^r \\
d\theta^* &= \left[\frac{\partial \theta^*}{\partial \tau} - \left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau} T''\right) \frac{y}{1-\tau}\xi(.)\right] \Delta\tau^r \\
d\tau &= \left[1 - \frac{y}{1-\tau}\xi(.)T''\right] \Delta\tau^r
\end{aligned}$$

where the elasticity of labour supply $\xi(.)$ features circularity from non-linearity of T (standard circularity term) and endogeneity of $\tilde{T}$ through attention θ (new circularity terms). Hence, we get

$$dV = \frac{\partial \mathcal{U}}{\partial c} \left[(\tau - \tilde{\tau}) + \frac{\partial \Phi}{\partial \theta} \left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau} T''\right)\right] \frac{y}{1-\tau}\xi\Delta\tau^r - \frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \tau}\Delta\tau^r$$

which finally allows us to characterize $dL_2(w)$

$$\begin{aligned}
\frac{dL_2}{p} &= \left\{\frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c} \left[(\tau - \tilde{\tau}) + \frac{\partial \Phi}{\partial \theta} \left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau} T''\right)\right] - \tau\right\} \frac{y}{1-\tau}\xi\Delta\tau^r \\
&\quad - \frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c}\frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \tau}\Delta\tau^r
\end{aligned}$$

Introducing social welfare weights $g(w) = \frac{G'(V)}{p}\frac{\partial \mathcal{U}}{\partial c}$ and using a first-order approximation of $dL_2(w)$ at w^r, we finally obtain the total effect of the reform

$$\begin{aligned}
\frac{d\mathcal{L}}{p} &= \frac{dL_2(w^r)}{p} f(w^r)\Delta w^r + \int_{w=w^r}^{\infty} \frac{dL_3(w)}{p} f(w)dw \\
&= \left\{g(w^r) \left[(\tau - \tilde{\tau}) + \frac{\partial \Phi}{\partial \theta} \left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau} T''\right)\right] - \tau\right\} \frac{y}{1-\tau}\xi\Delta\tau^r f(w^r)\Delta w^r \\
&\quad - g(w^r)\frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \tau}\Delta\tau^r f(w^r)\Delta w^r + \int_{w=w^r}^{\infty} (1 - g(w))\Delta\tau^r \frac{dy|_w}{dw}(w^*)\Delta w^r f(w)dw
\end{aligned}$$

Characterizing the optimal tax system by the optimality condition $\frac{d\mathcal{L}}{p} = 0$, a rearrangement of terms yields:

$$\begin{aligned}
\frac{T'(y^*(w^r))}{1-T'(y^*(w^r))} &= \frac{1}{\xi(.)}\frac{\frac{dy|_w}{dw}(w^r)}{y^*(w^r)}\frac{1-F(w^r)}{f(w^r)}\int_{w=w^r}^{\infty}(1-g(w))\frac{f(w)}{1-F(w^r)}dw \\
&+ g(w^r)\frac{T'(y^*(w^r))-\tilde{T}'(y^*(w^r))}{1-T'(y^*(w^r))} \\
&+ g(w^r)\left(\frac{\frac{\partial\Phi}{\partial\theta}\left(\frac{\partial\theta^*}{\partial y}+\frac{\partial\theta^*}{\partial\tau}T''\right)}{1-T'(y^*(w^r))}-\frac{\partial\Phi}{\partial\theta}\frac{\partial\theta^*}{\partial\tau}\right)
\end{aligned}$$

□

The first line simply corresponds to an adaptation of the standard Saez (2001) formula with $y^*(.)$ and $\xi(.)$ incorporating misperceptions of the tax schedule. If we are to assume agents debiasing does not occur too rapidly which is the case with rational inattention, when agents overestimate tax rates, income will be relatively lower and elasticity relatively higher pushing towards lower optimal tax rates. In contrast, when agents underestimate tax rates, income will be relatively higher and elasticity relatively lower pushing towards higher optimal tax rates. The remaining terms on the right hand side are specific to our setup with endogenous misperceptions[8].

The second term corresponds to the direct welfare change induced by the reform when individuals are not perfect utility maximizers due to their misperceptions ($T' \neq \tilde{T}'$) and the envelope theorem no longer applies. Notice that this term pushes the optimal tax rate upward when agents underestimate marginal tax rates ($T' > \tilde{T}'$) and downward when agents overestimate marginal tax rates ($T' < \tilde{T}'$). Indeed, the government wants to correct individual behavior meaning increasing (resp. decreasing) taxes when agents work too much (resp. too little). In a nutshell, this term magnifies any pre-existing difference between the prior and the actual tax rate.

The third term relates to the utility costs incurred by the agents for their effort to better perceive the tax system. In the large bracket, the term on the left is positive and pushes *ceteris paribus* optimal tax rates upwards because lower tax rates increase labor supply, thus attention and thus perception costs. In contrast, the other term in the bracket pushes optimal tax rates towards agents priors since larger differences between their prior and their actual tax rate induce agents to pay more attention to the tax schedule and thus incur higher perceptions costs. In a nutshell, this term reduces any pre-existing difference between the prior and the actual tax rate.

The previous proposition characterizes the shape of the optimal tax schedule given social welfare weights $g(w)$ up to a normalization by the social marginal costs of public

[8]They correspond to the behavioral wedge in the work of Farhi, Gabaix (2017).

funds p – the Lagrange multiplier of the budget constraint – which we now pin down:

Proposition 5. *At the optimum, the marginal cost of public funds p is given by*

$$p = \int_0^\infty G'(V(w))\frac{\partial \mathcal{U}}{\partial c} f(w)dw \iff \int_0^\infty g(w)f(w)dw = 1$$

Proof. Let consider a reform that consists in a uniform lump-sum increase in taxes $\Delta\rho$. Absent income effects, there are not behavioral reaction and the impact of the reform is simply given by

$$d\mathcal{L} = \int_0^\infty \left[-G'(V(w))\frac{\partial \mathcal{U}}{\partial c}\Delta\rho + p\Delta\rho\right] f(w)dw$$

Characterizing the optimum by the optimality condition $d\mathcal{L} = 0$ yields the result. □

We next characterize the optimal complexity for the tax system

Proposition 6. *Suppose $\kappa \in [0, \bar{\kappa}]$. If the optimal level of complexity is interior, it is characterized by*

$$\kappa = \frac{\int_0^\infty \left\{T' - g(w)\left[(T' - \tilde{T}') + \frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau}T''\right)\right]\right\} y\xi_\kappa f(w)dw}{\int_0^\infty g(w)\left(\frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \Phi}{\partial \kappa}\right) f(w)dw}$$

Proof. Let consider a reform that consists in an increase in complexity $\Delta\kappa$. The impact of the reform is given by

$$\frac{d\mathcal{L}}{p} = \int_0^\infty \frac{dL}{p} f(w)dw$$

where the impact on each individual writes

$$\frac{dL}{p} = \frac{G'(V)}{p}\left[\frac{\partial \mathcal{U}}{\partial c}(1 - T')dy^* + \frac{\partial \mathcal{U}}{\partial c}dy^* - \frac{\partial \mathcal{U}}{\partial c}d\Phi\right] + T'dy^*$$

Recognizing that $\Phi = \Phi(\theta, \kappa)$ we have $d\Phi = \frac{\partial \Phi}{\partial \theta}d\theta^* + \frac{\partial \Phi}{\partial \kappa}d\kappa$ where $d\kappa$ is simply equal to $\Delta\kappa$. We thus have to characterize dy^* and $d\theta^*$ induced by the reform. Since $y^*(\theta, \tau, \hat{\tau}, w)$ and $\theta^*(y, \tau, \hat{\tau}, \kappa, w)$ are implicitly defined as fixed-point solutions, they are jointly determined by the system

$$\begin{aligned} dy^* &= \frac{\partial y^*}{\partial \theta}d\theta + \frac{\partial y^*}{\partial \tau}d\tau \\ d\theta^* &= \frac{\partial \theta^*}{\partial y}dy^* + \frac{\partial \theta^*}{\partial \tau}d\tau + \frac{\partial \theta^*}{\partial \kappa}d\kappa \\ d\tau &= T''(y^*)dy^* \end{aligned}$$

This system yields

$$\begin{aligned} dy^* &= \frac{\frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial \kappa}}{1 - \left(\frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial \tau} + \frac{\partial y^*}{\partial \tau}\right)T'' - \frac{\partial y^*}{\partial \theta}\frac{\partial \theta^*}{\partial y}}\Delta\kappa := \frac{y}{\kappa}\xi_\kappa(.)\Delta\kappa \\ d\theta^* &= \left[\frac{\partial \theta^*}{\partial \kappa} + \left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau}T''\right)\frac{y}{\kappa}\xi_\kappa(.)\right]\Delta\kappa \\ d\tau &= T''\frac{y}{\kappa}\xi_\kappa(.)\Delta\kappa \end{aligned}$$

Thus,

$$\frac{dL}{p} = \left\{ T'\frac{y}{\kappa}\xi_\kappa(.) - g\left[(T' - \tilde{T}')\frac{y}{\kappa}\xi_\kappa(.) + \frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau}T'' \right)\frac{y}{\kappa}\xi_\kappa(.) + \left(\frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \Phi}{\partial \kappa} \right) \right] \right\} \Delta\kappa$$

Characterizing the optimum by the optimality condition $d\mathcal{L} = 0$ yields

$$\kappa = \frac{\int_0^\infty \left\{ T' - g(w)\left[(T' - \tilde{T}') + \frac{\partial \Phi}{\partial \theta}\left(\frac{\partial \theta^*}{\partial y} + \frac{\partial \theta^*}{\partial \tau}T'' \right) \right] \right\} y\xi_\kappa f(w)dw}{\int_0^\infty g(w)\left(\frac{\partial \Phi}{\partial \theta}\frac{\partial \theta^*}{\partial \kappa} + \frac{\partial \Phi}{\partial \kappa} \right) f(w)dw}$$

□

An increase in complexity induces changes in perceptions and thus labor supply that entail two effects: a revenue effect and a welfare effect. At the individual level, the revenue effect (first term of the numerator) is a revenue gain if the reform makes the individual work more ($\xi_\kappa > 0$) which happens when the agent underestimates taxes ($\tilde{\tau} < \tau$ i.e. $\hat{\tau} < \tau$) and an increase in complexity prompts him to rely more heavily on his prior and thus underestimate taxes even more. Otherwise, an increase in complexity is associated to a revenue loss.

The welfare effect relates to misallocation and perceptions costs. An increase in complexity prompts an increase in the difference $T' - \tilde{T}'$ and thus in the associated utility misallocation costs. In addition, an increase in complexity κ translates into an increase of perception costs. Direct perception costs incurred as fixed costs upon the reform appear in the denominator as a scaling factor while indirect perception costs through variations of perceptions that stem from changes in y are featured in the numerator.

These effects are aggregated across individuals to determine the optimal complexity of the tax system. In our calibration, when all individuals underestimate taxes, the revenue gains prominently dominate and the government wishes to implement the most complex tax system to prevent upward adjustment of perceived tax rates. Conversely, when all individuals overestimate taxes, there are only losses to increasing complexity and the government wishes to implement the least complex tax system to allow for downward adjustment of perceived tax rates.

4 Conclusion

We introduce endogenous misperceptions of taxes to an otherwise standard taxation model in order to study the potential gains from tax complexity. Contrary to the idea that tax complexity is an inefficient characteristics of tax systems, we show that it may be part of the optimal policy.

Indeed, tax complexity reduces labor supply elasticities to effective tax rates, thus relaxing the equity-efficiency trade-off. Under realistic distributions of taxpayers' priors about taxes, we show that tax complexity may be used as a novel instrument to increase social welfare, even when accounting for misallocation and attention costs. Moreover, the implementation of non-linear tax schedules helps the government to increase the potential benefits from tax complexity.

Although preliminary, these results nonetheless underline the importance of taxpayers' priors about taxes and their impact for the desirability of tax complexity. The introduction of a non-linear tax schedule is in this regard particularly promising as it will let us study important forms of misperceptions that have been widely documented in the literature, such as ironing. We plan to extend our work in two directions. First, the priors distribution could be the result of some form of learning process. Hence, they may ultimately be endogenous and correspond to a stable equilibrium. Second, we remained quite agnostic about policy tools that may help a government to increase complexity. We wish to dig further in this direction and be more specific about the ways the government may do so.

Finally, in this paper we only consider the gains and losses from complexity through the relaxation of the equity-efficiency trade-off. However, tax complexity also affects taxpayers compliance and may be costly to implement. While this would most likely affect our predictions in terms of optimal complexity, identifying the potential gains of tax complexity within a standard taxation framework is an essential first step. Future research shall extend the reflexion on tax complexity as a potential instrument of tax policy.

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