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Inattention and the Taxation Bias^{*}

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Abstract

This paper studies how information frictions in agents' tax perceptions affect the design of actual tax policy. Developing a positive theory of tax policy, we show that agents' inattention interacts with policymaking and induces the government to implement inefficiently high tax rates: this is the taxation bias. We quantify the magnitude of this policy distortion for the US economy. Overall, our findings suggest that existing information frictions – and thereby tax complexity – lead to undesirable, large and regressive tax increases.

Keywords: Optimal taxation; inattention. JEL classification code: H21; D90.

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1 Introduction

A growing body of evidence documents substantial information frictions in agents' tax perceptions (Chetty, 2015; Bernheim and Taubinsky, 2018; Stantcheva, 2019). In particular, taxpayers tend to partially ignore non-salient taxes and transfers (Chetty et al., 2009; Miller et al., 2015; Taubinsky and Rees-Jones, 2017), to rely on linearizing heuristics (Liebman and Zeckhauser, 2004; Rees-Jones and Taubinsky, 2019) and to misunderstand some characteristics of income tax schedules (Saez, 2010; Aghion et al., 2017). Taken together, these findings indicate that agents' tax perceptions are shaped by their attention to taxes and potential behavioral biases.

In light of this evidence, a burgeoning normative literature analyzes the design of optimal tax policy in the presence of information frictions in agents' tax perceptions.¹ This literature characterizes optimal tax policies in terms of sufficient statistics that capture agents' earnings responses to tax changes and perception biases at the optimum. Doing so, it generally sidesteps the issue that agents' tax perceptions may adjust to changes in tax policy and remains agnostic about the mechanisms behind these adjustments.² In their general treatment of optimal taxation with behavioral agents, Farhi and Gabaix (2015, p. 13) emphasize that "a difficulty confronting all behavioral policy approaches is a form of Lucas critique: how do the underlying biases change with policy?".

In practice, tax policy is likely influenced by the way agents' perceptions adjust to tax changes. Policymakers may for instance be tempted to increase taxes if agents are inattentive and only perceive a fraction of tax increase. In contrast to their normative counterparts, such positive policy implications remain surprisingly unexplored. This paper aims at filling this gap by studying how information frictions in agents' tax perceptions affect the design of actual tax policy.

We develop a positive theory of tax policy in a setting where agents' labor supply is determined by their tax perceptions. We show that the adjustment of agents' tax perceptions interacts with policymaking and generates a distortion in actual tax policy. Specifically, we show that inattention leads the government to implement inefficiently high tax rates: this is the taxation bias. The key insight is that inattention creates the illusion that earnings responses to tax reforms are lower than they actually are, thereby inducing a commitment problem in the choice of tax policy.

We then quantify the magnitude of this policy distortion through a simple sufficient statistics formula that we bring to the data. We further illustrate our theoretical results

¹For instance, Goldin (2015) shows that a government may implement non-salient taxes to reduce the deadweight loss of taxation. Gerritsen (2016) highlights that tax misperceptions introduce a new corrective motive for taxation and derives adjusted optimal tax formulas. Integrating both insights Allcott et al. (2018) revisit the Atkinson and Stiglitz (1976) result when commodity taxes are not salient.

²This is at the essence of the sufficient statistics approach. See Chetty (2009) or Kleven (2018) for a general discussion and Reck (2016) for a discussion in a behavioral context.

using numerical simulations which shed a new light on the implications of inattention and misperceptions. Overall, our findings suggest that existing information frictions lead to undesirable, large and regressive tax increases.

Our theoretical framework considers a population of heterogeneous and rationally inattentive agents who choose their earnings and consumption given their tax perceptions.³ We model agents' tax perceptions as resulting from a Bayesian learning model with a choice of information (Mackowiak et al., 2018; Gabaix, 2019). That is, taxpayers are endowed with a prior (or belief) about tax policy and can collect additional, but costly, information in the form of a signal. The precision of this signal is endogenous: the more attentive a taxpayer is, the more precise her signal and the more accurate her posterior (or perception). As a result, agents' perceived tax rate is in expectation given by a weighted average between their prior and the actual tax rate where the weight on the latter captures agents' attention to tax policy. Importantly, we allow the prior to be systematically biased to capture potential perception biases thereby building a bridge between behavioral models with ad-hoc misperceptions and standard rational inattention frameworks. This model thus captures the use of biased rule-of-thumbs as default while allowing taxpayers to improve their tax perceptions if they find optimal to do so (Morrison and Taubinsky, 2019).

Building on this general tax perception model, we develop a positive theory of tax policy that we formalize as a simultaneous game between rationally inattentive agents and a welfarist government.⁴ Agents endogenously choose their attention to taxes and the government sets tax policy to maximize social welfare taking attention choices into account. In equilibrium, (i) neither taxpayers nor the government has an incentive to deviate, and (ii) taxpayers' actions and perceptions are mutually consistent with the government's choice of tax policy. Our main result is that – irrespective of potential perception biases – inattention leads to the implementation of inefficiently high tax rates.

Central to this result is a dichotomy between direct and indirect adjustments in perceptions upon changes in tax policy. Indeed, as agents' tax perceptions are determined by a combination of the actual tax rate and their prior, there are two margins through which perceptions may adjust: a *direct* margin capturing the attention agents devote

³The taxation bias follows from the presence of inattention, be it endogenous or exogenous. We nonetheless adopt a rational inattention model given the strong empirical support for the endogeneity of attention and this model in particular. For instance, Hoopes et al. (2015) find that rational inattention motives and shocks to tax salience drive taxpayers' online information search. Taubinsky and Rees-Jones (2017) show in a shopping experiment that tripling the tax rate nearly doubles agents' attention to taxes. Morrison and Taubinsky (2019) provide further compelling evidence that observed attention patterns are consistent with theoretical predictions of rational inattention models.

⁴None of our theoretical result hinges on a particular objective function for the government; it could as well be reflecting political economy forces or wider fairness concerns (Saez and Stantcheva, 2016).

to observing taxes and thus changes in tax policies, and an *indirect* margin capturing variations in the prior. For a given prior, inattentive agents only perceive a fraction of the change in tax policy which dampens their earnings responses. The government thus targets a higher tax rate than if agents were perfectly attentive. In equilibrium, agents' priors must however be consistent with the government's choice of tax policy. As a result, ex post earnings responses are larger than what anticipated ex ante. The government implements inefficiently high tax rates because it fails to internalize the indirect adjustment of the prior (arising as an equilibrium mechanism) in its choice of tax policy. In a nutshell, taxpayers' inattention to taxes creates the illusion that tax reforms induce lower efficiency costs than they actually do and ultimately prompts the government to misbehave from a normative perspective.

Fundamentally, this reflects a commitment problem. By implicitly restricting the set of tax policies to precommited policy rules, the aforementioned normative literature characterizes tax policy under commitment. This commitment tax policy is by definition the welfare-maximizing tax policy in the presence of information frictions in agents' tax perceptions. However, a side effect of information frictions is that actual policymakers cannot credibly commit to implement this optimal policy. Indeed, given agents' inattention, a discretionary government cannot resist the temptation to increase tax rates beyond their optimal levels, thereby introducing a taxation bias. We formally define the taxation bias as the difference between equilibrium tax rates under discretion and commitment and establish the existence of a positive taxation bias under a mild general requirement.

We then seek to illustrate the implications of this policy distortion and to quantify its magnitude. To do so, we parametrize our tax perception model with Gaussian distributions to provide further theoretical results and numerical simulations. They indicate that even small information frictions induce significant deviations in tax policy. Moreover, they allow to disentangle the implications of inattention to taxes from that of potential behavioral biases reflected in agents' priors. The optimal (or commitment) tax policy is mostly driven by equilibrium perception biases reflected in agents' posteriors. That is, the deviation in the optimal tax policy (Farhi and Gabaix, 2015) from a benchmark without information frictions (Saez, 2001) increases with the bias in the prior and decreases with attention. The actual (or discretionary) tax policy is similarly impacted by equilibrium perception biases but it also depends on taxpayers' attention through a second channel: the policy distortion induced by inattention. The taxation bias, which measures the difference between the two, is thus primarily shaped by attention to taxes and relatively less by potential behavioral biases.

This result transpires in the simple sufficient statistics formula we derive for the

taxation bias when income taxes are linear. Indeed, beyond the elasticity of earnings with respect to changes in the perceived marginal net-of-tax rate, it shows that the key sufficient statistic to estimate is the income-weighted average attention in the population. This statistic captures the fact that richer agents are more attentive to tax policy as documented by Taubinsky and Rees-Jones (2017) and as emerges in our endogenous attention model. While income taxes are nonlinear in the US economy, a linear tax model provides a reasonable first-order approximation (Piketty and Saez, 2013). Fitting a linear tax model to US tax data, we find a tax rate of 29.5 percentage points. Further relying on the existing empirical literature to calibrate our sufficient statistics, we estimate that the taxation bias is approximately equal to 3.7 percentage points. This means that the linearized US income tax rate is more than 12% higher than what would be optimal holding the government's objective constant: the taxation bias is large.⁵

We then show that our findings hold important and counterintuitive implications. Situations in which behavioral biases were previously thought to be welfare improving may actually turn out to be welfare decreasing. To illustrate this point, we carry out a welfare analysis in an economy where taxpayers' priors systematically underestimate tax rates (e.g. salience bias). As this downwards bias reduces the efficiency cost of taxation for any given tax rate, we unsurprisingly find that information frictions induce a welfare gain if the government was to implement the optimal tax policy. However, the optimal tax policy cannot be credibly implemented and the actual tax policy features an additional welfare loss due to the taxation bias. As inattention grows, the welfare loss from this policy distortion increases faster than the welfare gain from tax underestimation. Therefore, even if agents systematically underestimate tax rates, information frictions can be detrimental to welfare when agents are not sufficiently attentive to tax policy.

Last, we extend our analysis to nonlinear tax schedules. The government's incentive to increase the marginal tax rate at a given earnings level then depends on agents' attention at (or close to) this earnings level. As a consequence, the positive correlation between income and attention results in an income-specific taxation bias that is globally decreasing with income: the taxation bias is large at low income levels and virtually nonexistent at top income levels. The taxation bias thus attenuates the U-shape pattern of marginal tax rates (Saez, 2001) and reduces the progressivity of actual income tax schedules.

This paper contributes to the behavioral public economics literature recently reviewed by Bernheim and Taubinsky (2018). It is the first to analyze the implications of information frictions in agents' tax perceptions for actual tax policy. We present a novel positive

⁵While the existence of a taxation bias does not depend on the objective of the policymaker, the magnitude of the taxation bias does. We use the social welfare weights that can be inferred from actual tax policy given agents' inattention as our baseline and provide a sensitivity analysis.

theory of tax policy that we link to the existing normative theory to show that inattention generates important policy distortions.^{6,7}

Central to this result is the dichotomy between direct and indirect perception adjustments induced by inattention and highlighted in recent empirical evidence. For instance, Sausgruber and Tyran (2005) and Fochmann and Weimann (2013) show that, with time and experience, taxpayers tend to internalize the impact of non-salient taxes they initially ignored.⁸ Moreover, if taxpayers act upon their perceptions this dichotomy should also be reflected in earnings choices. Chetty (2012) documents a systematic difference between micro (capturing direct adjustments) and macro (capturing total adjustments) estimates of the elasticity of taxable income and rationalizes this difference by the existence of adjustment rigidities such as information frictions at the micro level.

By showing that information frictions induce a commitment problem leading to inefficient policy outcomes, this paper builds a perhaps unexpected bridge to an earlier literature on the inconsistency of policymaking (Kydland and Prescott, 1977). This justifies our use of the term *taxation bias* in analogy to the *inflation bias* (Barro and Gordon, 1983). A large body of evidence documents the existence of information frictions affecting consumers, firms or even professional forecasters (see e.g. Coibion and Gordonichenko, 2015). Consequently, our analysis suggests that policy distortions may arise in a wide variety of settings in which the portable framework developed in this paper could be fruitfully applied.

Policymaking is, at least to some extent, discretionary. In the realm of taxation, discretion is usually discussed in the context of capital levies in which there is indisputable historical evidence of discretionary policies (e.g. Japan post WWII, Italy in 1992, Cyprus in 2013). While less salient for income taxes, discretionary behaviors are likely reflected in the obnoxious complexity of existing tax systems. The French constitutional court has for instance repealed specific items of tax bills for their "excessive complexity" arguing they would not be understood by taxpayers (Conseil Constitutionnel, 2005, 2012). As a result, it should not come as a surprise that individuals strongly oppose tax complexity, even after acknowledging the potential advantages of differential tax treatments (Blesse et al., 2019). Indeed, our findings suggest that by inducing information frictions, tax complexity prompts the government to misbehave from a normative perspective.

⁶While the term 'positive' sometimes refers to settings in which tax policy is determined as the outcome of a political economy process, it here refers to the discretionary nature of policymaking. See Matějka and Tabellini (2017) for the implications of (rational) inattention in a political economy process.

⁷This finding has potentially important implications for the inverse-optimum approach which aims at inferring the government's objective function from the shape of actual tax schedules (Bourguignon and Spadaro, 2012; Lockwood and Weinzierl, 2016; Jacobs et al., 2017).

⁸Indirect adjustments may also help explain why surveys of taxpayers' perceptions do not provide clear cut evidence of systematic tax rate underestimation (Fochmann et al., 2010; Gideon, 2017); a finding that is *prima facie* hard to reconcile with e.g. ironing behaviors or salience biases.

The rest of the paper is organized as follows. To build up the intuition, we first characterize in Section 2 the taxation bias in a stylized representative agent model with exogenous attention. Section 3 microfounds the behavior of heterogeneous and rationally inattentive taxpayers. In Section 4, we formalize our positive theory of tax policy and establish the existence of a taxation bias. We then derive a simple sufficient statistics formula for the taxation bias that we take to the data and we illustrate our theoretical results with numerical simulations in Section 5. Section 6 turns to the welfare implications of information frictions in tax perceptions and Section 7 provides an extension to nonlinear tax schedules. The last section concludes. Unless stated in the text all proofs are relegated to the Appendix.

2 Taxation bias in a stylized model

Consider a canonical labor income taxation model where the government sets a linear tax rate τ to maximize tax revenue. Let $Y(1 - \tau)$ be the aggregate earnings function. The tax revenue function $\tau Y(1 - \tau)$ has an inverted U-shape and is nil when τ is equal to 0 or 100%. As is well-known (e.g. Piketty and Saez (2013)), the revenue maximizing tax rate follows an inverse elasticity rule and is equal to

$$\tau^r = \frac{1}{1+e} \tag{1}$$

where e is the elasticity of aggregate earnings with respect to the net-of-tax rate.

Assume now that because of information frictions taxpayers are unable to perfectly observe the tax rate. They must nonetheless form an estimate of the latter to decide how much to work. Call this estimate the perceived tax rate $\tilde{\tau}$ and suppose it is determined by a convex combination of a common prior $\hat{\tau}$ and the actual tax rate τ

$$\tilde{\tau} = \xi \tau + (1 - \xi)\hat{\tau},\tag{2}$$

where the weight $\xi \in [0, 1]$ can be interpreted as a measure of taxpayers' attention to the actual tax rate τ .⁹ Indeed, when $\xi = 1$, taxpayers perfectly observe changes in the tax rate whereas, when $\xi = 0$, they are completely inattentive to tax changes and fully anchor their perception on their prior. Since individual earnings choices depend on their perceived tax rate, aggregate earnings now write $Y(1 - \tilde{\tau})$. The tax revenue function becomes $\tau Y(1 - \tilde{\tau})$ which remains concave with respect to the actual tax rate τ given the tax perception model in equation (2).

 $^{^{9}}$ Gabaix (2019) argues this is a unifying framework to modeling various behavioral biases and attention theories.

How do information frictions interact with the design of actual tax policy? Consider a situation in which taxpayers expect the government to implement the optimal tax rate in the absence of information frictions, that is $\hat{\tau} = \tau^r$. Now, suppose the government sets $\tau = \tau^r$ and consider the effect of a policy deviation that consists in a small increase in the tax rate $d\tau$. This mechanically increases tax revenues by $M = Y(1-\tilde{\tau})|_{\tilde{\tau}=\tau^r} d\tau$ while it generates a behavioral response $dY = -\frac{\partial Y(1-\tilde{\tau})}{\partial 1-\tilde{\tau}}|_{\tilde{\tau}=\tau^r}\xi d\tau$ as inattentive taxpayers only observe a fraction ξ of the increase in the tax rate $d\tau$. By definition of τ^r , the mechanical effect M outweighs the fiscal externality $FE = \tau^r dY$ induced by the behavioral response when agents are not fully attentive ($\xi < 1$). As a result, the government systematically deviates from tax policy τ^r and ends up choosing a higher tax rate.

Conceptually, an important consequence of inattention is to anchor taxpayers' perceptions on their prior. Because of this anchoring, the government has an incentive to implement policy deviations that taxpayers are going to partially ignore. This is a form of discretionary policy which arises as a side-effect of information frictions in tax perceptions. The government thus chooses its tax policy taking agents' priors and attention into account. Specifically, tax policy $\tau(\xi, \hat{\tau})$ is decreasing in taxpayers' prior $\hat{\tau}$ and attention parameter ξ

$$\tau(\xi, \hat{\tau}) = \begin{cases} \frac{1-(1-\xi)\hat{\tau}}{\xi(1+e)} & \text{if } \hat{\tau} \ge 1 - \frac{\xi}{1-\xi}e\\ 1 & \text{otherwise} \end{cases}$$
(3)

where the elasticity of aggregate earnings is defined with respect to the perceived net-oftax rate $e \equiv \frac{1-\tilde{\tau}}{Y} \frac{\partial Y}{\partial(1-\tilde{\tau})} \geq 0$. The solution is interior whenever attention ξ or the prior $\hat{\tau}$ are high enough – otherwise the government finds it optimal to impose a 100% tax – and coincides with the inverse elasticity rule when agents are perfectly attentive ($\xi = 1$) and thus fully informed.

Figure 1 plots tax policy $\tau(\xi, \hat{\tau})$ as a function of agents' prior for different attention levels. It shows that small information frictions generate notable deviations in the government behavior. If agents' prior is that the government implements the inverse elasticity rule – $\tau^r = 75\%$ assuming e = 0.33 – the government chooses a tax rate of 82% (resp. 77%) when the attention parameter ξ is equal to 0.75 (resp. 0.90).¹⁰ This corresponds to point A (resp. B).

An equilibrium is as a situation in which (i) neither taxpayers nor the government has an incentive to deviate and (ii) taxpayers' actions and perceptions are mutually consistent with the government's choice of tax policy. We here focus on rational equilibria in which

¹⁰As an element of comparison, Gabaix (2019) states (p. 5) that "on average, the attention parameter estimated in the literature is 0.44, roughly halfway between no attention and full attention" while adding that "attention is higher when the incentives to pay attention are stronger" which should likely be the case when it comes to taxing 75% of one's income.



Figure 1: Optimal tax policy and equilibrium outcomes

NOTE: Optimal policy as a function of the prior $\hat{\tau}$ for different values of the attention parameter ξ . The elasticity of aggregate earnings with respect to the perceived net-of-tax rate is set to 0.33.

agents correctly anticipate the equilibrium tax policy $\hat{\tau} = \tau^{eq}$ and defer the introduction of biased equilibria to Section 4. Plugging this equilibrium condition in the government's choice of tax policy (3) we obtain that the equilibrium tax policy is

$$\tau^{\rm eq} = \frac{1}{1+\xi e} \tag{4}$$

Graphically, the rational equilibrium is represented by the point where the 45-degree line ($\hat{\tau} = \tau^{eq}$) intersects the government policy function. Again, small information rigidities lead to large deviations in equilibrium. In a rational equilibrium, the tax rate is 80% (resp. 77%) when attention is such that 75% (resp. 90%) of a tax reform is directly internalized by taxpayers. This corresponds to point C (resp. D).

The government is unable to reach the top of the Laffer curve: the equilibrium tax rate is inefficiently high. We refer to this phenomenon as the *taxation bias* in analogy to the *inflation bias* (Barro and Gordon, 1983). While the government internalizes the direct impact of its choice on agents' perceptions (proportional to attention ξ), it does not internalize the equilibrium impact associated with the adjustment of the prior (proportional to inattention $1 - \xi$). In Barro and Gordon's (1983) words, "the equality of policy expectations and realizations is a characteristic of equilibrium – not a prior constraint" (p. 591). Hence, inattention resurges the possibility that discretionary policies lead to inefficient outcomes (Kydland and Prescott, 1977).

To formalize this result, we characterize the optimal policy under commitment τ^* . This is the optimal policy of a government who can credibly commit to implement a tax level and thereby has to take into account the equilibrium effect of its choice of tax policy on perceptions. By definition, this is the optimal policy in the presence of information frictions and it coincides in this stylized rational equilibrium framework with the inverse elasticity rule $\tau^* = \tau^r$ (point E). However and as shown above, it cannot be an equilibrium policy under discretion in the presence of inattention.

Defining the taxation bias as the difference between the tax rates under discretion and commitment we have

$$\tau^{\rm eq} - \tau^{\star} = \frac{(1-\xi)e}{(1+\xi e)(1+e)} \ge 0 \tag{5}$$

Therefore, the taxation bias is strictly positive when agents are not fully attentive to taxes ($\xi < 1$). Moreover, the (absolute) size of the taxation bias increases with agents inattention $1 - \xi$ and with the elasticity e as they intuitively both make policy deviations relatively more attractive.

To highlight the mechanisms that lead to a taxation bias, we have analyzed in this section a stylized representative agent model in which agents' behavior and attention are exogenously given and in which the government implements a linear tax policy to maximize tax revenue. In the remainder of the paper we broaden the scope of the analysis by studying the problem of a welfare-maximizing government facing a heterogeneous population of agents whose individual behavior is fully micro-founded and whose attention is endogenous. We also extend the equilibrium concept to allow for perception biases in equilibrium and examine how the taxation bias affects (the progressivity of) non-linear tax schedules. These extensions provide valuable insights on the magnitude and implications of the taxation bias in a policy relevant environment.

3 Agents' behavior, perceptions and attention

This section describes the behavior of taxpayers in the economy. Because of information frictions, taxpayers may not freely observe the tax rate implemented by the government. They rely on a Bayesian learning model with costly information acquisition to form their perceptions about the tax schedule in order to decide how much to earn and consume.

3.1 Primitives and assumptions

We consider a population of agents with heterogeneous productivities w which are private information and distributed from a well-defined probability distribution function $f_w(w)$. We assume taxpayers have a utility function U(c, y; w) where c is consumption and y earnings and where we impose U(.) to be continuously differentiable, increasing in consumption $(U_c > 0)$, decreasing in effort $(U_y < 0 \text{ and } U_w > 0)$ and such that the Spence-Mirrlees condition holds $(MRS_{yc} \text{ decreases with skill } w)$. For simplicity, we consider a separable and quasi-linear utility U(c, y; w) = c - v(y; w) in the body of the paper and show in the Online Appendix how we can extend the analysis to more general utility functions.¹¹

Agents choose their consumption c and earnings y subject to an income tax T(y). Because of information frictions, we assume that taxpayers are unable to freely observe T(y) and instead rely on individual-specific perceived income tax schedules denoted $\tilde{T}(y)$.

Assumption 1 (linear representation). Individuals use a linear representation of the tax schedule $\tilde{T}(y) = \tilde{\tau}y - \tilde{R}$

To make their consumption and earnings choices, individuals rely on their perceptions of the tax liability at each earnings level. Assumption 1 imposes that taxpayers use a linear representation of the tax schedule. Hence, agents only need to form estimates of the marginal tax rate $\tilde{\tau}$ and the intercept \tilde{R} thereby reducing the dimensionality of the perceptions formation problem to two parameters.¹²

In most of the paper, we consider that the actual tax schedule is also linear and denote by (τ_0, R_0) its slope and intercept. Consequently, we define (τ, R) as the associated random variables from the point of view of the agents. In Section 7 we extend the analysis to non-linear tax schedules.

3.2 Individual problem

Individuals jointly choose an allocation (c, y) and how much information to collect about the tax schedule. This one-step problem is equivalent to a two-step problem that we characterize. The first step identifies the optimal allocation choice given a perceived tax schedule $\tilde{T}(y)$ while the second step determines the optimal information acquisition taking into account how perceptions affect allocations.

¹¹Separability between earnings and consumption preferences combined with quasi-linearity guarantees the absence of income effects in labor supply decisions and considerably simplifies the analysis.

¹²Beyond the fact that a linear approximation is usually a good approximation of existing tax schedules (Piketty and Saez, 2013), recent empirical evidence suggests that in practice taxpayers tend to use linear representations of tax schedules (Rees-Jones and Taubinsky, 2019).

Allocation choice Agents choose consumption c and earnings y to maximize their utility subject to their perceived budget constraint which depends on their perceptions of the tax schedule. This problem writes

$$\max_{\substack{c,y\\ \text{s.t.}}} \int_{\tau} U(c,y;w) \ \tilde{q}(\tau) d\tau$$
(6)
s.t. $c \le R + (1-\tau)y$

where $\tilde{q}(\tau)$ is the perceived probability distribution of the marginal tax rate τ . With a separable and quasi-linear utility function, the first-order condition determining earnings writes

$$\frac{\partial v(y;w)}{\partial y} = 1 - \tilde{\tau} \tag{7}$$

with $\tilde{\tau} \equiv E_{\tilde{q}(\tau)}[\tau]$ the average perceived marginal tax rate. Consequently, the average perceived marginal tax rate $\tilde{\tau}$ is a sufficient statistics for labor supply and uniquely pins down optimal earnings $y^*(\tilde{\tau}; w)$. Hence, a direct implication of quasi-linear separable preferences is that tax liability, and in particular the perceived value of the demogrant \tilde{R} , is irrelevant for labor supply and only matters to determine agents' consumption levels.

Assumption 2 (slack budget). Consumption adjusts such that agents exhausts their true budget i.e. $c^*(\tilde{\tau}; w) = R_0 + (1 - \tau_0)y^*(\tilde{\tau}; w)$

We assume consumption adjusts to ensure that the true budget constraint holds ex post.¹³ The only parameter of interest for agents' allocation choice is thus the perceived marginal tax rate $\tilde{\tau}$.

Given this allocation choice, an agent's indirect utility is

$$V(\tilde{\tau}, \tau_0, R_0; w) = R_0 + (1 - \tau_0) y^*(\tilde{\tau}; w) - v \left(y^*(\tilde{\tau}; w); w \right)$$
(8)

Figure 2 summarizes the allocation choice in a y-c diagram. Perceptions of the tax schedule determine earnings (tangency condition with perceived budget line) while consumption adjusts to the true budget constraint (intersection with true budget line).

A natural observation from Figure 2 is that misperceptions induce utility misoptimization costs: the utility level \bar{U} associated with the choice under accurate perceptions (black dot) is higher than the utility level U^* associated with the choice under misperceptions (grey dot). However, when agents underestimate tax rates ($\tilde{\tau} < \tau_0$) misperceptions also induce efficiency gains: earnings y^* chosen under misperceptions are larger than earnings \bar{y} at the optimal allocation. As a result, tax underestimation may increase social welfare

 $^{^{13}}$ This assumption is used throughout the behavioral tax literature as emphasized in Reck (2016) who discusses different budget adjustment rules in misperception models. See also Farhi and Gabaix (2015) for a related discussion.



Figure 2: Allocation choice in a y-c diagram

NOTE: The figure displays an exemple of allocation choice when the agent underestimates the marginal tax rate $\tilde{\tau} < \tau_0$. The grey (resp. black) dot represents the allocation choice of an individual who misperceives (resp. correctly perceives) the tax schedule. The plain lines are the indifference curves and the dashed lines the budget contraints.

if efficiency gains dominate utility misoptimization costs.

Perceptions formation Tax perceptions here follow from a Bayesian learning model with a choice of information (in Gabaix's (2019) terminology). They result from the combination of an exogenous and free prior (also referred to as a belief or an anchor) and an endogenous and costly information acquisition process. We choose this model for its wide use in economics, its well-understood micro-foundations and the fact that – as we show – it generates predictions that are consistent with the empirical evidence.

Let $\hat{q}(\tau)$ be the prior probability distribution about the tax rate and $\hat{\tau} \equiv E_{\hat{q}}[\tau]$ the expected tax rate derived from the prior. This probability distribution accounts for sources of structural and subjective uncertainty which may be related to policy primitives (e.g. hidden tastes for redistribution), economic fundamentals (e.g. shocks to the government expenditure requirements), institutions (e.g. inability to implementation a chosen policy), heuristic decision rules (e.g. ironing), etc.

In the following, we voluntarily remain agnostic about the origin of the prior and the sources of uncertainty it may capture for two reasons. First, the assumed ex ante uncertainty essentially represents a motive for taxpayers to learn in our setup and the main results of the paper will hold for a wide variety of well-defined smooth priors. Second, while the empirical literature clearly indicates that taxpayers tend to misperceive tax rates, there is yet no consensus on the exact rationale – or rationales – behind these mis-

perceptions. Hence, we consider diverse situations ranging from priors that are correct on average to priors that are systematically biased due to cognitive or perception biases.

Information about the actual tax rate τ_0 takes the form of an unbiased Gaussian signal with precision $1/\sigma^2$. For a realization s of the signal, the posterior belief follows from Bayes law

$$\tilde{q}(\tau|s;\sigma) \propto \phi(s;\tau,\sigma^2)\hat{q}(\tau)$$
(9)

where $\phi(s; \tau, \sigma^2)$ is the Gaussian pdf with mean τ and variance σ^2 . Building on the rational inattention literature (Sims, 2003), the information content transmitted through the signal is measured from the entropy reduction between the prior and the posterior

$$\mathcal{I}(\sigma) \equiv H(\hat{q}(\tau)) - E_{p(s)} \Big[H(\tilde{q}(\tau|s;\sigma)) \Big]$$
(10)

where $H(q(\tau)) \equiv -\int q(\tau) \log_2(q(\tau)) d\tau$ is the differential entropy (in bits) of the probability distribution $q(\tau)$ and $E_{p(s)}[.]$ the expectation taken over the marginal distribution of signals $p(s) \equiv \int \phi(s; \tau, \sigma) \hat{q}(\tau) d\tau$. Intuitively, $\mathcal{I}(\sigma)$ is a measure of the expected amount of information transmitted through the signal. To account for the energy and time devoted to acquiring and processing information, taxpayers suffer a utility cost κ per unit (bit) of processed information.¹⁴ The attention strategy of a taxpayer with productivity w thus results from an arbitrage between improved private decisions thanks to more accurate information and the cost to acquire this information. More specifically, she chooses the signal's precision – or equivalently its standard error $\sigma^*(\hat{q}(\tau), \kappa, w)$ – to maximize her expected indirect utility

$$\max_{\sigma} \qquad \iint V\big(\tilde{\tau}(s,\sigma),\tau,R;w\big) \ \phi(s;\tau,\sigma) \ \hat{q}(\tau) \ dsd\tau - \kappa \mathcal{I}(\sigma) \tag{11}$$

where $\tilde{\tau}(s,\sigma) \equiv E_{\tilde{q}(\tau|s;\sigma)}[\tau]$ is the expected perceived marginal tax rate once the signal is observed and henceforth referred to as the perceived tax rate. Note that the decision to acquire information is here only based on the information contained in the prior distribution $\hat{q}(\tau)$ which ensures the internal consistency of this learning model.¹⁵

In the following, we denote by $f_{\tilde{\tau}}(\tau|\tau_0, w)$ the posterior distribution of $\tilde{\tau}(s, \sigma^*)$ for a taxpayer with productivity w and signal s drawn from the Gaussian distribution with mean τ_0 and variance σ^* . This function summarizes the distribution of agent w perceptions in the economy. Moreover, for a given perceived tax rate $\tilde{\tau}$, agent w indirect utility net of information costs writes

$$\mathcal{V}(\tilde{\tau}, \tau_0, R_0; w, \kappa) = V(\tilde{\tau}, \tau_0, R_0; w) - \kappa \mathcal{I}(\sigma^*)$$
(12)

¹⁴Our results naturally extend to more general information cost functions.

¹⁵In other words, agents "don't know what they don't know".

3.3 Tractable Gaussian model

The general Bayesian learning model presented above is generally intractable. We here focus on the Gaussian formulation in order to derive some predictions and implications of the model. As highlighted in the inattention literature (Maćkowiak and Wiederholt, 2015; Mackowiak et al., 2018), a closed form solution to problem (11) can be obtained under the following assumption.

Assumption 3 (tractable Gaussian learning). Let the prior $\hat{q}(\tau)$ be the Gaussian distribution with mean $\hat{\tau}$ and variance $\hat{\sigma}^2$ and assume that agents use a quadratic approximation of their indirect utility to choose their attention strategies.

Under the assumption that the prior is Gaussian, the posterior will also be Gaussian and the information measure $\mathcal{I}(\sigma^*)$ takes a simple form.¹⁶ Relying on a second-order approximation of indirect utility, the solution to this problem can then be derived.

Lemma 1. In a tractable Gaussian learning model, the expected perceived marginal tax rate $\tilde{\tau}$ is given by

$$\tilde{\tau}(s,\sigma^{\star}) = \xi(\sigma^{\star})s + (1 - \xi(\sigma^{\star}))\hat{\tau}$$
(13)

 \square

where $\xi(\sigma^*) \equiv \frac{\hat{\sigma}^2}{\hat{\sigma}^2 + \sigma^{*2}} \in [0, 1]$ is a measure of attention strategies.

Proof. See Appendix A.2

The perceived tax rate $\tilde{\tau}$ is given by a convex combination of the prior $\hat{\tau}$ and the realization of the signal s where the weight ξ is a measure of attention. Indeed, the lower the attention parameter ξ is, the more taxpayers rely on their prior $\hat{\tau}$ and the less attention they devote to acquiring information about the actual tax rate through the signal s. In other words, agents tend to choose to ignore their signal if they do not invest in information acquisition and the signal is hence relatively uninformative in comparison to the prior.

Lemma 2. In a tractable Gaussian learning model, the optimal attention strategy ξ is given by

$$\xi = \max\left(0, 1 + \frac{\kappa}{\hat{\sigma}^2 \int \frac{\partial^2 y^*}{\partial \bar{\tau}^2} \Big|_{\bar{\tau}=\tau} \phi(\tau; \hat{\tau}, \hat{\sigma}) d\tau}\right).$$
(14)

Proof. See Appendix A.2

¹⁶One may instead consider that the prior is a truncated Gaussian with support on [0, 1] in order to ensure that perceived tax rates $\tilde{\tau}$ always remain between zero and one. Doing so, the problem remains tractable but formulas become a lot less transparent. In practice, our simulations suggest that when the prior is sufficiently informative (low variance) and the tax rate not too extreme, the posterior support belongs to [0, 1] a.s. with a Gaussian prior.

Each taxpayer's attention strategy ξ is characterized by equation (14). Attention decreases with the information cost κ and increases with the uncertainty in the prior $\hat{\sigma}^2$. It also depends on the responsiveness of agents labor supply decisions to changes in perceived tax rates through $\frac{\partial^2 y^*}{\partial \hat{\tau}^2}$. Indeed, an agent's responsiveness to changes in perceptions determines the value of information acquisition. As a result, attention increases with earnings ability w and with expected prior tax rates. Intuitively, agents who are more productive have a greater latitude in their earnings choice and will thus be more attentive – and hence responsive – to taxes. In a similar fashion, responsiveness to tax changes and thus attention increases when expected tax rates increase because it shifts the labor supply function to regions with a larger curvature.

Predictions and implications Agents choose their attention strategies through the maximization of their expected indirect utility which is based on their prior. Attention is hence unaffected by an unanticipated change in the realized tax rate $d\tau_0$. As a result, an unanticipated change in the tax rate $d\tau_0$ induces a change in the distribution of the posterior $f_{\tilde{\tau}}(\tilde{\tau}|w)$ only through a change in the signal *s* which is now drawn from a novel distribution $\phi(s; \tau_0 + d\tau_0, \sigma^*)$. Therefore, taxpayers' perceived tax rate slowly adjusts to news and perceptions are anchored on the prior. Anchoring is a widely documented bias in the behavioral literature (Gabaix, 2019) which has two major implications in this context.

First, if agents' prior is biased ($\hat{\tau} \neq \tau_0$) and agents are not fully attentive ($\xi < 1$), the posterior and hence agents perceptions of the tax schedule will also be biased (almost surely). Indeed, taking expectations over signal realizations we have that

$$\tau_0 - E_{\phi(s)}[\tilde{\tau}(s,\sigma^*)] = \tau_0 - [\xi\tau_0 + (1-\xi)\hat{\tau}] = (1-\xi)(\tau_0 - \hat{\tau}).$$
(15)

Second, taxpayers labor supply responses to unanticipated changes in the tax rate are attenuated by anchoring. Indeed, taking the prior as given, responses to tax changes only transit through the variation of the signal which is weighted by attention ξ . Formally, this means $\frac{d\tilde{\tau}}{d\tau_0} = \xi$ such that

$$\frac{dy^{\star}}{d\tau_0} = \xi \frac{dy^{\star}}{d\tilde{\tau}} \tag{16}$$

Intuitively, $\frac{dy^{\star}}{d\tilde{\tau}}$ captures agents' preferences while ξ is a dampening factor that captures the fraction of the tax change that agents perceive. As a result the elasticity of labor supply with respect to unanticipated changes in the tax rate decreases in the presence of inattention.

The predictions derived from a Bayesian learning model with a choice of information thus seem consistent with the bulk of the empirical evidence on tax perceptions and behavioral responses to taxes. Most importantly, it can account for the presence of systematic perception biases and implies that elasticities will be lower when inattention is at play. In addition the model also generates dispersion in perceptions – through the noisiness of the signal – and features an increase in overall attention upon tax increases which hold potentially important welfare implications (Taubinsky and Rees-Jones, 2017).

4 Discretion, commitment and the taxation bias

This section introduces the problem of the government and formalizes our positive theory of tax policy. It characterizes tax policy under discretion and commitment and provides a formal definition of the equilibrium. A general result on the existence of a taxation bias concludes.

4.1 Government problem and discretion

We consider a welfarist government that maximizes a general social welfare function summing an increasing and weakly concave transformation G(.) of taxpayers' indirect utilities net of information costs. It chooses a target tax schedule (τ_g, R_g) , where τ_g is the marginal tax rate and R_g the demogrant, taking the distribution of skills $f_w(w)$ in the population as given.

Following Matějka and Tabellini (2017), we introduce implementation shocks ϑ as an underlying source of uncertainty in the model. The target tax rate is implemented up to a realization of this implementation shock such that the actual tax rate is $\tau_0 = \tau_g + \vartheta$ where ϑ is a white noise drawn from an exogenous distribution $f_{\Theta}(\vartheta)$ known to both taxpayers and the government. We assume the actual demogrant R_0 adjusts to the realization of the implementation shock ϑ to ensure that the government budget constraint is always binding. Conceptually, these implementation shocks are introduced to ensure that Bayesian taxpayers have an incentive to learn in equilibrium. They allow to formally close the model but have an otherwise negligible impact on the optimal tax policy. Hence, we sometimes use small shocks approximations in which case we explicitly disregard the small effects they may induce.

The government problem writes

 \mathbf{S}

$$\max_{\tau_g, R_g} \qquad E_{\vartheta} \left[\iint G\Big(\mathcal{V}(\tilde{\tau}, \tau_0, R; \kappa, w) \Big) \ f_{\tilde{\tau}}(\tau | \tau_0; w) \ f_w(w) d\tau dw \right]$$
(17)

.t.
$$\iint \tau_0 y^{\star}(\tilde{\tau}; w) \ f_{\tilde{\tau}}(\tau | \tau_0; w) \ f_w(w) d\tau dw \ge R_0 + E$$
(18)

where E is an exogenous expenditure requirement, the expectation is taken over the implementation shock ϑ and $f_{\hat{\tau}}(\tau | \tau_0; w)$ is the posterior distribution of perceived rates for a taxpayer with productivity w given the actual tax rate $\tau_0 = \tau_g + \vartheta$. **Discretionary policy** The government's optimal tax policy solves problem (17). When doing so, it takes the prior distribution $\hat{q}(\tau)$ as given. This is a form of Nash conjecture used to compute the best response of the government. While the problem is fundamentally simultaneous, it can be equivalently described by the following sequence of events which we here layout for the sake of clarity:

- 0. Agents are endowed with a common prior $\hat{q}(\tau)$ and the distribution of skills is $f_w(w)$.
- 1. The government sets the target tax policy (τ_g, R_g) to maximize (17).
- 2. The actual tax rate $\tau_0 = \tau_g + \vartheta$ is implemented up to an implementation shock drawn from a known distribution $f_{\Theta}(\vartheta)$ and the actual demogrant R_0 adjusts to the resource constraint.
- 3. Taxpayers choose their attention strategies using their common prior $\hat{q}(\tau)$, observe a Gaussian signal s about τ_0 which precision depends on their attention and decide how much to consume and earn.
- 4. The government levies taxes and redistributes through the demogrant.

The government understands that taxpayers will gather information and adjust their decisions in reaction to its choice of tax policy, it therefore plays "first" in the abovedescribed sequence of events. However, it (i) treats the prior distribution $\hat{q}(\tau)$ and the skill distribution $f_w(w)$ as predetermined state variables and (ii) cannot directly influence agents' attention strategies since they are based on agents' predetermined prior. As a result, the government does not have a particular strategic advantage from playing "first" – thus reflecting the simultaneous nature of the problem. Importantly, the government is as rational and informed as in the standard Mirrlees (1971) model and the novelty relates to information frictions on the agents' side.

The tax policy of the government follows from Proposition 1, where first-order conditions have to hold in expectation of the realization of the implementation shock.

Proposition 1. The discretionary tax policy (τ_g, R_g) is characterized by

$$(\tau_g): E_{\vartheta} \left[\int \left\{ \underbrace{\int \left[-\frac{G'(\mathcal{V})}{p} y^* + y^* \right] f_{\tilde{\tau}}(\tau | \tau_0; w) d\tau}_{\text{mechanical & welfare effects}} + \underbrace{\int \left[\frac{G(\mathcal{V})}{p} + \tau_0 y^* \right] \frac{df_{\tilde{\tau}}(\tau | \tau_0; w)}{d\tau_g} \Big|_{\hat{q}(.)} d\tau}_{\hat{q}(.)} d\tau \right\} f_w(w) dw \right] = 0 \quad (19)$$

$$(R_g): \quad E_{\vartheta}\left[\iint \left[\frac{G'(\mathcal{V})}{p} - 1\right] f_{\tilde{\tau}}(\tau | \tau_0; w) f_w(w) d\tau dw\right] = 0$$

$$\tag{20}$$

together with the resource constraint (18) and where p represents the social marginal cost of public funds.

Proof. See appendix A.3

The first order condition (19) captures the (expected) effects of a marginal increase in the target tax rate $d\tau_g$. The first line measures the impact of the reform on allocations when the distribution of perceptions remains fixed. It corresponds to the standard mechanical and welfare effects: a marginal increase in the tax rate mechanically increases tax revenue by $y^* d\tau_g$ additional dollars but reduces taxpayers' consumption and thus welfare by $\frac{G'(\mathcal{V})}{p}y^* d\tau_g$ dollars (Piketty and Saez, 2013).

The second line in condition (19) relates to the impact of the reform on the distribution of perceptions and thus captures behavioral responses to the reform. Indeed, behavioral responses transit through variations in the posterior distribution $f_{\tilde{\tau}}(\tau|\tau_0, w)$ of perceived tax rates $\tilde{\tau}$ which reflect changes in the actual tax rate τ_0 . A marginal increase in the tax rate increases, on average, the perceived tax rate by $d\tilde{\tau}$ and thus reduces tax revenue by $\tau_0 y^*(\tilde{\tau}) d\tilde{\tau}$. This is a reformulation of the standard behavioral effect. Moreover, because agents misoptimize, the envelope theorem no longer applies and a marginal deviation from taxpayers' perceived rate induces a welfare cost equal to $\frac{G(V(\tilde{\tau}))}{p}d\tilde{\tau}$. This new welfare effect introduces a corrective motive for taxation in the presence of misperceptions common to optimal tax models with behavioral agents (Gerritsen, 2016; Farhi and Gabaix, 2015).

Condition (20) states that in the absence of income effects, social marginal welfare weights $g \equiv \frac{G'(\mathcal{V})}{p}$ average to 1 at the optimum: the government is indifferent between having an additional dollar or redistributing an additional dollar (Saez, 2001).

4.2 Equilibrium definition

An equilibrium is a set of target tax policy, denoted $(\tau_g^{\text{eq}}, R_g^{\text{eq}})$, and a set of attention, consumption and earnings decisions such that neither the government nor taxpayers have an incentive to deviate. Moreover, in equilibrium agents' prior $\hat{q}(\tau)$ must be mutually consistent with the government's target tax rate and with the uncertainty induced by the implementation shock.

As discussed in the introduction, there is a large body of evidence suggesting the existence of systematic perception biases. Therefore, we allow for a potential perception bias b in agents' common prior but remain agnostic on the origin of this potential bias. We henceforth call rational (resp. biased) an equilibrium in which agents correctly (resp. incorrectly) anticipate the target tax policy such that b = 0 (resp. $b \neq 0$).

Given the structure of the problem, the only free variables are the government's target tax rate τ_g , agents' attention strategies and the equilibrium distribution of the common prior $\hat{q}(\tau)$. Hence, for the sake of simplicity our formal definition of the discretionary

equilibrium only involves these variables. Once they are set, all remaining variables may be mechanically deduced.

Definition 1 (equilibrium). Given the distribution of the implementation shock $f_{\Theta}(\vartheta)$, the equilibrium is a set of target tax rate τ_g^{eq} chosen by the government and attention strategies chosen by the agents such that

- (a) The target tax rate $\tau_g^{\text{eq}} \in [0,1]$ solves the government's problem (17) given the common prior distribution $\hat{q}(\tau)$.
- (b) Attention strategies solve agents' problem (11) given the prior distribution $\hat{q}(\tau)$.
- (c) The common prior distribution $\hat{q}(\tau)$ is the pdf of $\tau_q^{\text{eq}} + b + \vartheta$.

Condition (a) and (b) guarantee that the government and the agents will not have an incentive to deviate while condition (c) ensures that agents' prior and actual tax policy are mutually consistent up to an arbitrary bias b. Indeed, condition (c) implies that the average prior is $\hat{\tau} = \tau_g^{\text{eq}} + b$ in equilibrium. Consequently, taxpayers correctly anticipate the government policy in the rational equilibrium (b = 0) and their attention strategies then reflect their willingness to observe the implementation shock ϑ – which is indeed the only information conveyed through the signals. Hence, implementation shocks are here essentially introduced to ensure that Bayesian taxpayers have an incentive to learn in equilibrium but do not otherwise play an economically meaningful role.

4.3 Commitment and the taxation bias

The discretionary equilibrium is socially suboptimal. To formalize this point, we characterize the welfare-maximizing feasible tax policy. It corresponds to the optimal policy that would be chosen by the government if it could credibly commit to a tax policy. We thus refer to it as the commitment tax policy.

Commitment policy The commitment tax policy is the policy that would be chosen by a benevolent social planner who has the same information as the government but internalizes all equilibrium effects of tax policy. By implicitly restricting the set of tax policies to precommited policy rules, the normative literature (e.g. Farhi and Gabaix (2015)) characterizes this commitment tax policy which corresponds to the optimal tax policy in the presence of information frictions.

Formally, the commitment tax policy solves the government's problem (17) subject to the additional feasibility condition that agents' prior and actual tax policy realizations have to be mutually consistent in equilibrium (condition (c) in Definition 1). It is characterized by the following first order conditions. **Proposition 2.** The commitment tax policy (τ_q^*, R_q^*) is characterized by

$$(\tau_{g}^{\star}) : E_{\vartheta} \left[\int \left\{ \underbrace{\int \left[-\frac{G'(\mathcal{V})}{p} y^{\star} + y^{\star} \right] f_{\tilde{\tau}}(\tau | \tau_{0}; w) d\tau}_{\text{mechanical & welfare effects}} + \underbrace{\int \left[\frac{G(\mathcal{V})}{p} + \tau_{0} y^{\star} \right] \frac{df_{\tilde{\tau}}(\tau | \tau_{0}; w)}{d\tau_{g}} d\tau}_{\text{direct & equilibrium behavioral responses}} \right\} f_{w}(w) dw \right] = 0$$
(21)

$$(R_g^{\star}) : E_{\vartheta} \left[\iint \left[\frac{G'(\mathcal{V})}{p} - 1 \right] f_{\tilde{\tau}}(\tau | \tau_0; w) f_w(w) d\tau dw \right] = 0$$
(22)

together with the resource constraint (18) and where p represents the social marginal cost of public funds. This is the policy implemented in a commitment equilibrium.¹⁷

Proof. See Appendix A.3

As before, conditions have to hold in expectation because of the implementation shock ϑ . The main difference between Propositions 1 and 2 is that the derivative $\frac{df_{\tilde{\tau}}(\tilde{\tau}|\tau_0;w)}{d\tau_g}$ in equation (21) now reflects changes in the signal received (direct adjustment) as well as changes in the prior (equilibrium adjustment). Hence, equilibrium adjustments are here internalized in the choice of tax policy.

Taxation bias The discrepancy between the discretionary and commitment equilibria represents a taxation bias. It is a measure of the deviation from the welfare-maximizing feasible tax policy τ_q^* .

Definition 2 (taxation bias). The taxation bias is the difference between the equilibrium tax rates under discretion τ_g^{eq} and commitment τ_g^{\star} .

The taxation bias arises as a consequence of the government's inability to internalize equilibrium adjustments in its choice of tax policy which induces a commitment problem. Proposition 3 relates the existence of a positive taxation bias to the associated aggregate equilibrium behavioral responses.

Proposition 3. When both equilibria exist and are unique, there is a positive taxation bias if and only if

$$E_{\vartheta} \bigg[\iint \bigg(\frac{G(\mathcal{V})}{p} + (\tau_g^{\star} + \vartheta) y^{\star} \bigg) \bigg(\frac{df_{\tilde{\tau}}(\tau | \tau_g^{\star} + \vartheta; w)}{d\tau_g} - \frac{df_{\tilde{\tau}}(\tau | \tau_g^{\star} + \vartheta; w)}{d\tau_g} \Big|_{\hat{q}(.)} \bigg) f(w) d\tau dw \bigg] \le 0 \quad (23)$$

¹⁷The commitment tax policy is not an equilibrium policy in the sense of Definition 1 because tax policy solves a different problem under commitment. Hence, notions of equilibrium under commitment implicitly refer to the equilibrium of a game in which tax policy would solve the commitment problem. The equilibrium tax policy is then simply equal to the commitment tax policy since all equilibrium adjustments are internalized in the choice of tax policy through the feasibility constraint.

Proof. τ_g^* solves equation (21). Then, condition (23) implies that the left hand-side of equation (19) is ≥ 0 when evaluated at τ_g^* . Hence, it directly follows from the existence and uniqueness of the discretionary equilibrium that $\tau_g^{\text{eq}} \geq \tau_g^*$.

Equation (23) represents the expected change in welfare due to a marginal increase in the prior average. The term $G(\mathcal{V})/p$ stands for the welfare impact of the failure of the envelope condition. It is therefore of second order and can be overlooked when perception biases b are small. Therefore, the above condition holds whenever the expected change in aggregate tax revenue following a marginal increase in the prior average is negative (and of first order). In other words, when perception biases are small there is a positive taxation bias as long as agents tend to work less when they anticipate higher taxes – a mild condition. This shows that information frictions lead to upward distortions in actual tax policy: a discretionary government implements inefficiently high tax rates in equilibrium.

5 Gaussian illustration and sufficient statistics

This section presents an application to a setting with Gaussian implementation shocks. This allows us to derive simpler characterizations of the discretionary and commitment tax policies and to illustrate our findings with numerical simulations. We further provide a sufficient statistics formula for the taxation bias that we use to empirically assess its magnitude in the actual US economy.

5.1 Gaussian discretionary equilibrium

Let the implementation shocks be normally distributed, that is $f_{\Theta}(\vartheta)$ is the pdf of the Gaussian distribution $\mathcal{N}(0, \sigma_{\vartheta}^2)$. The common prior distribution $\hat{q}(\tau)$ is then also Gaussian in equilibrium to ensure that priors are consistent with actual tax policy realizations (condition (c) in Definition 1). Because the Gaussian family is self-conjugate with respect to a Gaussian likelihood, agent w posterior distribution $f_{\tilde{\tau}}(\tau|\tau_0, w)$ is Gaussian as well with (type-specific) mean $\mu = \xi \tau_0 + (1 - \xi)(\tau_g + b)$ in equilibrium. Introducing these equilibrium conditions into Proposition 1, we characterize the discretionary equilibrium tax policy.

Proposition 1'. Up to a first order approximation of the integrands in Proposition 1, the Gaussian discretionary equilibrium tax policy $(\tau_g^{\text{eq}}, R_g^{\text{eq}})$ solves

$$E_{\vartheta} \left[\int \left\{ \underbrace{(1-g) y^{\star}}_{\text{mech. \& wel. effects}} + \underbrace{\left(g(1-\xi)(b-\vartheta) + \tau_0 \right) \frac{dy^{\star}}{d\tilde{\tau}} \xi}_{\text{direct behavioral responses}} \right\} \Big|_{\tilde{\tau}=\mu} dF_w(w) \right] = 0 \quad (24)$$

together with $E_{\vartheta} \left[\int g_{|\tilde{\tau}=\mu} dF(w) \right] = 1$, the government resource constraint (18) and where we have introduced social marginal welfare weights $g \equiv \frac{G'(\mathcal{V})}{p}$.

Proof. See Appendix A.4.

Equation (24) provides a simple expression of taxpayers' direct behavioral responses to tax changes and their impact for the discretionary equilibrium tax policy. Indeed, taxpayers adjust their earnings choice according to changes in their perceived tax rate. Behavioral responses $\frac{dy^*}{d\tilde{\tau}}$ are thus attenuated by the type-specific attention parameter ξ measuring the fraction of the change in taxes that agents observe. Moreover, the new welfare effect associated with the failure of the envelope theorem is directly proportional to the average size of the error in the posteriors $\mu - \tau_0 = (1-\xi)(b-\vartheta)$ multiplied by social welfare weights g. It again captures the corrective motive for taxation in the presence of perception biases.

Figure 3 plots the tax rates (left panel) and income weighted average attention levels (right panel) in the Gaussian discretionary equilibria for different values of the information cost parameter κ . In these simulations, the distribution of skills is calibrated from the 2016 March CPS data and extended with a Pareto tail (k = 2) for incomes above \$200,000. We assume that the government has a log objective and agents have isoelastic work disutility given by $v(y, w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ where we set $\epsilon = 1/e$ with the structural elasticity parameter e = 0.33 (Chetty, 2012). A detailed presentation of the simulation procedure and the calibration strategy is available in the Online appendix.¹⁸

These simulations highlight the importance of information rigidities for tax policy. Under discretion, the equilibrium tax rate (left panel) increases substantially when taxpayers are inattentive (right panel). As the information cost parameter κ increases, attention decreases and the equilibrium tax rate increases. For example, when the average attention level (weighted by incomes) is equal to 0.8, the tax rate at the rational equilibrium is 47.5% in comparison to a 44% tax rate without information frictions. Introducing a systematic downward bias of 5 percentage points in agents priors further increases the equilibrium tax rate, for instance by 1 to 2 percentage points when $\kappa =$ \$60/bit/year. The influence of the systematic perception bias *b* strengthens with taxpayers inattention because it is the equilibrium perception bias that matters for tax policy.

Finally, taxpayers are *ceteris paribus* less attentive when there is little prior uncertainty about the tax rate or, equivalently in equilibrium, when the variance of implementation shocks σ_{ϑ}^2 is small. In this case, the government has higher incentives to increase taxes and the discretionary equilibrium tax rate is higher. It should however be noted that the main effect of the parameter σ_{ϑ}^2 is to rescale the mapping between attention

¹⁸Our simulations indicate that the loss in accuracy due to the approximation in Proposition 1' is very small (with our calibration). Comparing this tax rate to the one obtained directly from Proposition 1, the largest error is smaller than 1% in relative terms.



Figure 3: Gaussian discretionary equilibrium

NOTE: The left panel reports the equilibrium target tax rates for different values of the information cost κ expressed in \$ /bit /year. The right panel reports the average attention parameter ξ weighted by incomes. Low (resp. high) uncertainty corresponds to Gaussian implementation shocks with a standard deviation equal to 0.05 (resp. 0.1). b is the equilibrium perception bias in agents' prior. The government has a log social welfare function and its policy follows from Proposition 1. Taxpayers have an iso-elastic disutility to work $v(y,w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ with $\epsilon = 1/0.33$. The distribution of skills $f_w(w)$ is calibrated using 2016 CPS data and a Pareto tail for high incomes.

levels ξ and the information cost parameter κ . Indeed equilibrium attention strategies depend on the ratio $\kappa/\sigma_{\vartheta}^2$ as can be seen from equation (14). Therefore, once we consider pairs of $(\kappa, \sigma_{\vartheta}^2)$ that induce the same (income-weighted) average attention, tax rates in the low and high uncertainty equilibria are similar.¹⁹

 $^{^{19}}$ For example, we find that when the (income-weighted) average attention level is 80%, the difference between the tax rates in the low and high uncertainty equilibria is only equal to 0.2 percentage points.

5.2 Commitment and the taxation bias

With Gaussian implementation shocks, the characterization of the commitment tax policy can be simplified to

Proposition 2'. Up to a first order approximation of the integrands in Proposition 2, the Gaussian commitment (equilibrium) tax policy (τ_a^*, R_a^*) solves

$$E_{\vartheta} \left[\int \left\{ \underbrace{(1-g)y^{\star}}_{\text{mech. \& wel. effects}} + \underbrace{\left(g(1-\xi)(b-\vartheta) + \tau_0\right)\frac{dy^{\star}}{d\tilde{\tau}}\left(1 - \frac{d\xi}{d\tau_g}(b-\vartheta)\right)}_{\text{direct \& equilibrium behavioral responses}} \right\} \Big|_{\tilde{\tau}=\mu} dF_w(w) \right] = 0 \quad (25)$$

together with $E_{\vartheta} \left[\int g_{|\hat{\tau}=\mu} dF(w) \right] = 1$, the government resource constraint (18) and where we have introduced social marginal welfare weights $g \equiv \frac{G'(\mathcal{V})}{p}$.

Proof. See Appendix A.4.

The direct and equilibrium responses to a change in taxes is now captured through the term $\frac{dy^*}{d\tilde{\tau}} \left(1 - \frac{d\xi}{d\tau_g}(b - \vartheta)\right)$. In the latter, the factor 1 stands for the fact that the government accounts for the equilibrium adjustment of priors when setting its policy. The supplemental term $\frac{d\xi}{d\tau_g}(b - \vartheta)$ captures the effect of changes in attention ξ following a marginal increase in the tax rate on equilibrium tax perceptions. This term vanishes (in expectation) when agents correctly anticipate the tax rate (b = 0) and prompts the government to decrease the tax rate when agents underestimate tax rates (b < 0). Indeed, increasing the tax rate increases attention and thereby reduces tax underestimation in equilibrium which is detrimental to efficiency.

In the left panel of Figure 4 we report the commitment equilibrium tax rates for different values of the information cost parameter κ . In the rational equilibrium (b = 0), the tax rate is only marginally higher in the presence of information frictions. Indeed, the policymaker finds it optimal to marginally increase taxes to prompt taxpayers to be more attentive to implementation shocks. In downward biased equilibria (b < 0), the government further increases the tax rate to exploit the efficiency gains from agents tax underestimation. Indeed, because taxpayers remain inattentive in equilibrium and the prior is downward biased, perceived tax rates are lower than the actual rate. Ultimately, this underestimation of tax rates reduces the efficiency costs of taxation allowing for tax increases. The leverage to increase tax rates is however limited here because the policymaker realizes that it also prompts increases in agents' prior and attention. This results in an increase of perceived tax rates which ultimately increases the efficiency costs of taxation. Consequently, commitment equilibrium tax rates are much smaller than discretionary equilibrium tax rates depicted in Figure 3.

As a consequence, and as depicted in the right panel of Figure 4, the taxation bias increases as the information cost parameter κ grows. Even small information frictions



Figure 4: Taxation bias

NOTE: Difference between positive and normative tax rates for different values of the information cost κ expressed in annual \$ / bit. Low (resp. high) uncertainty corresponds to Gaussian implementation shocks with a standard deviation equal to 0.05 (resp. 0.1). b is the equilibrium perception bias in agents' prior. The government has a log social welfare function and its policy follows from Proposition 2' for the commitment equilibrium. Taxpayers' behavior relies on Assumptions 3.1-3.5 and an iso-elastic disutility to work $v(y, w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ with $\epsilon = 1/0.33$ (Chetty, 2012). The distribution of skills $f_w(w)$ is calibrated using 2016 CPS data.

generate a significant taxation bias. Our simulations indicate that in a rational equilibrium, there is a taxation bias of 4 (resp. 3.5) percentage points in the presence of low (resp. high) uncertainty when the income-weighted average attention parameter is 0.8. Moreover, the taxation bias is above 10 percentage points when the income-weighted average attention falls below 0.55.

The taxation bias can thus lead to significant upward distortions in actual tax rates when the income-weighted average attention turns out to be low. We now show theoretically that this is indeed a key sufficient statistic to empirically assess the magnitude of the taxation bias.

5.3 Sufficient statistics formulas and taxation bias in the US

We derive sufficient statistics formulas for the equilibrium tax policy under discretion and commitment that echo textbook optimal tax formulas and that we combine to obtain a sufficient statistics formula for the taxation bias. To obtain simple sufficient statistics formulas we further assume that preferences are iso-elastic such that the structural labor supply elasticity e - i.e. computed with respect to the perceived marginal net-of-tax rate – is constant and that implementation shocks and perception biases are small.

Corollary 1. A sufficient statistics formula for the Gaussian discretionary equilibrium tax rate characterized in Proposition 1' is

$$\tau_g^{\rm eq} \simeq \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} - b \ \frac{\overline{g(1-\xi)y^{\star}\xi} \ e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e}$$
(26)

where all endogenous right hand side quantities are evaluated at τ_g^{eq} and we have introduced the mean operator $\bar{x} \equiv \int x(w) f(w) dw$.

Proof. See Appendix A.5.

The first term in equation (26) corresponds to the textbook optimal linear tax formula up to the presence of the income weighted average attention $\overline{y^*\xi}$. The second term corresponds to the corrective motive of taxation in the presence of perception biases.

Corollary 2. A sufficient statistics formula for the Gaussian commitment equilibrium tax rate characterized in Proposition 2' is

$$\tau_g^{\star} \simeq \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e} - b \frac{\overline{g(1-\xi)y^{\star}} e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e}$$
(27)

where all endogenous right hand side quantities are evaluated at τ_g^* and we have introduced the mean operator $\bar{x} \equiv \int x(w) f(w) dw$.

Proof. See Appendix A.5.

The first term now exactly coincides with the textbook optimal linear tax formula while the second term again corresponds to the corrective motive of taxation in the presence of perception biases. It should however be noted that corrective terms in equations (26) and (27) are not identical. Their sign are however identical and both are proportional to the perception bias b.

Focusing on near-rational equilibria – that is equilibria with small perception biases $b \simeq 0$ such that corrective terms are second-order – we obtain a simple sufficient statistics formula for the taxation bias.

Proposition 4. A sufficient statistics formula for the taxation bias in Gaussian nearrational equilibria is

$$\tau_g^{\rm eq} - \tau_g^\star \simeq \frac{\overline{(1-\xi)y^\star}}{\overline{(1-g)y^\star}} \ e \ t^2 \tag{28}$$

where all endogenous right hand side quantities are evaluated at the actual tax rate t.

Proof. See Appendix A.5.

This simple formula for the taxation bias is reminiscent of the one provided Section 2 and is a generalization to a situation in which the government has tastes for redistribution and agents' attention is endogenous and hence type-specific.²⁰ The income-weighted average attention $\overline{\xi y^{\star}}$ – or equivalently inattention $\overline{(1-\xi)y^{\star}}$ – thus becomes a key sufficient statistic for the taxation bias. *Ceteris paribus*, the taxation bias increases with the structural elasticity of labor supply e, with the square of the actual tax rate t and decreases with the government redistributive tastes.²¹

In an attempt to gauge the empirical magnitude of the taxation bias in the actual US economy, we bring this sufficient statistics formula to the data. The meta-analysis of Gabaix (2019) combines existing measures of attention to sales taxes to trace out the evolution of average attention with the stakes. We find that income taxes in the US are well approximated by a linear tax schedule with a tax rate of t = 29.46% which would correspond to an average attention parameter of about 0.70. Focusing on the US personal income tax, Rees-Jones and Taubinsky (2019) estimate that agents' attention parameter to their marginal tax rate is equal to 0.81. Accordingly, we consider an average attention of 0.75 to taxes as our baseline. We are then able to compute the associated income-weighted average attention using our model of endogenous attention and the actual distribution of income.

Turning to other sufficient statistics, we take the structural elasticity parameter e = 0.33 estimated by Chetty (2012) and use an inverse optimum approach to deduce the US government's redistributive tastes from the actual tax policy.²²

In the actual US economy, we estimate that the taxation bias is roughly equal to 3.66 percentage points in our baseline calibration. This means that the US income tax rate is 12% higher than what would be optimal holding the government's redistributive objective constant. Table 1 provides a sensitivity analysis varying average attention and

$$\tau_g^{\rm eq} - \tau_g^{\star} \simeq \frac{\operatorname{cov}(\xi, y^{\star}) - \overline{(1-\xi)}\overline{y^{\star}}}{\operatorname{cov}(g, y^{\star})} \ e \ t^2$$

 $^{^{20}}$ Equation (28) can also be expressed in terms of covariances as

²¹Intuitively, the taxation bias *increases* with the government's redistributive tastes as it relatively increases the incentives to implement unanticipated tax increases. However, this first-order effect here transits through an increase in the actual tax rate t and we get the inverse relationship controlling for t.

²²That is, we deduce $\overline{(1-g)y^{\star}}$ from equation (26) assuming $b \simeq 0$.

Taxation bias		Average attention parameter		
(percentage points)		0.65	0.75	0.85
Benthamite	0.27	5.21	3.66	2.17
${\it redistribution}$	0.50	3.11	2.18	1.29
parameter	1.00	1.85	1.30	0.77

Table 1: Estimated taxation bias in the actual US economy

NOTE: Our estimation of the taxation bias (in percentage points) follows from the characterization in Proposition 4. A larger Benthamite parameter corresponds to a more redistributive objective. The value in bold corresponds to our baseline estimate for the 2016 US economy.

the government's redistributive objective. For the latter we use a Benthamite social welfare function for which we vary the value of the parameter that shapes the desire for redistribution. The value of 0.27 closely approximates the welfare weights we estimate using an inverse optimum approach and a value of 1 corresponds to a logarithmic social welfare function – which captures rather extreme redistributive tastes. For realistic redistributive tastes and attention parameters, the magnitude of the taxation bias in the actual US economy ranges from 1.29 to 5.21 percentage points and our baseline estimate of 3.66 lies in the middle of this range.

6 Welfare implications

This section analyzes the welfare implications of information frictions. It first decomposes the variation in aggregate social welfare between potential welfare gains that may be attained with information rigidities (commitment) and the welfare losses associated to actual policy distortions (discretion). It then quantifies the relative importance of the different channels through which information rigidities ultimately affect welfare and redistribution at the individual level.

6.1 Information rigidities and aggregate welfare

Let $SW^{\text{eq}}(b,\kappa)$ be the social welfare from equation (17) evaluated at the discretionary equilibrium. The total welfare impact of information rigidities writes $\Delta SW^{\text{eq}}(b,\kappa) \equiv$ $SW^{\text{eq}}(b,\kappa) - SW^{\text{eq}}(0,0)$ ²³ It may be decomposed between the potential welfare gains from misperceptions and the welfare costs induced by the taxation bias as follows

$$\Delta SW^{\rm eq}(b,\kappa) = \underbrace{SW^{\rm eq}(b,\kappa) - SW^{\star}(b,\kappa)}_{\text{Taxation bias } (\leq 0)} + \underbrace{SW^{\star}(b,\kappa) - SW^{\star}(0,0)}_{\text{Potential gains}}$$
(29)

²³Note that $SW^{eq}(0,b) = SW^{eq}(0,0)$ since as soon as the information cost κ is nil, agents have perfect information and whether priors are biased is irrelevant.

where $SW^{\star}(b,\kappa)$ is the social welfare attained under commitment.

The welfare impact of the taxation bias is negative since the commitment tax policy is by definition the welfare-maximizing feasible policy. As a result, information rigidities are welfare improving if and only if this negative welfare impact is dominated by the welfare gains induced by misperceptions, that is $|SW^{eq}(b,\kappa) - SW^{\star}(b,\kappa)| \leq SW^{\star}(b,\kappa) - SW^{eq}(0,0)$.

This condition requires a downward bias in priors b < 0 such that agents underestimate tax rates. This can be easily seen when looking at the sufficient statistics formula for the commitment tax rate in equation (27). Indeed, when b = 0 the commitment tax rate is equal to the optimal tax rate without information up to a first order approximation. Therefore, there cannot be first order gains from information rigidities. However, equation (28) indicates that the taxation bias is nonetheless positive. Consequently, the total welfare impact is negative. Panel B of Figure 5 illustrates this result for Gaussian implementation shocks.²⁴

While a negative perception bias is necessary for information rigidities to be welfare improving, it is not a sufficient condition. Information rigidities should also not be too large to ensure taxpayers are sufficiently attentive to tax policy. Indeed, as the information cost parameter κ grows, the welfare losses induced by the taxation bias increase more rapidly than the welfare gains from the negative perception bias. Indeed, the former is convex while the latter is concave.

Panel A of Figure 5 illustrates this mechanism with Gaussian implementation shocks. When the downward equilibrium perception bias is equal to 5 percentage points, the welfare gains induced by information rigidities dominate the welfare cost induced by the taxation bias as long as the information cost parameter κ is lower than 25/bit/year. Above this threshold, inattention and the associated deviation from the commitment policy become too important such that information rigidities are welfare decreasing. Therefore, downwards biases in perceived marginal tax rates will be typically associated with a *decrease* – rather than an *increase* – in aggregate social welfare when agents are not

²⁴Strangely enough, the potential gain is first decreasing and then increasing when b is small or nil. While the magnitude of the potential gain is small and thus negligible in comparison to the impact of the taxation bias, it deserves to be briefly explained. Consider the two extreme cases where $\kappa = 0$ and $\kappa \mapsto \infty$. Hence, ξ is respectively equal to one or zero for each taxpayer. Everything else being equal, aggregate earnings are larger when $\kappa \mapsto \infty$ as agents behave as if there were no implementation shocks when deciding how much to earn (individual earnings are a concave function of the perceived rate), while they fully adjust to these shocks when $\kappa = 0$. Consequently, the potential gain converges to a positive value as κ tends to infinity. However, when κ is small but strictly positive, some taxpayers noisily observe the implementation shocks so that the variance of their earnings choices increases. Ultimately, it lowers aggregate earnings and generates a negative and decreasing potential gain for small values of κ . Simulations indicate that the above described variations in aggregate earnings dominate other second order effects (e.g. misoptimization costs).

sufficiently attentive to tax policy.



Figure 5: Welfare decomposition

NOTE: Welfare decomposition from equation (29) for different values of the information cost κ . The standard deviation for the Gaussian implementation shocks is equal to 0.05. *b* is the equilibrium perception bias in agents' prior. The government has a log social welfare function and its policy follows from Proposition ??. Taxpayers have an iso-elastic disutility to work $v(y,w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ with $\epsilon = 1/0.33$ (Chetty, 2012). The distribution of skills $f_w(w)$ is calibrated using 2016 CPS data.

6.2 Redistributive impacts

We now turn to an analysis of the welfare implications of information rigidities at the individual level. Let $\Delta \mathcal{V} \equiv \mathcal{V}_{\kappa}(\tau_g^{\text{eq}}(\kappa), w) - \mathcal{V}_0(\tau_g^{\star}(0), w)$ be the variation in the expected utility of a taxpayer with skill w between the discretionary equilibrium when the information cost is κ and a counterfactual with perfect information. Using a quasi-linear and separable utility function allows us to decompose the variation in expected utility induced by information rigidities in the following way (see Appendix A.7 for precise definitions)

$$\Delta \mathcal{V} = \Delta^{\mathcal{V}} R + \Delta^{\mathcal{V}} \tau_g + \Delta^{\mathcal{V}} \text{info cost} + \Delta^{\mathcal{V}} b + \Delta^{\mathcal{V}} \text{uncertainty}$$
(30)

that is, the welfare impact of information rigidities at the individual level arises from a variation in the demogrant R, the tax rate τ_g , the cost of information acquisition $\kappa \mathcal{I}(\sigma^*)$,

the misoptimization costs induced by potential perception bias b, and the change in overall uncertainty. The increase in the demogrant has a positive effect on expected utility while all other terms are negative.



Figure 6: Variation in expected utility

NOTE: Expected utility decomposition from equation (30) by deciles of the productivity level w. The standard deviation for the Gaussian implementation shocks is equal to 0.1. There is no perception bias in agents' prior b = 0 and the information cost is $\kappa = 50$. The government has a log social welfare function and its policy follows from Proposition 1'. Taxpayers' behavior relies on Assumptions 3.1-3.5 and an iso-elastic disutility to work $v(y,w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ with $\epsilon = 1/0.33$ (Chetty, 2012). The distribution of skills $f_w(w)$ is calibrated using 2016 CPS data.

Figure 6 plots the above expected utility decomposition with Gaussian implementation shocks ($\sigma_{\vartheta} = 0.1$), no perception bias (b = 0) and an information cost κ of \$50/bit per year.

Information rigidities induce policy distortions that create losers and winners. Indeed, the redistributive impact of information rigidities is driven by the increase in the tax rate and thus in redistribution through the demogrant. This naturally benefits low skill workers at the extent of high skill workers.

Somewhat surprisingly, information costs represent a relatively small deadweight loss for society in comparison to the large indirect impact of information frictions on tax policy and welfare. Moreover, it turns out that these information costs are higher for high skill workers because they have higher incentives to collect information and are thus more attentive. Extending our analysis to non-linear tax schedules, we show in the next section that this regressivity of attention has an impact on actual tax progressivity.

7 Tax progressivity and the taxation bias

In this section we extend the analysis to non-linear tax schedules. We find that the taxation bias becomes heterogeneous across income levels and ultimately reduces tax progressivity.

7.1 Introducing nonlinear tax schedules

We allow the government to use a nonlinear tax schedule T(y) but the setup introduced in Section 3 is otherwise unchanged. In particular, we maintain Assumption 1 that individuals use a linear representation of the tax schedule $\tilde{T}(y) = \tilde{\tau}y - \tilde{R}$ which now raises a new question: in the continuum of marginal tax rates $\{T'(y)\}_y$, what is the marginal tax rate $T'(y_w)$ agent w gathers information about?

Absent income effects, the perceived marginal tax rate $\tilde{\tau}_w$ remains a sufficient statistics for labor supply and uniquely pins down earnings $y^*(\tilde{\tau}_w; w)$.²⁵ Using this mapping, we define an agent w ex ante – before information acquisition – optimal earnings level $\hat{y}_w = y^*(\hat{\tau}_w; w)$ and make the following assumption.

Assumption 4 (prior reliance). Taxpayer w gathers information about the actual marginal tax rate $\tau_0(\hat{\tau}_w, w) \equiv T'_0(\hat{y}_w)$ at her ex-ante optimal earnings level \hat{y}_w .

Essentially, Assumption 4 guarantees the internal consistency of the perception formation process by ensuring agents have no additional information ex ante than that contained in their prior. Moreover, it gives a novel allocative role for the prior as taxpayers now linearize the tax schedule around the income level that they deem optimal ex ante.²⁶

The presence of a nonlinear tax schedule does not fundamentally affect equilibrium concepts. Two refinements are nevertheless necessary. First, for the sake of simplicity we assume that implementation shocks ϑ uniformly affect marginal tax rates at all earnings levels y such that $T'_0(y) = T'_g(y) + \vartheta$. Second, the equilibrium condition (c) from Definition 1 – which characterizes the equilibrium adjustment of priors – now becomes

²⁵While the perceived marginal tax rate $\tilde{\tau}$ was already type-specific in the previous sections – through type-specific attention choices –, we here introduce the subscript w to emphasize that it will in addition be type-specific through agents' type-specific priors (see Assumption 4).

²⁶To illustrate this new allocative role, consider the limit where the information cost κ goes to zero. Perceptions are then perfect $\tilde{\tau}_w = \tau_0(\hat{\tau}_w, w)$ and each agent chooses earnings $y_{w|\hat{\tau}_w} = y^*(\tau_0(\hat{\tau}_w, w); w)$. This is in contrast to the full information case in which earnings are the solution to a fixed-point problem characterized by $y_w = y^*(T'_0(y^*(.)); w)$. In a rational equilibrium (b = 0), both income concepts coincide. They will however differ in biased equilibria $b \neq 0$.

(c') The type-specific prior distribution $\hat{q}_w(\tau)$ is the pdf of $T'_a(\hat{y}_w) + b + \vartheta$.

That is, each taxpayer's prior is consistent with her marginal tax rate of interest up to an arbitrary perception bias b. Incidentally, the prior average $\hat{\tau}_w \equiv E_{\hat{q}_w(.)}[\tau]$ is thus necessarily type-specific in equilibrium when the government implements a nonlinear tax schedule. While natural in our context, this poses a potential challenge for the resolution of this nonlinear tax model.

We rely on a perturbation approach in order to derive the optimal tax schedule. Following Jacquet and Lehmann (2017), one needs three assumptions to solve for the optimal non-linear tax schedule using a tax perturbation approach. (i) The tax function $T_g(.)$ must be twice differentiable. (ii) The optimization program of each taxpayer must admit a unique global maximum. (iii) Agents' second-order conditions must hold strictly. While (i) and (ii) are generic requirements to ensure the global smoothness of the problem so that tax perturbations will not induce individuals to jump between different maxima, condition (iii) has less intuitive consequences.

In standard models, condition (iii) – combined with a single crossing assumption on individuals preferences – ensures the existence of an increasing mapping between earnings y and skills w. This is known as a monotonicity condition on allocations.²⁷ It is a requirement for the tax perturbation approach which disciplines the curvature of the tax function $T''_g(.)$. Here, allowing for type-specific priors and a perception bias b poses a potential threat to the existence of an increasing mapping between earnings y and skills w. In the Online Appendix, we show that under our assumptions the monotonicity condition is also expected to hold when $T''_g(.)$ is smooth enough. As a result, we solve for the optimal tax schedule assuming the monotonicity condition is verified and check ex post that it holds at the optimum.

7.2 ABCD tax formula

We can now solve for the optimal nonlinear tax schedule. The government chooses a target nonlinear tax schedule $T_g(.)$ that consists in a continuum of marginal tax rates $\{T'_g(y)\}_y$ and a tax level indexed by the demogrant $T_g(0)$. It is implemented up to an implementation shock ϑ on marginal tax rates and the tax level adjusts such as to satisfy the government budget constraint ex post. The government problem writes

²⁷It follows from agents incentive constraints in a mechanism design approach.

$$\max_{T'_g(.),T_g(0)} \qquad E_{\vartheta} \left[\iint G\Big(\mathcal{V}(\tilde{\tau}_w, T_0(.); \kappa, w) \Big) \ f_{\tilde{\tau}}(\tau | \tau_0(\hat{\tau}_w, w); w) \ f_w(w) \ d\tau dw \right]$$
(31)

s.t.
$$\iint T_0(y^{\star}(\tilde{\tau}_w; w)) \ f_{\tilde{\tau}}(\tau | \tau_0(\hat{\tau}_w, w); w) \ f_w(w) \ d\tau dw \ge E$$
(32)

where E is an exogenous expenditure requirement, $f_{\tilde{\tau}}(\tau | \tau_0(\hat{\tau}, w); w)$ is the posterior distribution of agent w perceived tax rate and with the indirect utility function

$$\mathcal{V}(\tilde{\tau}_w, T_0(.); \kappa, w) = y^{\star}(\tilde{\tau}_w; w) - T_0(y^{\star}(\tilde{\tau}_w; w)) - v\left(y^{\star}(\tilde{\tau}_w; w); w\right) - \kappa \mathcal{I}(\sigma^{\star})$$
(33)

We solve this problem using a perturbation approach. Namely, we consider the effect of a reform that consists in a small increase $\Delta \tau^r$ in marginal tax rates in a small bandwidth of earnings $[y^r - \Delta y, y^r]$ and characterize its impact on the objective function of the government. Following the tax perturbation literature, this reform may be apprehended through three mechanisms: a mechanical effect, a welfare effect and a behavioral effect. However, analyzing the impact of a reform in this setting with information frictions in tax perceptions calls for a careful identification of the agents affected by the reform.

The standard mechanical and welfare effects capture the change in taxes and welfare for individuals w whose earnings are higher than y^r given their perceived tax rates $\tilde{\tau}_w$. Following from the aforementioned monotonicity condition, it corresponds to all agents with a productivity $w \ge w^r$ where $y^*(\tilde{\tau}_{w^r}; w^r) \equiv y^r$. In contrast, the behavioral effect comes from taxpayers who are learning the marginal tax rate affected by the reform. That is, all agents whose ex ante optimal earnings level \hat{y} belong to $[y^r - \Delta y, y^r]$. Again using the monotonicity condition, we can equivalently identify these agents as those with a productivity $w \in [\hat{w}^r - \Delta \hat{w}, \hat{w}^r]$ where $y^*(\hat{\tau}_{\hat{w}^r}; \hat{w}^r) \equiv y^r$. Note that the two cut-offs w^r and \hat{w}^r differ almost surely.²⁸

We then characterize the discretionary and commitment equilibrium tax schedules assuming Gaussian implementation shocks. As before, these conditions are easier to interpret after applying a small implementation shocks approximation which is what we report in Proposition 5, relegating general conditions to the Online Appendix.

Proposition 5 (ABCD formula). Assuming small Gaussian implementation shocks, the equilibrium non-linear tax schedule is to a first-order approximation characterized by

$$\frac{T'_{g}(y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r})) + g(\hat{w}^{r})|_{\tilde{\tau}=\mu_{\hat{w}^{r}}} \left(\mu_{\hat{w}^{r}} - T'_{g}(y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r}))\right)}{1 - \mu_{\hat{w}^{r}}} = \frac{1}{e^{\frac{d\mu_{\hat{w}^{r}}}{d\tau_{g}}}|_{\tilde{\tau}=\mu_{\hat{w}^{r}}}} \frac{1}{y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r})} \frac{\frac{dy^{\star}(\hat{\tau}_{\hat{w}^{r}};\hat{w}^{r})}{dw}}{f_{w}(\hat{w}^{r})} \int_{w^{r}}^{\infty} \left(1 - g(w)|_{\tilde{\tau}=\mu_{w}}\right) f_{w}(w) \ dw \tag{34}$$

²⁸The two cut-offs coincide only when $\hat{\tau}_w = \tilde{\tau}_w$. That is, when b = 0 and $\vartheta = 0$. Since we focus on Gaussian implementation shocks here, it is never the case (a.s.).

together with the transversality condition $\int g(w)|_{\tilde{\tau}_w=\mu_w} dF(w) = 1$ and the government budget constraint (32), where all endogenous quantities are evaluated at their equilibrium values.

Moreover the ex-post average perceived marginal tax rate is $\mu_w \equiv \xi \tau_0(\hat{\tau}_w, w) + [1-\xi]\hat{\tau}_w$ such that $\frac{d\mu_w}{d\tau_g} = \xi$ under discretion and $\frac{d\mu_w}{d\tau_g} = 1 + \frac{d\xi}{d\tau_g} [\tau_0(\hat{\tau}_w, w) - \hat{\tau}_w]$ under commitment. Proof. See Online Appendix.

Under commitment and absent perception biases (b = 0), the ABCD formula boils down to the ABC formula derived in Diamond (1998) and the standard interpretation prevails.²⁹ The presence of perception biases $(b \neq 0)$ has several effects. First, it creates a disconnect between w^r and \hat{w}^r new to this non-linear setting. Second, it adds a welfare effect $(g(\hat{w}^r)(1-\xi)b)$ in the numerator of the LHS) related to the failure of the envelope theorem when agents misoptimize. Third, it adds an efficiency term (fraction on the RHS with $\frac{d\mu_w}{d\tau_g} = 1 + \frac{d\xi}{d\tau_g} [\tau_0(\hat{\tau}_w, w) - \hat{\tau}_w]$ in the denominator) accounting for the variation in agents equilibrium misperception when their attention ξ changes in response to tax reforms.

As before, the emergence of a taxation bias comes from the discrepancy between the estimated impact of a reform under discretion and under commitment. Under discretion, the government fails to internalize the equilibrium impact of the reform on perceptions and accordingly considers that an increase $\Delta \tau^r$ in marginal tax rates only increases perceived marginal tax rates by $\xi \Delta \tau^r \leq \Delta \tau^r$. Increasing marginal tax rates is thus perceived as less costly in terms of efficiency than it really is. As a result, marginal tax rates are in a discretion equilibrium higher than in a commitment equilibrium. In other words, marginal tax rates are higher than they should be from a normative perspective: this is the taxation bias.

What is new to this non-linear setting is that the taxation bias affecting the marginal tax rate $T'_g(y^r)$ at a given level of earnings y^r is driven by the attention level of agents of type \hat{w}^r . Surprisingly, agents \hat{w}^r may not even be located at earnings y^r in the presence of perception biases. More importantly, if attention levels vary across the earnings distribution, the taxation bias will have an impact of the progressivity of the tax schedule.

7.3 Numerical illustration

To illustrate this property we represent in Figure 7 the target nonlinear tax schedules implemented under a discretion equilibrium (actual tax policy – dashed black line) and under commitment (optimal tax policy – full black line). Simulations are carried out absent systematic perception biases (b = 0) such that the optimal nonlinear tax schedule

²⁹The additional term on the RHS disappears since $\frac{d\mu_w}{d\tau_g} = 1$ while we have that $\hat{\tau}_w^{\text{eq}} \approx \tilde{\tau}_w^{\text{eq}}$ ensuring both $w^r \approx \hat{w}^r$ and $\tilde{\tau}_w^{\text{eq}} \approx T'_g(y^*(\mu_{\hat{w}^r}^{\text{eq}}; \hat{w}^r))$.





NOTE: Target non-linear tax schedules (black curves) and attention levels (grey curves) under a discretion equilibrium (actual tax policy) and under commitment (optimal tax policy) for a value of the information cost $\kappa = 30$ \$/*bit/yr*. The government has a log social welfare function and follows the optimal policy from Proposition 5. Taxpayers' have an iso-elastic disutility to work $v(y, w) = (y/w)^{1+\epsilon}/(1+\epsilon)$ with $\epsilon = 1/0.33$ (Chetty, 2012). The distribution of skills $f_w(w)$ is calibrated using 2016 CPS data and extended with a Pareto-tail of parameter a = 2 (Saez, 2001).

corresponds to the textbook optimal nonlinear tax schedule of Saez (2001). We thus naturally retrieve the known U-shape pattern of marginal tax rates.

Because of the taxation bias, marginal tax rates are higher under discretion than under commitment. Strikingly, this difference in marginal tax rates is not constant across earnings levels. For instance, agents located at the first decile (resp. the median) of the earnings distribution face a marginal tax rate of 50% (resp. 44%) under commitment and a marginal tax rate of 63% (resp. 52%) under discretion. In contrast, the marginal tax rate faced by individuals in the top decile (resp. top percentile) increases by at most 4 (resp. 1) percentage points. This reflects the impact of the taxation bias on the progressivity of the tax schedule coming from the variation in attention ξ across earnings.

Attention levels represented in Figure 7 (grey lines) are indeed generally increasing in earnings. In our model, more productive agents have intuitively more latitude to choose the earnings level they see fit and attach thus a higher value to being informed about the tax schedule. As a result, attention globally increases with productivity and thus –

through the monotonicity condition – with earnings.³⁰ Note that this pattern is obtained assuming all individuals have the same cost of information κ . Therefore, assuming that more able workers are also more efficient at collecting information would only reinforce the striking result that, because it decreases with income, inattention to taxes induces regressive tax increases.

Conclusion

We develop a positive theory of tax policy in the presence of information frictions and show that agents' inattention to taxes leads to a taxation bias. We find that this taxation bias is undesirable, large and regressive. Because it reflects a commitment problem, our results suggest that the welfare gains from using precommited tax rules could be large. Alternatively, the model identifies a key parameter to limit the government's deviations from the optimal tax policy: the information cost κ . Therefore, it would be interesting for future research to investigate the determinants behind information costs driving agents' inattention. Indeed, if the latter are related to the complexity of tax systems, monitoring and restricting tax complexity may be a simple and effective way to prevent the implementation of such inefficient and regressive tax increases.

While some of our results may be model-specific, our analysis sheds a new light on the welfare consequences of information frictions in agents' tax perceptions. It underlines that downward biases in tax perceptions are not necessarily welfare improving. They do lower the efficiency costs of taxation in existing tax systems, but existing tax systems without misperceptions are arguably not the right counterfactual to use for welfare analysis. Indeed, there may be other (equilibrium) effects at play – which here take the form of a taxation bias. We show that the welfare consequences of such effects may be dominant thereby delivering counterintuitive welfare implications. One should thus be very careful with the welfare implications drawn from the measurement of misperceptions. We believe that this general lesson applies outside of the realm of taxation.

References

Aghion, P., Akcigit, U., Lequien, M., and Stantcheva, S. (2017). Tax simplicity and heterogeneous learning. NBER Working Paper. 1

Allcott, H., Lockwood, B., and Taubinsky, D. (2018). Ramsey strikes back: Optimal

³⁰The pattern reverts at the very beginning of the earnings distribution because as the marginal tax rate approaches one, we approach the origin of the labor supply function where earnings become infinitely responsive to changes in the marginal tax rates. As a result, very low productive agents end up choosing very high attention levels.

commodity tax and redistribution in the presence of salience effects. In *AEA Papers* and *Proceedings*, volume 108, pages 88–92. 1

- Atkinson, A. B. and Stiglitz, J. E. (1976). The design of tax structure: direct versus indirect taxation. *Journal of public Economics*, 6(1-2):55–75. 1
- Barro, R. J. and Gordon, D. B. (1983). A positive theory of monetary policy in a natural rate model. *Journal of Political Economy*, 91(4):589–610. 5, 8
- Bernheim, B. D. and Taubinsky, D. (2018). Behavioral public economics. In *Handbook* of *Behavioral Economics*, volume 1, pages 381–516. Elsevier. 1, 4
- Blesse, S., Buhlmann, F., and Doerrenberg, P. (2019). Do people really want a simple tax system? Evidence on preferences towards income tax simplification. 5
- Bourguignon, F. and Spadaro, A. (2012). Tax-benefit revealed social preferences. The Journal of Economic Inequality, 10(1):75–108. 5
- Chetty, R. (2009). Sufficient statistics for welfare analysis: A bridge between structural and reduced-form methods. *Annu. Rev. Econ.*, 1(1):451–488. 1
- Chetty, R. (2012). Bounds on elasticities with optimization frictions: A synthesis of micro and macro evidence on labor supply. *Econometrica*, 80(3):969–1018. 5, 22, 25, 27, 30, 31, 36, 47
- Chetty, R. (2015). Behavioral economics and public policy: A pragmatic perspective. American Economic Review, 105(5):1–33. 1
- Chetty, R., Looney, A., and Kroft, K. (2009). Salience and taxation: Theory and evidence. American Economic Review, 99(4):1145–77. 1
- Coibion, O. and Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *American Economic Review*, 105(8):2644–78. 5
- Conseil Constitutionnel (2005). Décision n. 2005-530 DC du 29 décembre 2005. 5
- Conseil Constitutionnel (2012). Décision n. 2012-662 DC du 29 décembre 2012. 5
- Diamond, P. A. (1998). Optimal income taxation: An example with a U-shaped pattern of optimal marginal tax rates. *American Economic Review*, pages 83–95. 35
- Farhi, E. and Gabaix, X. (2015). Optimal taxation with behavioral agents. NBER Working Paper. 1, 3, 11, 18, 19

- Fochmann, M., Kiesewetter, D., Blaufus, K., Hundsdoerfer, J., and Weimann, J. (2010). Tax perception - an empirical survey. Argus Discussion Paper. 5
- Fochmann, M. and Weimann, J. (2013). The effects of tax salience and tax experience on individual work efforts in a framed field experiment. *FinanzArchiv: Public Finance Analysis*, 69(4):511–542. 5
- Gabaix, X. (2019). Behavioral inattention. In Handbook of Behavioral Economics, Vol 2, edited by D Bernheim, S DellaVigna and D Laibson, Forthcoming. Elsevier. 2, 6, 7, 12, 15, 27
- Gerritsen, A. (2016). Optimal taxation when people do not maximize well-being. *Journal* of *Public Economics*, 144:122–139. 1, 18
- Gideon, M. (2017). Do individuals perceive income tax rates correctly? Public Finance Review, 45(1):97–117. 5
- Goldin, J. (2015). Optimal tax salience. Journal of Public Economics, 131:115–123. 1
- Hoopes, J. L., Reck, D. H., and Slemrod, J. (2015). Taxpayer search for information: Implications for rational attention. American Economic Journal: Economic Policy, 7(3):177–208. 2
- Jacobs, B., Jongen, E. L., and Zoutman, F. T. (2017). Revealed social preferences of dutch political parties. *Journal of Public Economics*, 156:81–100. 5
- Jacquet, L. and Lehmann, E. (2017). Optimal income taxation with composition effects. CESifo Working Paper Series. 33
- Kleven, H. J. (2018). Sufficient statistics revisited. 1
- Kydland, F. E. and Prescott, E. C. (1977). Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economy*, 85(3):473–491. 5, 9
- Liebman, J. B. and Zeckhauser, R. J. (2004). Schmeduling. 1
- Lockwood, B. B. and Weinzierl, M. (2016). Positive and normative judgments implicit in us tax policy, and the costs of unequal growth and recessions. *Journal of Monetary Economics*, 77:30–47. 5
- Maćkowiak, B. and Wiederholt, M. (2015). Business cycle dynamics under rational inattention. The Review of Economic Studies, 82(4):1502–1532. 14
- Mackowiak, B. A., Matejka, F., Wiederholt, M., et al. (2018). Survey: Rational inattention, a disciplined behavioral model. *CEPR Discussion Papers.* 2, 14, 41

- Matějka, F. and Tabellini, G. (2017). Electoral competition with rationally inattentive voters. SSRN 3070204. 5, 16
- Miller, B. M., Mumford, K., et al. (2015). The salience of complex tax changes: Evidence from the child and dependent care credit expansion. *National Tax Journal*, 68(3):477– 510. 1
- Mirrlees, J. A. (1971). An exploration in the theory of optimum income taxation. *The Review of Economic Studies*, 38(2):175–208. 17
- Morrison, W. and Taubinsky, D. (2019). Rules of thumb and attention elasticities: Evidence from under- and overreaction to taxes. 2
- Piketty, T. and Saez, E. (2013). Chapter 7 optimal labor income taxation. In Alan J. Auerbach, Raj Chetty, M. F. and Saez, E., editors, *Handbook of Public Economics*, vol. 5, volume 5 of *Handbook of Public Economics*, pages 391 – 474. Elsevier. 4, 6, 10, 18, 45
- Reck, D. (2016). Taxes and mistakes: What's in a sufficient statistic? SSRN 2268617. 1, 11
- Rees-Jones, A. and Taubinsky, D. (2019). Measuring "Schmeduling". Review of Economic Studies. 1, 10, 27
- Saez, E. (2001). Using elasticities to derive optimal income tax rates. Review of Economic Studies, 68(1):205–229. 3, 4, 18, 36, 47
- Saez, E. (2010). Do taxpayers bunch at kink points? American Economic Journal: Economic Policy, 2(3):180–212. 1
- Saez, E. and Stantcheva, S. (2016). Generalized social marginal welfare weights for optimal tax theory. American Economic Review, 106(1):24–45. 2
- Sausgruber, R. and Tyran, J.-R. (2005). Testing the Mill hypothesis of fiscal illusion. Public choice, 122(1-2):39–68. 5
- Sims, C. A. (2003). Implications of rational inattention. *Journal of Monetary Economics*, 50(3):665–690. 13
- Stantcheva, S. (2019). Understanding economic policies: What do people know and learn? In Preparation. 1
- Taubinsky, D. and Rees-Jones, A. (2017). Attention variation and welfare: theory and evidence from a tax salience experiment. *The Review of Economic Studies*, 85(4):2462– 2496. 1, 2, 4, 16

A Appendix

A.1 Solution to the Toy Model with Imperfect Information

The government seeks to maximize tax revenue taking the prior as given. Its problem writes $\max_{\tau} \tau Y(1-\tilde{\tau})$ such that $\tilde{\tau} = \xi \tau + (1-\xi)\hat{\tau}, \{\tau, \hat{\tau}\} \in [0,1]^2$ and $\xi \in (0,1)$. The associated Lagrangian is $\mathscr{L}(\tau, \lambda) = \tau Y(1-\xi\tau-(1-\xi)\hat{\tau}) + \lambda(\tau-1)$. Following from the first order Kuhn and Tucker conditions, $\tau = 1$ if and only if $\hat{\tau} \leq 1 - \frac{\xi}{1-\xi}e$ and $\tau = \frac{1-(1-\xi)\hat{\tau}}{\xi(1+e)}$ otherwise. These conditions are also sufficient since the problem is convex under the assumption that $\tau Y(1-\tau)$ is concave.

At the rational equilibrium, the prior is correct $\hat{\tau} = \tau^*$. Guess that the rational equilibrium is interior. Hence, $\tau^* = \frac{1}{1+\xi e}$. Because e > 0, it implies that $\hat{\tau} > 1 - \frac{\xi}{1-\xi}e$ in equilibrium, thus confirming the guess. It is then straightforward to prove that $\tau^*Y(1-\tau^*) < \tau^r Y(1-\tau^r)$ where $\tau^r \equiv \frac{1}{1+e}$ as $\tau^r = \arg \max_{\tau \in [0,1]} \tau Y(1-\tau)$. Moreover, the taxation bias $\tau^* - \tau^r = \frac{(1-\xi)e}{(1+\xi e)(1+e)}$ is strictly positive for all $\xi \in (0, 1)$.

A.2 Reformulation of the Tractable Gaussian Learning

The indirect utility of a taxpayer is given by equation (12). Performing a second order Taylor approximation of the latter around τ_0 gives

$$V_{\tau_0}^2(\tilde{\tau}, \tau_0, R_0; w) = V(\tau_0, \tau_0, R_0; w) + (\tilde{\tau} - \tau_0) \frac{\partial V}{\partial \tilde{\tau}} \Big|_{\tilde{\tau} = \tau_0} + \frac{(\tilde{\tau} - \tau_0)^2}{2} \frac{\partial^2 V}{\partial \tilde{\tau}^2} \Big|_{\tilde{\tau} = \tau_0}$$
(A.1)

where $\frac{\partial V}{\partial \tilde{\tau}}|_{\tilde{\tau}=\tau_0} = 0$ and $\frac{\partial^2 V}{\partial \tilde{\tau}^2}\Big|_{\tilde{\tau}=\tau_0} = \frac{\partial^2 y^*}{\partial \tilde{\tau}^2}$ from (7). Hence,

$$\iint V_{\tau}^{2}(\tilde{\tau},\tau,R;w)\phi(s;\tau,\sigma)\phi(\tau;\hat{\tau},\hat{\sigma})dsd\tau = \int \left[V(\tau,\tau,R;w) + \frac{\tilde{\sigma}^{2}}{2} \frac{\partial^{2}y^{\star}}{\partial\tilde{\tau}^{2}} \Big|_{\tilde{\tau}=\tau} \right] \phi(\tau;\hat{\tau},\hat{\sigma})d\tau$$

where $\tilde{\sigma}^2$ is the posterior variance and we are using the fact that with a Gaussian prior and a Gaussian signal, the posterior is also Gaussian. Accordingly, the expected information reduction writes

$$\mathcal{I}(\sigma) = \frac{1}{2} \left(\log(2\pi e \hat{\sigma}^2) - \log(2\pi e \tilde{\sigma}^2) \right) = \frac{1}{2} \log \frac{\hat{\sigma}^2}{\tilde{\sigma}^2}$$
(A.2)

where $\frac{1}{2}\log(2\pi e\sigma^2)$ is the differential entropy (in bits) of a Gaussian distribution with variance σ^2 . Therefore, in a Gaussian model, problem (11) becomes

$$\max_{\tilde{\sigma} \ge \hat{\sigma}} \quad \tilde{\sigma}^2 \int \frac{\partial^2 y^*}{\partial \tilde{\tau}^2} \Big|_{\tilde{\tau}=\tau} \phi(\tau; \hat{\tau}, \hat{\sigma}) d\tau - \kappa \log \frac{\hat{\sigma}^2}{\tilde{\sigma}^2}$$
(A.3)

This problem has been extensively studied in the literature. For instance, a step-bystep derivation of the solution is provided in Mackowiak et al. (2018). It shows that the perceived tax rate is $\tilde{\tau} = \xi s + (1 - \xi)\hat{\tau}$ where $\xi \in [0, 1]$ is a measure of the attention level set optimally to

$$\xi = \max\left(0, 1 + \frac{\kappa}{\hat{\sigma}^2 \int \frac{\partial^2 y^*}{\partial \tilde{\tau}^2} \Big|_{\tilde{\tau}=\tau} \phi(\tau; \hat{\tau}, \hat{\sigma}) d\tau}\right)$$
(A.4)

A.3 Proofs of Proposition 1 and 2

We here prove both propositions at the same time since the only difference between the two problems is in the nature of responses to tax changes that are taken into account. We thus solve the general problem where all agents' responses are taken into account (including equilibrium adjustments) to obtain Proposition 2 and from which Proposition 1 naturally follows.

The Lagrangian associated to problem (17) writes

$$\mathscr{L}(\tau_g, R, p) = E_{\vartheta} \bigg[\iint \bigg[G \Big(\mathcal{V}(\tilde{\tau}, \tau_g + \vartheta, R, \kappa; w) \Big) + p \Big((\tau_g + \vartheta) y^{\star}(\tilde{\tau}; w) - R_0 - E \Big) \bigg] f_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w) f_w(w) d\tilde{\tau} dw \bigg]$$
(A.5)

The first-order condition associated with the choice of the marginal tax rate τ_g is

$$\frac{1}{p}\frac{d\mathscr{L}}{d\tau_g} = E_{\vartheta} \left[\int \left\{ \int \left[\frac{G'(\mathcal{V})}{p} \frac{d\mathcal{V}}{d\tau_g} + y^{\star} \right] f_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w) d\tilde{\tau} + \int \left[\frac{G(\mathcal{V})}{p} + (\tau_g + \vartheta)y^{\star} - R_0 - E \right] \frac{df_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w)}{d\tau_g} d\tilde{\tau} \right\} f_w(w) dw \right]$$
(A.6)

where $\frac{df_{\tilde{\tau}}(\tilde{\tau}|\tau_g+\vartheta;w)}{d\tau_g}$ is the change in the posterior distribution of perceived tax rate for type w and captures agents' responses to tax changes.

By definition $\int f_{\tilde{\tau}}(\tilde{\tau}|\tau_g + \vartheta; w) d\tilde{\tau} = 1$ thus $\int \frac{df_{\tilde{\tau}}(\tilde{\tau}|\tau_g + \vartheta; w)}{d\tau_g} d\tilde{\tau} = 0$. Moreover, the quasilinearity of utility implies that $\frac{d\mathcal{V}}{d\tau_g} = -y^*(\tilde{\tau}; w)$. Therefore, the optimality condition $\frac{1}{p} \frac{d\mathscr{L}}{d\tau_g} = 0$ writes

$$E_{\vartheta} \left[\int \left\{ \int \left[-\frac{G'(\mathcal{V})}{p} y^{\star} + y^{\star} \right] f_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w) d\tilde{\tau} \right.$$

$$\left. + \int \left[\frac{G(\mathcal{V})}{p} + (\tau_g + \vartheta) y^{\star} \right] \frac{df_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w)}{d\tau_g} d\tilde{\tau} \right\} f_w(w) dw \right] = 0$$
(A.7)

This is equation (21) from Proposition 1 and characterizes the commitment tax rate. Equation (19) from Proposition 2 which characterizes the tax rate chosen by a discretionary government is obtained by when agents' responses to a change in the tax rate is computed holding agents' prior \hat{q} constant. That is $\frac{df_{\tilde{\tau}}(\tilde{\tau}|\tau_g+\vartheta;w)}{d\tau_g}\Big|_{\hat{q}(.)}$ replaces $\frac{df_{\tilde{\tau}}(\tilde{\tau}|\tau_g+\vartheta;w)}{d\tau_g}$ in equation (A.7).

The first-order condition associated with the choice of the demogrant R is

$$\frac{1}{p}\frac{d\mathscr{L}}{dR} = E_{\vartheta} \left[\iint \left[\frac{G'(\mathcal{V})}{p} \frac{d\mathcal{V}}{dR} - 1 \right] f_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w) f_w(w) d\tilde{\tau} dw \right]$$
(A.8)

By quasi-linearity we have $\frac{d\nu}{dR} = 1$. The optimality condition $\frac{1}{p} \frac{d\mathscr{L}}{dR} = 0$ thus writes

$$E_{\vartheta} \left[\iint \left[\frac{G'(\mathcal{V})}{p} - 1 \right] f_{\tilde{\tau}}(\tilde{\tau} | \tau_g + \vartheta; w) f_w(w) d\tilde{\tau} dw \right] = 0$$
(A.9)

This is equation (20) from Proposition 1 and equation (22) from Proposition 2.

A.4 Optimal policies in tractable Gaussian case

Conditions (A.7) and (A.9) apply to any learning leading to a differentiable posterior distribution of perceptions $f_{\tilde{\tau}}(\tau | \tau_0; w)$ with positive support on [0, 1], where $\tau_0 = \tau_g + \vartheta$. Further insights may be gained by using a tractable Gaussian learning (Assumption 3). Indeed, in this case $f_{\tilde{\tau}}(\tau | \tau_0; w)$ is a Gaussian pdf $\phi(\tau; \mu, \sigma^2)$ with mean $\mu = \xi \tau_0 + (1 - \xi)\hat{\tau}$ and variance $\sigma^2 = \sigma^{\star 2}$. We can thus express agents' responses to tax reforms in terms of changes in the true tax rate τ_0 , changes in the prior mean $\hat{\tau}$ and induced changes in attention ξ that correspond to changes in the precision of the signal σ^{\star} . To do so, we use a first-order approximation of the objective at the mean μ and exploit the following Lemma.

Lemma 3. Let $\psi(x)$ be a differentiable real-valued function, $\psi_a(x) = \psi(a) + (x - a)\psi'(a)$ its first-order Taylor approximation evaluated at a and $\phi(x; \mu, \sigma^2)$ the pdf of the Gaussian distribution with mean μ and variance σ^2 . Then,

$$\int_{\mathbb{R}} \psi_{\mu}(x)\phi(x;\mu,\sigma^2)dx = \psi(\mu)$$
(A.10)

$$\int_{\mathbb{R}} \psi_{\mu}(x) \frac{\partial \phi(x; \mu, \sigma^2)}{\partial \mu} dx = \psi'(\mu)$$
(A.11)

$$\int_{\mathbb{R}} \psi_{\mu}(x) \frac{\partial \phi(x; \mu, \sigma^2)}{\partial \sigma} dx = 0$$
(A.12)

Proof. Equation (A.10) directly follows from $\int_{\mathbb{R}} (x - \mu)\phi(x;\mu,\sigma^2) = 0$ by definition of the mean. To prove equation (A.11), realize that $\int_{\mathbb{R}} \frac{\partial\phi(x;\mu,\sigma^2)}{\partial\mu} dx = 0$ and $\frac{\partial\phi(x;\mu,\sigma^2)}{\partial\mu} = \frac{x-\mu}{\sigma^2}\phi(x;\mu,\sigma^2)$ so that $\int_{\mathbb{R}} (\psi(\mu) + (x - \mu)\psi'(\mu))\frac{\partial\phi(x;\mu,\sigma^2)}{\partial\mu} dx = \frac{\psi'(\mu)}{\sigma^2} \int_{\mathbb{R}} (x - \mu)^2\phi(x;\mu,\sigma^2) = \psi'(\mu)$. Equation (A.12) follows from the fact that $\int_{\mathbb{R}} \frac{\partial\phi(x;\mu,\sigma^2)}{\partial\sigma} dx = 0$ such that the integral of a constant is nil and that $\frac{\partial\phi(x;\mu,\sigma^2)}{\partial\sigma}$ is symmetric such that the integral of x also nil by a symmetry argument.

Rewriting equation (A.7) as

$$E_{\vartheta} \left[\int \left\{ \int \left[-\frac{G'(\mathcal{V})}{p} y^{\star} + y^{\star} \right] \phi(\tau; \mu, \sigma^2) d\tau \right.$$

$$\left. + \int \left[\frac{G(\mathcal{V})}{p} + \tau_0 y^{\star} \right] \left(\frac{d\phi(\tau; \mu, \sigma^2)}{d\mu} \frac{d\mu}{d\tau_g} + \frac{d\phi(\tau; \mu, \sigma^2)}{d\sigma} \frac{d\sigma}{d\tau_g} \right) d\tau \right\} f_w(w) dw \right] = 0$$
(A.13)

allows us to apply Lemma 3 to obtain with $\mu = \xi \tau_0 + (1 - \xi)\hat{\tau}$

$$E_{\vartheta} \left[\int \left\{ \left[-\frac{G'(\mathcal{V})}{p} y^{\star} + y^{\star} \right] \right|_{\tilde{\tau}=\mu} + \left[\left(\frac{G'(\mathcal{V})}{p} (\tilde{\tau} - \tau_0) + \tau_0 \right) \frac{dy^{\star}}{d\tilde{\tau}} \frac{d\mu}{d\tau_g} \right] \Big|_{\tilde{\tau}=\mu} \right\} f_w(w) dw \right] = 0$$
(A.14)

since taking $\psi(\tau) = \left[\frac{G(\mathcal{V})}{p} + \tau_0 y^*\right](\tau)$ implies $\psi'(\mu) = \left[\left(\frac{G'(\mathcal{V})}{p}(\tilde{\tau} - \tau_0) + \tau_0\right)\frac{dy^*}{d\tilde{\tau}}\right](\mu)$ by the modified envelope condition. Recall that $\mu = \xi \tau_0 + (1 - \xi)\hat{\tau}$. Now, in equilibrium we

have by definition that $\hat{\tau} = \tau_g + b$ meaning $\mu = \tau_g + \xi \vartheta + (1-\xi)b$ and $\mu - \tau_0 = (1-\xi)(b-\vartheta)$. Hence, in equilibrium,

$$E_{\vartheta} \left[\int \left\{ \left[-\frac{G'(\mathcal{V})}{p} y^{\star} + y^{\star} \right] \right|_{\tilde{\tau} = \tau_g + \xi \vartheta + (1-\xi)b}$$

$$+ \left[\left(\frac{G'(\mathcal{V})}{p} (1-\xi)(b-\vartheta) + \tau_g + \vartheta \right) \frac{dy^{\star}}{d\tilde{\tau}} \frac{d\mu}{d\tau_g} \right] \Big|_{\tilde{\tau} = \tau_g + \xi \vartheta + (1-\xi)b} \right\} f_w(w) dw \right] = 0$$
(A.15)

Last, we characterize taxpayers' average response to tax reforms $\frac{d\mu}{d\tau_g}$ as computed under discretion and commitment. Under discretion, the policymaker takes agent's priors and thus attention strategies as given, hence $\frac{d\mu}{d\tau_g} = \xi \frac{d\tau_0}{d\tau_g} = \xi$ which yields equation (24). Under commitment, the policymaker internalizes the equilibrium condition that priors and thus attention strategies adjust to the tax policy such that $\frac{d\mu}{d\tau_g} = \xi \frac{d\tau_0}{d\tau_g} + (1-\xi) \frac{d\hat{\tau}}{d\tau_g} + \frac{d\xi}{d\tau_g}(\tau_0 - \hat{\tau}) = 1 + \frac{d\xi}{d\tau_g}(\vartheta - b)$ in equilibrium. This yields equation (25).

Transversality conditions follow from a direct application of Lemma 3 to equation A.9 with again $\mu = \tau_g + \xi \vartheta + (1 - \xi)b$:

$$E_{\vartheta}\left[\int \frac{G'(\mathcal{V})}{p}\Big|_{\tilde{\tau}=\mu}f(w)dw\right] = 1$$
(A.16)

A.5 Sufficient statistics formulas in tractable Gaussian case

Taking a small noise approximation, characterizations of equilibrium tax rates under discretion τ_g^{eq} and commitment τ_g^{\star} in this tractable Gaussian model write

$$\int \left[\left(1 - \frac{G'(\mathcal{V})}{p}\right) y^* + \left(\frac{G'(\mathcal{V})}{p}(1-\xi)b + \tau_g^{\text{eq}}\right) \frac{dy^*}{d\tilde{\tau}} \xi \right] \Big|_{\tilde{\tau} = \tau_g^{\text{eq}} + (1-\xi)b} f_w(w) dw = 0$$
$$\int \left[\left(1 - \frac{G'(\mathcal{V})}{p}\right) y^* + \left(\frac{G'(\mathcal{V})}{p}(1-\xi)b + \tau_g^*\right) \frac{dy^*}{d\tilde{\tau}} \left(1 - \frac{d\xi}{d\tau_g}b\right) \right] \Big|_{\tilde{\tau} = \tau_g^* + (1-\xi)b} f_w(w) dw = 0$$

Assuming preferences are iso-elastic, $U(c, y; w) = c - \frac{(y/w)^{1+\varepsilon}}{1+\varepsilon}$, the elasticity of earnings with respect to the perceived marginal net-of-tax rate e is constant

$$\forall \tilde{\tau}, w, \ e \equiv \frac{1 - \tilde{\tau}}{y^{\star}} \frac{dy^{\star}}{d(1 - \tilde{\tau})} = \frac{1}{\varepsilon} \iff \frac{dy^{\star}}{d\tilde{\tau}} = -e \frac{y^{\star}}{1 - \tilde{\tau}}$$
(A.17)

Plugging in e we get

$$\int \left[\left(1 - \frac{G'(\mathcal{V})}{p}\right) y^{\star} - \left(\frac{G'(\mathcal{V})}{p}(1-\xi)b + \tau_g^{\text{eq}}\right) e \frac{y^{\star}}{1-\tilde{\tau}} \xi \right] \Big|_{\tilde{\tau}=\tau_g^{\text{eq}}+(1-\xi)b} f_w(w) dw = 0$$
$$\int \left[\left(1 - \frac{G'(\mathcal{V})}{p}\right) y^{\star} - \left(\frac{G'(\mathcal{V})}{p}(1-\xi)b + \tau_g^{\star}\right) e \frac{y^{\star}}{1-\tilde{\tau}} \left(1 - \frac{d\xi}{d\tau_g}b\right) \right] \Big|_{\tilde{\tau}=\tau_g^{\star}+(1-\xi)b} f_w(w) dw = 0$$

To further simplify these formulas we now make a small perception bias approximation b << 1. This allows us to use the approximation $\frac{1}{1-\tau_g-(1-\xi)b} \approx \frac{1}{1-\tau_g}$ and to assume $\frac{d\xi}{d\tau_g}b << 1$ to simplify some terms^I. Defining social marginal welfare weights $g(w) \equiv \frac{G'(\mathcal{V})}{p}$ and the mean operator $\bar{x} = \int x(w)f(w)dw$ we get

$$\left\{ \overline{(1-g)y^{\star}} - \frac{\tau_g^{\mathrm{eq}}}{1-\tau_g^{\mathrm{eq}}} \overline{y^{\star}\xi} e - \frac{b}{1-\tau_g^{\mathrm{eq}}} \overline{g(1-\xi)y^{\star}\xi} e \right\} \Big|_{\tilde{\tau}=\tau_g^{\mathrm{eq}}+(1-\xi)b} = 0$$

$$\left\{ \overline{(1-g)y^{\star}} - \frac{\tau_g^{\star}}{1-\tau_g^{\star}} \overline{y^{\star}} e - \frac{b}{1-\tau_g^{\star}} \overline{g(1-\xi)y^{\star}} e \right\} \Big|_{\tilde{\tau}=\tau_g^{\star}+(1-\xi)b} = 0$$

which simplify to the compact sufficient statistics formulas

$$\tau_g^{\rm eq} = \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} - b \ \frac{\overline{g(1-\xi)y^{\star}\xi} \ e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} \tag{A.18}$$

$$\tau_g^{\star} = \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e} - b \frac{\overline{g(1-\xi)y^{\star}} e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e}$$
(A.19)

where all endogenous quantities on the right hand-side of the equations are evaluated at respectively $\tilde{\tau} = \tau_g^{\text{eq}} + (1 - \xi)b$ and $\tilde{\tau} = \tau_g^{\star} + (1 - \xi)b$. In other words formulas are expressed in terms of sufficient statistics evaluated at the optimum.

A.6 Taxation bias in tractable Gaussian case

A difficulty in comparing τ_g^{eq} and τ_g^{\star} is that some right-hand side quantities are endogenous to the tax rate and thus evaluated at different tax rates. To overcome this difficulty, we use a small taxation bias approximation $\tau_g^{\text{eq}} \approx \tau_g^{\star} = t$ such that quantities can be evaluated to a first-order approximation at the same tax rate. Furthermore, we assume that corrective motives associated to the presence of a perception bias b are evaluated at tax rate t such that we can finally directly compare

$$\tau_g^{\rm eq} = \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} - b \ \frac{\overline{g(1-\xi)y^{\star}\xi} \ e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} \tag{A.20}$$

$$\tau_g^{\star} = \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e} - b \frac{\overline{g(1-\xi)y^{\star}} e}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} e}$$
(A.21)

The first terms on the right-hand side corresponds to the standard optimal tax formula (e.g. Piketty and Saez (2013)) whereas the second are corrective terms associated to the existence of a perception bias b. For small perception biases, these corrective terms are second-order and go in the same direction for both positive and normative tax rates. They

^IIn our simulations we do check that $\frac{d\xi}{d\tau_g}$ does not take large values (it takes values between 0.2 and 1 in equilibrium) as a way to confirm the validity of this approximation.

are thus not driving the difference between the two and we disregard them to derive the following simple sufficient statistics formula for the taxation bias

$$\tau_g^{\text{eq}} - \tau_g^{\star} = \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}\xi} \ e} - \frac{\overline{(1-g)y^{\star}}}{\overline{(1-g)y^{\star}} + \overline{y^{\star}} \ e}$$
(A.22)

$$= \frac{\overline{(1-g)y^{\star}}\left(\overline{(1-g)y^{\star}}+\overline{y^{\star}}e\right)-\overline{(1-g)y^{\star}}\left(\overline{(1-g)y^{\star}}+\overline{y^{\star}\xi}e\right)}{\left(\overline{(1-g)y^{\star}}+\overline{y^{\star}\xi}e\right)\left(\overline{(1-g)y^{\star}}+\overline{y^{\star}}e\right)}$$
(A.23)
$$= \frac{e \tau_{a}^{\mathrm{eq}} \tau_{a}^{\star}}{\left(\overline{(1-g)y^{\star}}+\overline{y^{\star}\xi}e\right)}$$
(A.24)

$$= \frac{e \tau_g^{\text{eq}} \tau_g^{\star}}{(1-g)y^{\star}} \left(\overline{y^{\star}} - \overline{y^{\star}\xi}\right) \tag{A.24}$$

$$\simeq \frac{\overline{(1-\xi)y^{\star}}}{\overline{(1-g)y^{\star}}} e t^2 \tag{A.25}$$

A.7 Utility decomposition

Let $\mathcal{V}_{\kappa}(\tau_{g}^{\star}(\kappa), w)$ be the expected utility of taxpayer w at the positive equilibrium when the information cost is κ and the optimal target tax rate of the government is $\tau_{g}^{\star}(\kappa)$. Then, with a separable utility,

$$\mathcal{V}_{0}(\tau_{g}^{\star}(0), w) = E_{\tau_{0}|\tau_{g}^{\star}(0)} \Big[R_{0} + (1 - \tau_{0}) y^{\star}(\tau_{0}; w) - v(y^{\star}(\tau_{0}; w); w) \Big]$$

$$\mathcal{V}_{\kappa}(\tau_{g}^{\star}(\kappa), w) = E_{\tau_{0}|\tau_{g}^{\star}(\kappa)} \Big[\int \Big(R_{0} + (1 - \tau_{0}) y^{\star}(\tau; w) - v(y^{\star}(\tau; w); w) \Big) f_{\tilde{\tau}}(\tau|\tau_{0}, w) d\tau \Big] - \kappa \mathcal{I}(\sigma^{\star}(\hat{q}(\tau), \kappa, w))$$

Using straightforward algebra,

$$\mathcal{V}_{\kappa}(\tau_{g}^{\star}(\kappa), w) - \mathcal{V}_{0}(\tau_{g}^{\star}(0), w) = \Delta^{\mathcal{V}}R + \Delta^{\mathcal{V}}\tau + \Delta^{\mathcal{V}}b + \Delta^{\mathcal{V}}\text{uncertainty} + \Delta^{\mathcal{V}}\text{info cost}(A.26)$$

where

$$\Delta^{\mathcal{V}}R \equiv E_{\tau_0|\tau_g^{\star}(\kappa)}[R_0] - E_{\tau_0|\tau_g^{\star}(0)}[R_0]$$

is the change in the average demogrant,

$$\Delta^{\mathcal{V}}\tau \equiv E_{\tau_0|\tau_g^{\star}(\kappa)}[(1-\tau_0)y^{\star}(\tau_0;w) - v(y^{\star}(\tau_0;w);w)] - E_{\tau_0|\tau_g^{\star}(0)}[(1-\tau_0)y^{\star}(\tau_0;w) - v(y^{\star}(\tau_0;w);w)]$$

is the change in the expected utility due to the change in the tax target $\tau_g^\star,$

$$\Delta^{\mathcal{V}}b \equiv E_{\tau_0|\tau_g^*(\kappa)} \big[(1-\tau_0) \big(y^*(\tau_0+(1-\xi)b;w) - y^*(\tau_0;w) \big) \\ - \big(v(y^*(\tau_0+(1-\xi)b;w);w) - v(y^*(\tau_0;w);w) \big) \big]$$

is the change in the expected utility due to the bias b,

$$\Delta^{\mathcal{V}} \text{uncertainty} \equiv E_{\tau_0 | \tau_g^{\star}(\kappa)} \Big[\int (1 - \tau_0) \big(y^{\star}(\tau; w) - v(y^{\star}(\tau; w); w) \big) \\ \phi \big(\tau; \xi \tau_0 + (1 - \xi) (\tau_g^{\star}(\kappa) + b), (\xi \sigma^{\star})^2 \big) d\tau \\ - \big((1 - \tau_0) \big(y^{\star}(\tau_0 + (1 - \xi)b; w) - v(y^{\star}(\tau_0 + (1 - \xi)b; w); w) \big) \Big]$$

is the change in the expected utility due to noisy information and $\Delta^{\mathcal{V}}$ info $\cos t = -\kappa \mathcal{I}(\sigma^{\star}(\hat{q}(\tau), \kappa, w)).$

Online Appendix (Not for publication)

This online appendix first provides detailed information on the numerical simulations. Second, it gives all proofs and derivations for the extension to nonlinear taxation. Third, we show how to incorporate income effects in the analysis.

B Numerical simulations

Simulations are implemented using Matlab and the algorithm may be summarized as follows. We first estimate a log-normal distribution of skills that we extend with a Pareto tail. This distribution of skills is then binned into a discrete approximation and taken as given for the rest of the exercise. Second, we find the optimal policy of the government using an iterative routine. Starting with a guess for the optimal policy, we compute the optimal attention strategies and allocations in equilibrium (i.e. when the priors are adjusted). We then compute a new optimal policy given taxpayers' choices and iterate until convergence to a fixed point solution.

This appendix provides details on these different steps. We first present the calibration strategy for the skill distribution. Second, we explain how to solve for the optimal attention strategies and allocations for a given tax schedule. Finally, we discuss how the government's problem is solved in the linear tax setting before turning to the nonlinear case.

B.1 Skill distribution

Simulations require an exogenous distribution of skills $f_w(.)$. We fit the adjusted gross incomes from the 2016 March CPS data to a log-normal distribution. The parameters of the log-normal are chosen to exactly match the mean and median of the observed distribution. Following Saez (2001), we extend the log-normal distribution with a Pareto tail (k = 2) for annual incomes above \$200,000. We then discretize the income distribution using evenly distributed bins over the [200; 200,000] interval and evenly distributed bins (in ln scale) over the [200,000; 4,000,000] interval. This allows us to approximate integrals with Riemann sums.

To translate this income distribution into a skill distribution, we invert agents' firstorder conditions for labor supply. We first use OECD data on 2016 labor taxes in the US and fit a linear tax schedule $\{\tau_{obs}, R_{obs}\}$. Then, we impose a quasi-linear utility specification $u(c, y; w) = c - (y/w)^{1+\epsilon}/(1+\epsilon)$ with $e = 1/\epsilon = 0.33$ (Chetty, 2012). Assuming we are in a no bias equilibrium (i.e. rational expectation) such that agents' perceived tax rate coincide with the observed one τ_{obs} , this allows us to compute skills through $w = \left(\frac{y^{\epsilon}}{(1 - \tau_{obs})}\right)^{\frac{1}{1+\epsilon}}$. We also use the estimated linear tax system $\{\tau_{obs}, R_{obs}\}$ together with the actual distribution of earnings to deduce an exogenous expenditure requirement E for the government budget constraint.

B.2 Taxpayers' behavior

Taxpayers' choices are presented in Section 3. For the simulations, we consider Gaussian implementation shocks. Under this assumption, the equilibrium prior distribution is Gaussian as well. Consequently, one may easily compute the attention parameter (ξ) , income (y) and consumption (c) for each taxpayer. Given an attention cost κ , a marginal tax rate τ – that potentially varies for each individual – and an uncertainty parameter σ_{ϑ} , the attention strategy in equilibrium follows from equation (14). Gaussian integrals are approximated using Gauss-Hermite quadratures. Using an agent's first-order condition (7) and budget constraint, we compute her income, consumption and utility for different signal realizations. These computations are made for each type of agent w. The demogrant R is computed from the government budget constraint.

B.3 Optimal linear tax

Unless stated otherwise, we assume throughout our numerical exercise that the social planner has a log objective $G(.) = \log(.)$.

In order to compute the optimal linear tax under discretion, we start with a guess $\tau_{g,0}$. Using this guess, we can deduce each taxpayer's attention strategy when the prior is adjusted to the guess $\hat{\tau}_0 = \tau_{g,0} + b$. We then consider this distribution of attention strategies as constant and use a Matlab optimization routine to find a new $\tau_{g,1}$ which maximizes social welfare for these attention strategies. We then update the prior $\hat{\tau}_1 = \tau_{g,1} + b$, recompute the attention strategies and re-optimize until convergence $|\hat{\tau}_i - \tau_{g,i+1}| \leq 1e^{-5}$. This method is intuitive and captures the essence of the discretionary policy: the government maximizes its objective taking attention strategies as fixed.

We also implement an alternative algorithm where instead of maximizing social welfare numerically we directly pick a new tax rate using the government FOCs in Proposition 1 under a small signals approximation. We find comparable equilibrium rates. Similarly, we compute the optimal policy under commitment using the FOCs in Proposition 2.

B.4 Optimal nonlinear tax

In order to compute the optimal nonlinear tax, we again use an iterative routine. We start with a guess – namely, a constant marginal rate – and iterate until convergence of

the nonlinear tax schedule. We only present results for the unbiased equilibrium b = 0. We proceed in the same spirit as for the linear tax schedule:

- 1. Start with a guess for the nonlinear tax schedule
- 2. Compute the attention strategies $(\forall w)$ for a given adjusted prior $\hat{\tau}_w$
- 3. Compute allocations given attention strategies and tax schedule
- 4. Solve for the government FOCs at each w to deduce a new tax schedule
- 5. Repeat steps 1-4 until convergence.

To maintain the numerical stability of the algorithm we impose a slow adjustment of attention strategies ξ at each iteration. Indeed, marginal tax rates being sensitive to attention, one shall avoid large jumps in the attention parameter. The convergence criteria we use is the infinite norm for both marginal tax rates and attention strategies.

C Proofs for the extension to non-linear taxation

We here provide the proofs on the monotonicity condition and Proposition 5 (ABCD formula) of the main text.

C.1 Monotonicity

In this section, we demonstrate that the monotonicity condition is expected to hold for the quasi-linear and iso-elastic separable utility function that we consider in our simulations. For alternative specifications, we recommend to proceed using a guess-and-verify method. The latter is already implemented in our code and a warning is automatically displayed when the monotonicity does not hold ex post.

With a quasi-linear and iso-elastic separable utility function the first-order condition defining $y^*(\tilde{\tau}_w; w)$ is

$$(FOC)_y : 1 - \tilde{\tau}_w - \frac{1}{w} \left(\frac{y^*}{w}\right)^\epsilon = 0$$
(27)

Differentiating this equation with respect to w yields

$$\frac{\epsilon}{w^2} \left(\frac{y^*}{w}\right)^{\epsilon-1} \frac{dy^*(\tilde{\tau}_w; w)}{dw} = \frac{1+\epsilon}{w^2} \left(\frac{y^*}{w}\right)^{\epsilon} - \frac{d\tilde{\tau}_w}{dw}$$
(28)

Now – in expectation of the realization of the implementation shock ϑ – we also have $\tilde{\tau}_w = T'_g(y^*(\hat{\tau}_w; w)) + (1 - \xi)b$ which allows us to get

$$\frac{d\tilde{\tau}_w}{dw} = T_g''(y^*(\hat{\tau}_w; w)) \frac{dy^*(\hat{\tau}_w; w)}{dw} + \frac{d}{dw} \Big[(1-\xi)b \Big]$$
(29)

and we can show that

1. If agents correctly perceive marginal tax rates (b = 0), the equilibrium condition $\hat{\tau}_w = T'_g(y^*(\hat{\tau}_w; w)) + b$ becomes $\hat{\tau}_w = T'_g(y^*(\hat{\tau}_w; w)) = \tilde{\tau}$. We then have $\frac{dy^*(\hat{\tau}_w; w)}{dw} = \frac{dy^*(\tilde{\tau}_w; w)}{dw}$ such that plugging (29) with b = 0 into (28) the monotonicity condition boils down to

$$\frac{dy^{\star}}{dw} = \frac{\frac{1+\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon}}{\frac{\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon-1} + T_g''(y^{\star})} \ge 0 \iff -T_g''(y^{\star}) \le \frac{\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon-1} \tag{30}$$

2. If agents exhibit a small perception bias $(b \approx 0)$ such that we have $\frac{dy^*(\hat{\tau}_w;w)}{dw} \approx \frac{dy^*(\tilde{\tau}_w;w)}{dw}$ plugging (29) into (28) the monotonicity condition rewrites

$$\frac{dy^{\star}}{dw} = \frac{\frac{1+\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon} - \frac{d}{dw} \left[(1-\xi)b \right]}{\frac{\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon-1} + T_g''(y^{\star})} \ge 0 \iff \begin{cases} -T_g''(y^{\star}) \le \frac{\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon-1} \\ \frac{d}{dw} \left[(1-\xi)b \right] \le \frac{1+\epsilon}{w^2} \left(\frac{y^{\star}}{w}\right)^{\epsilon} \end{cases}$$
(31)

where the equivalence comes from the fact that the other case in which we would have $-T_g''(y^*) \geq \frac{\epsilon}{w^2} \left(\frac{y^*}{w}\right)^{\epsilon-1}$ is infeasible.

Hence, the monotonicity condition will hold if the tax function $T_g(y)$ is sufficiently smooth such that its second derivative is bounded (in absolute value).

C.2 Proposition 5 (ABCD formula)

We proceed with a tax perturbation approach in order to characterize the nonlinear tax schedule chosen under discretion and under commitment. Consider a tax schedule $T_g(.)$ and a reform that consists in a small increase $\Delta \tau^r$ in marginal tax rates in a small bandwidth of earnings $[y^r - \Delta y^r, y^r]$ and let us compute its impact on the government's objective (written in Lagrangian form)

$$\mathscr{L} = E_{\vartheta} \bigg[\iint \left\{ G \Big(\mathcal{V}(\tilde{\tau}_w, T_0(.); \kappa, w) \Big) + p \Big(T_0(y^*(\tilde{\tau}_w; w)) - E \Big) \right\} f_{\tilde{\tau}_w}(\tau | \tau_0; w) f_w(w) d\tau dw \bigg] (32)$$

where p is the multiplier associated to the government's budget constraint and is equal to the social marginal value of public funds at the optimum.

Impact of the reform For a given target tax schedule $T_g(.)$, the reform has

- a mechanical effect dM and a welfare effect dW that translate the lump-sum increase of $\Delta \tau^r \Delta y^r$ in the tax liabilities of agents $w \in [w^r, \infty[$ defined by $y^*(\tilde{\tau}_{w^r}; w^r) \equiv y^r$ where $E_s[\tilde{\tau}_w|\hat{\tau}_w] = \xi T'_0(y^*(\hat{\tau}_w; w)) + (1 - \xi)\hat{\tau}_w$ with $T'_0 = T'_g + \vartheta$
- a labor supply or behavioral effect dB that translates an increase $\Delta \tau^r$ in marginal tax rates that impacts the perceived marginal tax rates $\tilde{\tau}_w$ of agents $w \in [\hat{w}^r \Delta \hat{w}^r, \hat{w}^r]$ defined by $y^*(\hat{\tau}_{\hat{w}^r}; \hat{w}^r) \equiv y^r$ and $y^*(\hat{\tau}_{\hat{w}^r}; \hat{w}^r \Delta \hat{w}^r) \equiv y^r \Delta y^r$

such that the total impact on the government's objective is

$$\frac{d\mathcal{L}}{p} = \frac{dM}{p} + \frac{dW}{p} + \frac{dB}{p}$$
(33)

with

$$\frac{dM}{p} + \frac{dW}{p} = \int_{w^r}^{\infty} E_{\vartheta} \left[\int \left\{ \Delta \tau^r \Delta y^r - \frac{G'(\mathcal{V}(w))}{p} \frac{\partial U}{\partial c} \Delta \tau^r \Delta y^r \right\} f_{\tilde{\tau}}(\tau | \tau_0; w) \, d\tau \right] f_w(w) \, dw$$
$$= \int_{w^r}^{\infty} E_{\vartheta} \left[\int \left(1 - g(w) \right) \Delta \tau^r \Delta y^r \, f_{\tilde{\tau}}(\tau | \tau_0; w) \, d\tau \right] f_w(w) \, dw \tag{34}$$

since we here have, holding $\tilde{\tau}_w$ constant,

$$d\mathcal{V} = \frac{d}{dc} \Big\{ U\Big(\underbrace{y^{\star}(\tilde{\tau}_w;w) - T_0(y^{\star}(\tilde{\tau}_w;w))}_{c}, y^{\star}(\tilde{\tau}_w;w);w\Big) - \kappa \mathcal{I}(\sigma^{\star}) \Big\} dc = -\frac{\partial U}{\partial c} dT_0 \quad (35)$$

and

$$\frac{dB}{p} = \int_{\hat{w}^r - \Delta \hat{w}^r}^{\hat{w}^r} E_{\vartheta} \left[\int \left\{ \frac{G(\mathcal{V}(w))}{p} + T_0(y^{\star}(\tilde{\tau};w)) \right\} \frac{df_{\tilde{\tau}}(\tau|\tau_0;w)}{d\tau_g} \Delta \tau^r \, d\tau \right] f_w(w) \, dw$$
$$\approx E_{\vartheta} \left[\int \left\{ \frac{G(\mathcal{V}(\hat{w}^r))}{p} + T_0(y^{\star}(\tilde{\tau};\hat{w}^r)) \right\} \frac{df_{\tilde{\tau}}(\tau|\tau_0;\hat{w}^r)}{d\tau_g} \Delta \tau^r \, d\tau \right] f_w(\hat{w}^r) \, \Delta \hat{w}^r \quad (36)$$

since we here have, holding $\tilde{\tau}_w$ constant,

$$d\mathcal{V} = \frac{d}{d\tau_g} \Big\{ U\Big(y^{\star}(\tilde{\tau}_w; w) - T_0(y^{\star}(\tilde{\tau}_w; w)), y^{\star}(\tilde{\tau}_w; w); w \Big) - \kappa \mathcal{I}(\sigma^{\star}) \Big\} d\tau_g = 0 \quad (37)$$

Characterization of tax policy The optimality condition for the choice of tax policy $\frac{d\mathcal{L}}{p} = 0$ thus writes

$$E_{\vartheta} \left[\int \left\{ \frac{G(\mathcal{V}(\hat{w}^{r}))}{p} + T_{0}(y^{\star}(\tilde{\tau}_{\hat{w}^{r}};\hat{w}^{r})) \right\} \frac{df_{\tilde{\tau}_{\hat{w}^{r}}}(\tau|\tau_{0};\hat{w}^{r})}{d\tau_{g}} d\tau \right] \frac{f_{w}(\hat{w}^{r})}{\frac{dy^{\star}(\hat{\tau}_{\hat{w}^{r}};\hat{w}^{r})}{dw}} \\ + \int_{w^{r}}^{\infty} E_{\vartheta} \left[\int \left(1 - g(w) \right) f_{\tilde{\tau}_{w}}(\tau|\tau_{0};w) d\tau \right] f_{w}(w) dw = 0$$
(38)

where we have simplified through by $\Delta \tau^r \Delta y^r$ noting that

$$y^{\star}(\hat{\tau}; \hat{w}^r - \Delta \hat{w}^r) \equiv y^r - \Delta y^r \implies \Delta \hat{w}^r \frac{dy^{\star}(\hat{\tau}_{\hat{w}^r}; \hat{w}^r)}{dw} \approx \Delta y^r$$

Assuming we are in the tractable Gaussian case, the expost (after learning) distribution of the perceived marginal tax rate is Gaussian $f_{\tilde{\tau}_w}(\tau | \tau_0; w) \sim \mathcal{N}(\mu_w, \sigma^2)$ with mean $\mu_w = \xi \tau_0 + (1 - \xi) \hat{\tau}_w$ and variance parameter $\sigma = \sigma^*$. Applying Lemma 3 we can thus rewrite the optimality condition as

$$E_{\vartheta}\left[\left[\left\{\frac{G'(\mathcal{V}(\hat{w}^{r}))}{p}\left(\tilde{\tau}_{\hat{w}^{r}}-T_{0}'(y^{\star}(\tilde{\tau}_{\hat{w}^{r}};\hat{w}^{r}))\right)\right. + T_{0}'(y^{\star}(\tilde{\tau}_{\hat{w}^{r}};\hat{w}^{r}))\right]\frac{dy^{\star}}{d\tilde{\tau}}\frac{d\mu_{\hat{w}^{r}}}{d\tau_{g}}\right]\Big|_{\tilde{\tau}=\mu_{\hat{w}^{r}}}\frac{f_{w}(\hat{w}^{r})}{\frac{dy^{\star}(\hat{\tau}_{\hat{w}^{r}};\hat{w}^{r})}{dw}} + \int_{w^{r}}^{\infty}\left[1-g(w)\right]\Big|_{\tilde{\tau}=\mu_{w}}f_{w}(w)\ dw\right] = 0$$
(39)

where $\frac{d\mu_w}{d\tau_g} = \xi \frac{d\tau_0}{d\tau_g} = \xi$ under discretion since the government takes agents' priors as given whereas $\frac{d\mu_w}{d\tau_g} = \xi \frac{d\tau_0}{d\tau_g} + (1-\xi) \frac{d\hat{\tau}_w}{d\tau_g} + \frac{d\xi}{d\tau_g} (\tau_0 - \hat{\tau}_w)$ under commitment since the government internalizes that priors adjust to the choice of tax policy and are thus an endogenous object.

In addition, the Lagrange multiplier is – absent income effects – determined by the same transversality condition as before

$$E_{\vartheta} \left[\int_0^\infty \left[1 - g(w) \right] \Big|_{\tilde{\tau} = \mu_w} f_w(w) \ dw \right] = 0$$
(40)

which can be obtained in a perturbation approach by computing the impact of a uniform lump-sum increase in taxes.

ABCD formula To obtain our ABCD formula from equation (39), let us introduce $e = \frac{1-\tilde{\tau}_w}{y^*(\tilde{\tau}_w;w)} \frac{dy^*(\tilde{\tau}_w;w)}{d(1-\tilde{\tau}_w)}$ and assume that the shock ϑ is small to use $E_\vartheta[\psi(\vartheta)] \approx \psi(E_\vartheta[\vartheta])$ regardless of function ψ 's curvature such that $E_\vartheta[\psi(\tau_0)] \approx \psi(\tau_g)$. This yields

$$\frac{T'_{g}(y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r})) + g(\hat{w}^{r})|_{\tilde{\tau}=\mu_{\hat{w}^{r}}} \left(\mu_{\hat{w}^{r}} - T'_{g}(y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r}))\right)}{1 - \mu_{\hat{w}^{r}}} = \frac{1}{e^{\frac{d\mu_{\hat{w}^{r}}}{d\tau_{g}}}|_{\tilde{\tau}=\mu_{\hat{w}^{r}}}} \frac{1}{y^{\star}(\mu_{\hat{w}^{r}};\hat{w}^{r})} \frac{\frac{dy^{\star}(\hat{\tau}_{\hat{w}^{r}};\hat{w}^{r})}{dw}}{f_{w}(\hat{w}^{r})} \int_{w^{r}}^{\infty} \left(1 - g(w)|_{\tilde{\tau}=\mu_{w}}\right) f_{w}(w) \, dw \tag{41}$$

where $\mu_w = \xi T'_g(y^*(\hat{\tau}_w; w)) + (1 - \xi)\hat{\tau}_w$ and $\frac{d\mu_w}{d\tau_g} = \xi \frac{dT'_g(y^*(\hat{\tau}_w; w))}{d\tau_g} = \xi$ under discretion since the government takes agents' priors as given whereas $\frac{d\mu_w}{d\tau_g} = \xi + (1 - \xi)\frac{d\hat{\tau}_w}{d\tau_g} + \frac{d\xi}{d\tau_g}(T'_g(y^*(\hat{\tau}_w; w)) - \hat{\tau}_w)$ under commitment since the government internalizes that priors adjust to the policy rule and are thus an endogenous object.

Note that with a quasi-linear and iso-elastic separable utility function we have $y^*(\tilde{\tau}_w; w) = w^{1+\frac{1}{\epsilon}}(1-\tilde{\tau}_w)^{\frac{1}{\epsilon}}$ and $e = \frac{1}{\epsilon}$ such that

$$\frac{dy^{\star}(\tilde{\tau}_w;w)}{dw} = \left(1 + \frac{1}{\epsilon}\right) w^{\frac{1}{\epsilon}} (1 - \tilde{\tau}_w)^{\frac{1}{\epsilon}} = \frac{1 + e}{w} y^{\star}(\tilde{\tau}_w;w)$$
(42)

Assuming small (or no) perception biases such that $\tilde{\tau}_w \approx \hat{\tau}_w$ and $\frac{dy^{\star}(\tilde{\tau}_w;w)}{dw} \approx \frac{dy^{\star}(\hat{\tau}_w;w)}{dw}$ yields

$$\frac{T'_g(y^*(\mu^{\rm eq}_{\hat{w}^r};\hat{w}^r)) + g(\hat{w}^r)(1-\xi)b}{1-\tilde{\tau}^{\rm eq}_{\hat{w}^r}} = \frac{1}{\frac{d\mu_{\hat{w}^r}}{d\tau_g}} \frac{1+e}{e} \frac{1}{\hat{w}^r f_w(\hat{w}^r)} \int_{w^r}^{\infty} \left(1-g(w)\right) f_w(w) \ dw \ (43)$$

D Income effects

In this final section of the Online Appendix, we illustrate how the (linear tax) model in the paper could be extended to account for income effects and accordingly characterize tax policy under discretion and commitment. We now have to account for the fact that the average posterior tax rate is no longer a sufficient statistics for taxpayers' earnings choices. This requires a mere reformulation of the initial problem without income effects: integration in the government's problem is now with respect to the signal distribution.

In order to introduce income effects, it will prove useful to slightly reformulate taxpayers' problem introduced in Section 3. To this end, consider that there is a continuum of individuals at each skill w of size f(w) and let $Y(\tau_0) \equiv \iint y^*(\cdot)\phi(s;\tau_0,\sigma^*)dsdF(w)$ be the aggregate earnings. Then, because the government budget constraint is binding at the optimum, the demogrant writes $R(\tau_0) = \tau_0 Y(\tau_0) - E$ as the overall population remains of size one. Further, and given that a taxpayer's budget constraint binds ex post, consumption adjusts such that $c_0 = R(\tau_0) + (1 - \tau_0)y$. Therefore, an agent's utility is $u(R(\tau_0) + (1 - \tau_0)y, y)$ for a realization τ_0 and earnings choice y.

Given the above reformulation, the only uncertainty arises from the randomness in the realized tax rate. An individual therefore chooses the signal precision σ and income y to maximize her expected utility

$$\sup_{\sigma,y|s} \iint u(R(\tau) + (1-\tau)y, y; w)\phi(s; \tau, \sigma)\hat{q}(\tau)dsd\tau - \kappa \mathcal{I}(\sigma)$$
(44)

where admissible earnings policies for this individual's choice may depend on the signal s. Now, guess that the optimal attention strategy σ^* depends only on w, $\hat{q}(.)$, and κ . As a consequence, the optimal earnings choice $y^*(s, w; \sigma^*, \hat{q}(.))$ now solves

$$\int [(1-\tau)u_c(R(\tau) + (1-\tau)y^*, y^*; w) + u_y(R(\tau) + (1-\tau)y^*, y^*; w)]f(\tau|s; \sigma^*, \hat{q}(.))d\tau = 0$$
(45)

where $f(\tau|s; \sigma^*, \hat{q}(.)) = \frac{\phi(s;\tau,\sigma^*)\hat{q}(\tau)}{\int \phi(s;\tau,\sigma^*)\hat{q}(\tau)d\tau}$ from Bayes rule. Assume that a solution to equation (45) exists. In turn, it implies that

$$\sigma^{\star}(w, \hat{q}(.), \kappa) = \arg \sup_{\sigma} \iint u(R(\tau) + (1 - \tau)y^{\star}, y^{\star}; w)\phi(s; \tau, \sigma)\hat{q}(\tau)dsd\tau - \kappa \mathcal{I}(\sigma)(46)$$

thus confirming the guess on σ^* (when it exists). We can now define agents' indirect utility function

$$\mathcal{V}(s,\tau_0;w,\kappa,\hat{q}(.)) \equiv u(R(\tau_0) + (1-\tau_0)y^\star,y^\star;w) - \kappa \mathcal{I}(\sigma^\star)$$
(47)

Turning to the government problem, it requires a mere variation from (17)

$$\max_{\tau_g} \quad E_{\vartheta} \left[\iint G \Big(\mathcal{V} \big(s, \tau_0; w, \kappa, \hat{q}(.) \big) \Big) \phi(s; \tau_0, \sigma^{\star}) f_w(w) d\tau dw \right]$$
(48)

Note that the inner integration is now with respect to the signal distribution $\phi(s; \tau_0, \sigma^*)$ and no longer with respect to the posterior distribution of perceived rates. This is because the perceived tax rate $\tilde{\tau}$ is no longer a sufficient statistics for earnings choices. The first order condition for the target tax rate under discretion writes

$$E_{\vartheta} \left[\int \left\{ \int \left[G'(\mathcal{V}) \frac{d\mathcal{V}}{d\tau_g} \phi(s; \tau_0, \sigma^*) ds + \int G(\mathcal{V}) \frac{d\phi(s; \tau_0, \sigma^*)}{d\tau_g} ds \right\} f_w(w) dw \right] = 0$$
(49)

and the first order condition for the target tax rate under commitment writes

$$E_{\vartheta} \left[\int \left\{ \int \left[G'(\mathcal{V}) \left(\frac{d\mathcal{V}}{d\tau_g} + \frac{d\mathcal{V}}{d\hat{q}(.)} \frac{d\hat{q}(.)}{d\tau_g} \right) \phi(s; \tau_0, \sigma^\star) ds + \int G(\mathcal{V}) \frac{d\phi(s; \tau_0, \sigma^\star)}{d\tau_g} ds \right\} f_w(w) dw \right] = 0$$
(50)

This characterizes tax policy under discretion and commitment in the presence of income effects. The key difference between the two equations is the fact that the commitment tax policy takes into account the adjustment in the prior $\frac{d\hat{q}(.)}{d\tau_g}$ whereas the discretion tax policy does not. This leads to a taxation bias.