Effort and Compliance as Endogenous Taxpayer Decisions

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1. Introduction

Two important streams of research have emerged in the study of tax administration. The first addresses the determinants of taxpayer compliance. The classical approach of Allingham and Sandmo (1972) posits that the benefit of underreporting income is the prospect of lowering one's actual tax outlay, and that the costs are the penalties of getting caught doing so. A voluminous literature, both theoretical and empirical, has grown from this classical treatment. The second stream estimates the costs borne by taxpayers in the course of paying their tax liabilities. These compliance costs are typically estimated to equal a non-negligible fraction of tax revenues. They are also several times larger than the direct administrative costs associated with operating a tax agency.

While these two streams of research have traditionally been studied separately, the objective of this paper is to integrate them. The extent of taxpayer compliance and the magnitude of compliance costs are not determined in isolation of each other. Compliance costs will disincentivize the action that incurs them—compliance. Similarly, noncompliance costs disincentivize noncompliance. Reversing the direction of causality, greater compliance will require higher compliance costs while reducing the expected noncompliance costs. We demonstrate that the endogenous and simultaneous determination of taxpayer compliance and compliance costs is necessary for explaining many observed taxpayer reporting behaviors. We

[1] The views expressed in this paper are those of the authors, and do not necessarily represent the positions of the Internal Revenue Service or the Department of the Treasury.

also demonstrate that such endogeneity has important implications for interpreting estimates of compliance costs.

The costs of compliance may take many forms, including direct monetary outlays for tax preparation services as well as non-monetary costs like time and stress. We characterize all of these different types of costs as the “effort” taxpayers must expend in meeting their tax obligations. Within this broader definition of “effort,” we identify two distinct concepts of “compliance effort.” First, being compliant often involves direct costs, and some taxpayers who would otherwise wish to comply may be unwilling to pay all of those costs. Others may even overreport their liability if they perceive that paying a little extra tax would save them from having to spend an even greater amount in compliance costs. Second, accounting and tax code complexities lead to taxpayer uncertainty with regard to the amount that should be reported by law. This uncertainty can be reduced, but only with costly effort. We show that such uncertainty systematically leads to lower voluntary compliance, even if uncertain taxpayers are “on average” correct about their true liability. In both concepts, then, exogenous changes that reduce the effort required to be compliant can promote greater compliance.

Notice that this changes the taxpayer’s choice from “How much should I understate my income?” (the question inherent in the classical approach) to “How much effort should I put into this task?” The answer to the first question is jointly determined with the answer to the second question, though different taxpayers may be more fundamentally driven by one of these questions over the other. The motivating determinant of taxpayer reporting may even vary across lines on the tax return.

Even “inadvertent” errors are caused by the same mechanism. To see this, consider the extreme scenario in which *every* error on the tax return faced certain detection and a very draconian penalty (i.e., untenable to everyone). It’s natural to expect that such conditions would cause “inadvertent” errors to essentially vanish as taxpayers would willingly undertake much greater costs to ensure that their returns were perfectly accurate. That is, as taxpayers perceive the risks of noncompliance to be greater, they are willing to put more effort into meeting their tax obligations. Therefore, “inadvertent” errors actually result from a conscious choice as to how much effort to put into the taxpaying process, which depends on the taxpayer’s perceptions of the expected benefits and costs. In that sense, they are not really “inadvertent” at all.

Accounting for effort enables us to explain several taxpayer reporting patterns that are otherwise unexplained. We document several of these reporting patterns using data from the Internal Revenue Service’s (IRS) National Research Program (NRP). These data consist of the self-reported and IRS-corrected tax returns for a stratified random sample of taxpayers.

We also use our framework of endogenous effort to assess the predicted impact of various tax administration reforms that affect taxpayers’ effort. Such counterfactuals are of particular policy relevance given that compliance costs, as opposed to other classical compliance determinants like audit rates and nonclassical determinants like social norms, may be more readily and inexpensively affected by tax administrators and legislators. We also assess how these counterfactuals may differentially affect different types of taxpayers. In general, highly noncompliant taxpayers are driven by the classical financial benefits of underreporting their tax, but may take on certain “compliance costs” to lower their risks strategically. In contrast, taxpayers who are minimally noncompliant (our analysis of NRP data suggests there are many such taxpayers) are driven by compliance costs, and in turn will be more responsive to changes in said costs. These responses may have the dual effect of both increasing the welfare of both compliant and noncompliant taxpayers while simultaneously generating greater voluntary tax compliance. Of particular note, we demonstrate that reductions in compliance costs lead to Pareto superior outcomes in which specific taxpayers are better off, even though they may pay larger tax liabilities in response to these reductions, as are taxpayers in general to the extent that aggregate tax revenues will actually increase.

The paper proceeds as follows: Section 2 discusses relevant foundations in the tax compliance literature; Section 3 presents our theoretical model; Section 4 provides evidence from National Research Program (NRP) data consistent with our theory of effort; and Section 5 reflects on some key policy and empirical implications of our model.

2. Literature Review

Allingham and Sandmo (1972) and Yitzhaki (1974) provide the classical theoretical approach to tax compliance. The theory assumes that taxpayers are amoral expected utility maximizers akin to the stylized agent in the Becker (1968) economic theory of crime. As such, taxpayers would innately prefer to pay zero tax liability but are deterred from doing so by the threat of being audited and penalized. Andreoni and et al (1998) and Slemrod and Yitzhaki (2002) are useful surveys of theoretical and empirical studies of tax compliance and its determinants.

Much of the existing literature on compliance costs is descriptive in nature. It addresses two questions. First, how large are compliance costs? Second, what factors contribute to the determination of compliance costs? Of course, answering the second question requires that the researcher already have estimated the size of compliance costs.

Estimates of the size of compliance costs typically rely on survey data. Surveyed individuals may include taxpayers themselves but also professionals who assist in the determination and preparation of tax filings. Surveys typically estimate two forms of compliance costs: first, monetary outlays on professional tax preparation services; second, the time spent in the course of tax preparation. In order to generate a single aggregate compliance cost measure, a monetary value must be assigned to time. Surveys also do not capture other forms of compliance costs, for instance the stress of preparing one's taxes.

Slemrod and Sorum (1984) surveys Minnesota taxpayers and estimates that individual income tax compliance costs are approximately five to seven percent of tax revenue. Following TRA86, Blumenthal and Slemrod (1992) also survey Minnesota taxpayers and estimate that the reform had negligible impact on individual income tax compliance costs. Other survey-based studies include the Blumenthal and Slemrod (1995) study of foreign-source income taxation, the Slemrod and Blumenthal (1996) and Gupta and Mills (2003) studies of corporate income tax, and the Blumenthal and Kalambokidis (2006) study of non-profits' compliance costs of maintaining tax exempt status.

The Internal Revenue Service (IRS) itself has undertaken significant efforts to measure compliance costs using survey data. In 1988 the IRS and Arthur D. Little, Inc. developed a model of the paperwork compliance burden in response to the Paperwork Reduction Act of 1980. Since then, the IRS's survey efforts have expanded to account for a broader definition of taxpayers' compliance burdens. Guyton et al. (2003) and Marcuss *et al.* (2013) describe the current surveying procedure and model, the Individual Taxpayer Burden Model (ITBM), and provide summary statistics of its findings.

A noteworthy exception to the reliance on survey data is the Pitt and Slemrod (1989) study on the compliance costs of itemizing deductions on individual tax returns. The compliance cost is inferred from tax filings by calculating the savings that taxpayers forgo by taking the standard deduction rather than itemizing. The approach is similar to the Moffitt (1983) methodology for estimating the monetary value of the stigma associated with participation in welfare programs.[2] The drawback of this methodology is that it does not separate the different components of compliance cost (e.g. time vs. money). The virtues are threefold: first, it relies on revealed behavior rather than survey responses; second, it does not require the researcher to assume any specific monetary value for time; third, it captures the monetary value of compliance cost components like stress that are not typically included in surveys.

Besides estimating the size of compliance costs, the studies typically aim to address how different factors impact compliance costs. For instance, the Blumenthal and Slemrod (1992) study of individual income tax compliance costs uses a taxpayer's income and the types of income reported (e.g., capital gains, interest, dividends, rents, etc.) to explain compliance costs. The authors also merge their data with the earlier data from Slemrod and Sorum (1986) to estimate the effect of the TRA86 tax reform on compliance costs. More recently, Marcuss *et al*. (2013) use a taxpayer's (self-reported) income and the complexity of his (self-reported) non-0 line items to explain compliance costs. In Section 5 we discuss how our theory impacts the interpretation of these results. Here, we simply mention that if taxpayers' reporting is itself impacted by compliance costs, then the explanatory variables used in these studies are endogenously determined and their coefficients must be interpreted accordingly.

[2] Unlike welfare participation, itemization of deductions does not carry any stigma. Therefore, the forgone tax savings are more likely to identify compliance costs.

3. **Theoretical Model**

Our theoretical treatment distinguishes between two different concepts of “effort” associated with tax compliance. First, some effort is required to submit any non-0 report, even if that non-0 report is not necessarily accurate. If one takes a more macro view of the model, then this can be interpreted as the cost of filling out and submitting a Form 1040 compared with simply not filing. If one takes a more micro view of the model, where the taxpayer problem applies to each individual line item, then this is the cost of putting a non-0 value on a given line item. This cost may arise from the fact that additional documentation must be gathered that substantiates the non-0 report, or additionally, that a non-0 value on the line item requires filling out a corresponding tax form (e.g. the Schedule C form for sole proprietorship income).

We contrast this with the effort required to report *accurately*. Given the complexity of the tax code and tax filing process, it seems altogether reasonable that exerting a minimum level of effort to submit a non-0 report does not guarantee that said report is accurate. First, significant effort may be necessary to determine the correct amount to report. Second, even when that amount has been determined, the documentation and filing requirements necessary to report that amount may be burdensome. These costs may be borne before or after “tax season.” For instance, a sole proprietor earning Schedule C income must choose how well he will record income and expense receipts over the course of a year, prior to knowing what his end-of-year tax liability will be.

We account for these different types of effort by introducing two cost concepts into the taxpayer’s decision-making process. The first is a cost associated with reporting any non-zero amount, whether that report is accurate or not. The second is a cost associated with accuracy. Dealing with the first cost is rather straightforward but the second requires more consideration.

A simple way to account for the cost of accuracy would be to impose some functional relationship between a taxpayer's self-reported income and the effort required to report that amount. However, we elect not to do so because it is not clear how these two values are related. For instance, a taxpayer may have received some poorly documented taxable income that is difficult to understand how to report accurately. In that case, higher (and more accurate) amounts of self-reported income would require greater effort. Alternatively, a taxpayer may possess some potentially tax-exempt income, but the determination of said exemption requires additional research. Even if the research reveals that the income is tax-exempt, effort must be exerted in documenting the validity of the exemption. In that case, lower (and more accurate) amounts of self-reported income would require greater effort.

We instead assume that each taxpayer has an "easy," though not necessarily accurate, amount of income he could report. He also has a perceived distribution of true taxable income amounts, but the actual amount is determined, documented, and reported only with effort. We develop our model in a general fashion such that the expected true amount of income may be greater or less than the "easy-to-report" amount.

Our approach therefore requires us to consider how taxpayers will behave with different information sets. First, we consider the case of a taxpayer who knows his true taxable income. We derive that taxpayer's optimal report strategy contingent upon said income amount. Second, we consider the case of a taxpayer who does not know his true taxable income amount, but perceives some distribution of possible values. In this imperfect information environment, the taxpayer's choice set of self-reported income amounts is limited to either 0 or some alternative "easy" amount to report. Third, we consider the taxpayer who initially possesses imperfect information like the second taxpayer. However, he can choose to exert the effort to determine and document his true taxable income. The benefit of doing so is that the taxpayer can then follow the optimal strategy of the first taxpayer with perfect information. The cost is the effort required to be accurate.

It is worth emphasizing that our model with imperfect information is constructed to maintain some degree of generality. For instance, it is general enough to account for cases where taxpayers already know their true taxable income, and the cost of accuracy simply reflects the effort required to properly document and report that amount. This is simply a special case of our model in which the taxpayer's perceived distribution of true income values has zero variance around the true taxable income amount.

We make several simplifying assumptions in our theory. For instance, we assume that taxpayers are risk-neutral and subject to a linear income tax rate. We also assume that they face a fixed probability of audit, a fixed rate of detection conditional upon audit, and a fixed penalty rate. In reality, each may be endogenous to the taxpayer's compliance behavior. We do not claim these assumptions are realistic, but elect to maintain them in order to promote parsimony and focus on how our two different concepts of effort affect taxpayer behavior.

A. Perfect Information

We first consider the optimal tax reporting strategy for a risk-neutral taxpayer who possesses perfect information regarding his true taxable income, I. The taxpayer chooses how much income, R to self-report. He pays a linear tax rate, τ, on self-reported income, for a voluntary tax payment of τR.

The taxpayer's return is examined with constant probability α. If the taxpayer is found to have underreported he pays both the unpaid liability as well as a penalty, for a total payment of

$\theta_U \tau(I - R)$, where $\theta_U > 1$. (The subscript "U" denotes that this is the penalty multiplier when the taxpayer has been determined to have underreported.) If the taxpayer is found to have overreported, he receives $\theta_O \tau(R - I)$ back from the government. (The subscript "O" denotes that this is multiplier when the taxpayer has been determined to have overreported.) So, if the taxpayer receives back only the overpaid liability, then $\theta_O = 1$.

We assume that taxpayers face a fixed cost of c_R for submitting any $R > 0$ report. We assume that $c_R \geq 0$ and that c_R reflects the monetary equivalent of the effort necessary to submit a non-0 report. Taxpayers may pay this cost in monetary form (e.g. hiring a professional tax preparer), whereas others may pay in non-pecuniary forms (e.g. the time and stress associated with filing).

We assume that taxpayers face an idiosyncratic marginal cost of noncompliance, n. This cost is paid for each dollar of unpaid tax liability. For a taxpayer who underreports, the total noncompliance cost is given by $n\tau(I - R)$. We assume that these costs are paid whether or not the taxpayer's return is examined by the tax agency. These costs may reflect pecuniary costs, opportunity costs associated with increases in the detection or penalty rates, or psychological or reputational costs associated with noncompliance. In reality, some marginal costs of noncompliance may be incurred only upon examination (e.g. the effort required to respond to the examination) or regardless of whether examination occurs (e.g. psychological costs related to tax morale). Assuming that costs are paid only if examined does not impact the model's qualitative results. For our purposes we simply wish to account for the fact that taxpayers face different costs of noncompliance that heterogeneously impact the attractiveness of noncompliance.[3]

[3] Some taxpayers may even derive psychological pleasure from underreporting such that $n < 0$.

P is the taxpayer's pre-tax consumption level. P need not equal I, the taxpayer's true taxable income. The taxpayer chooses R to maximize his expected utility, or alternatively, minimize his expected total tax and effort-related cost. The taxpayer's indirect utility with perfect information, V_{INFO}, depends on I and n and is given by:

$$V_{\text{INFO}}(I,n) = \max_R \begin{cases} P - (\alpha\theta_U + n)\tau I & \text{if } R = 0 \\ P - \tau R - (\alpha\theta_U + n)\tau(I - R) - c_R & \text{if } R \in (0, I) \\ P - \tau I - c_R & \text{if } R = I \\ P - \tau R - \alpha\theta_O\tau(I - R) - c_R & \text{if } R > I \end{cases}$$

Overreporting is never desirable since an accurate $R = I$ report will always generate more utility than an $R > I$ report.[4] Due to the objective's linearity with respect to R, the taxpayer will always go "all or nothing," i.e. will always choose $R = 0$ or $R = I$. The taxpayer's optimal reporting strategy, given I and n, is given by

$$R_{\text{INFO}}(I,n) = \begin{cases} 0, & \text{if } n \le n_{\text{INFO}} \\ 0, & \text{if } n > n_{\text{INFO}} \text{ and I} \le I^*(n) \\ I, & \text{if } n > n_{\text{INFO}} \text{ and I} > I^*(n) \end{cases}$$

where

$$n_{\text{INFO}} = 1 - \alpha\theta_U$$

and

$$I^*(n) = \frac{c_R}{\tau(n - (1 - \alpha\theta_U))}.$$

n_{INFO} represents the threshold value of n below which taxpayers will always be noncompliant. Above n_{INFO}, taxpayers may or may not be compliant depending on their true income. If $c_R = 0$

[4] In reality, some taxpayers may find it beneficial to overreport. For instance, certain types of income may receive preferential tax treatment this year compared to next, so the taxpayer may wish to realize said income this year. Or, as in the next section, the taxpayer is uncertain as to the magnitude of I, and he perceives the cost of overreporting to be less than the effort necessary to report the correct amount. This model ignores such considerations.

(i.e. if a non-0 report requires no additional effort than a report of 0), then $I^*(n) = 0$ and any taxpayer with $n > n_{\text{INFO}}$ is voluntarily compliant. If $c_R > 0$, then a taxpayer with sufficiently small I (given n) may not find the benefits of compliance worth the extra fixed effort even if $n > n_{INFO}$.

It is worthwhile to note that the critical income that separates compliance from noncompliance varies with taxpayers' n. $dI^*/dn < 0$, reflecting that those with low idiosyncratic costs of noncompliance will be less willing to exert the effort to report the correct amount.

B. Imperfect Information

We now consider taxpayer choice in an environment where taxpayers are uncertain about their true taxable income. In the next section, we will allow for taxpayers to exert additional effort to determine their true taxable income. However, it will prove useful first to consider their choice without such an option.

We consider taxpayers who could each report either $R = 0$ or $R = X$. X represents the "easy" amount for taxpayers to self-report— that is, the amount of income that they could report and pay the effort cost c_R. However, their true taxable income I may be less than or greater than X. For instance, I may be greater than X if the taxpayer received some poorly documented taxable income that is difficult to evaluate accurately or if the taxpayer has some income that may or may not be tax-exempt in whole or in part, but the determination of said exemption requires additional research. Alternatively, I may be less than X if, for instance, the taxpayer is statutorily eligible for certain deductions, but the precise determination of these deductions will require additional effort.

These taxpayers each have a common "perception" of their distribution of true incomes, with cdf given by $G(I)$ and pdf $g(I)$. Since our current analysis is focused on the self-reporting of income, the domain of possible true incomes has a lower bound of 0. The distribution of true incomes is characterized by mean parameter μ and standard deviation σ. We remain agnostic as to the type of distribution as well as whether the "easy" report X understates or overstates μ. We also do not place any specific restrictions upon σ. In the limiting case where σ approaches zero, then the taxpayer knows his true income μ but is forced to report $R = 0$ or $R = X$.

We assume that the taxpayer's true income will be revealed upon examination. Therefore, taxpayers will have to pay an additional $\theta_U \tau(I - R)$ if they are examined and found to have underreported or will receive $\theta_O \tau(R - I)$ back if found to have overreported. Similarly, the taxpayer's idiosyncratic noncompliance costs are given by $n\tau(I - R)$ if they are noncompliant.

In this environment of inaccuracy, taxpayers do not know their true I and must make their choice based on expectations dictated by the true income distribution. The taxpayer's indirect utility with imperfect, inaccurate information, $V_{INACCURATE}$, depends on n and is given by:

$$V_{\text{INACCURATE}}(n) = \max_{R=\{0,X\}} \begin{cases} V_{\text{INACCURATE}}(n; R = 0), & \text{if } R = 0 \\ V_{\text{INACCURATE}}(n; R = X), & \text{if } R = X \end{cases}$$

where $V_{\text{INACCURATE}}(n; R = 0)$ is expected utility if $R = 0$ and $V_{\text{INACCURATE}}(n; R = X)$ is expected utility if $R = X$. The former is given by

$$V_{\text{INACCURATE}}(n; R = 0) = P - (\alpha\theta_U + n)\tau\mu.$$

If the taxpayer reports $R = 0$, he is guaranteed to have underreported; therefore, the taxpayer's expected tax payments and noncompliance costs ("expected" in terms of the uncertainty surrounding the likelihood of examination and the uncertain distribution of I) are given by $(\alpha\theta_U + n)\tau\mu$. On the other hand, taxpayers' expected utility if $R = X$ is given by

$$V_{\text{INACCURATE}}(n; R = X)$$
$$= P - \tau X - (\alpha\theta_U + n)\tau(\mathbb{E}[I|I > X] - X)(1 - G(X)) - \alpha\theta_O\tau(\mathbb{E}[I|I < X] - X)G(X) - c_R$$

where $\mathbb{E}[I|z]$ denotes the expectation of I conditional on z. With an $R = X$ report, it may turn out that the taxpayer has underreported or overreported. Expected utility therefore depends upon the expected amount of underreporting (or overreporting) conditional upon underreporting (or overreporting) having occurred, as well as the likelihood that each outcome occurs.

A taxpayer chooses $R = X$ if the expected utility of doing so exceeds that of $R = 0$. Taxpayer strategies in an environment of uncertainty are given by

$$R_{\text{INACCURATE}}(n) = \begin{cases} 0, & \text{if } n \leq n_{\text{REPORT}} \\ X, & \text{if } n > n_{\text{REPORT}} \end{cases}$$

where

$$n_{REPORT} = \frac{(1 - \alpha\theta_U) + \alpha(\theta_U - \theta_O)\left(\frac{X - \mathbb{E}[I|I < X]}{X}\right)G(X) + \frac{c_R}{\tau X}}{1 - \left(\frac{X - \mathbb{E}[I|I < X]}{X}\right)G(X)}.$$

Unlike the case with perfect information, taxpayer strategies can depend only on n, not n and I. After all, I is not known. n_{REPORT} represents the threshold noncompliance cost that dictates whether or not a taxpayer reports. Taxpayers with a low idiosyncratic cost of noncompliance n will not report anything – those with higher n will report X.

C. Comparing the Perfect and Imperfect Information Environments

We now compare equilibrium outcomes (e.g. taxpayer welfare and tax revenues) in informed and uninformed environments. The informed strategy in Section 1 depends on both n and the realized value of I, whereas the uninformed strategy in Section 2 depends only upon n. In order to make legitimate comparisons between the two environments, we must therefore compare expected outcomes for a taxpayer who originally finds himself in a position of not knowing his true income, but rather, that true income will be drawn from the $G(I)$ distribution. In the perfect information environment, he will eventually learn I and follow the I-dependent strategy discussed in Section 1. In the imperfect information environment, he will follow the I-independent strategy discussed in Section 2.

A basic result is that taxpayer welfare must be (weakly) greater with information. After all, the informed taxpayer could always follow the same strategy as the uninformed taxpayer. If the informed taxpayer follows a different strategy, it is only because the new strategy increases utility. However, we wish to go into greater detail with regards to *how much* greater taxpayer welfare is with information, and how this might vary across taxpayers (i.e. across different values of n). Furthermore, we want to consider how voluntary compliance and tax revenues might also differ between the two environments.

It can be shown that $n_{\text{REPORT}} > n_{\text{INFO}}$.[5] Comparing the outcomes with and without perfect information, there are therefore three types of taxpayers to consider.

1. Taxpayers with $\boldsymbol{n \leq n_{INFO}}$

[5] This is seen by rewriting $n_{\text{REPORT}} = (1 - \alpha\theta_U) + \left(n_{\text{REPORT}} + \alpha(\theta_U - \theta_O)\right)\left(\frac{X - \mathbb{E}[I|I<X]}{X}\right) G(X) + \frac{c_R - c_0}{\tau X} > 1 - \alpha\theta_U = n_{\text{INFO}}$.

These taxpayers have sufficiently low costs of noncompliance that their willingness to be wholly noncompliant is unaffected by the presence of information. They will report $R = 0$ regardless of whether they have information.

Because these taxpayers follow the same strategy with or without information, their expected utility is identical in both cases. After all, the value of information stems from the extent to which it enables the taxpayer to avoid using an uninformed strategy that is *ex post* (i.e. after realizing I) suboptimal. If the strategy with information is identical to the strategy without, then there is no *ex post* suboptimality associated with the uninformed decision. The taxpayer's expected utility both with and without information is given by

$$\mathbb{E}[V_{\mathrm{INFO}}(I,n)|n \leq n_{INFO}] = \mathbb{E}[V_{\mathrm{INACCURATE}}(n)|n \leq n_{INFO}] = P - (\alpha\theta_U + n)\tau\mu.$$

Since the taxpayer's strategy is unchanged by information, the expected tax revenues are also identical in both environments. Defining $T_{\mathrm{INFO}}(I,n)$ to be expected tax revenues (both voluntarily paid and those paid upon examination) for a taxpayer with (I,n) who will follow the informed strategy and $T_{\mathrm{INACCURATE}}(n)$ to be the expected tax revenues for a taxpayer with n who will follow the uninformed strategy:

$$\mathbb{E}[T_{\mathrm{INFO}}(I,n)|n \leq n_{INFO}] = \mathbb{E}[T_{\mathrm{INACCURATE}}(n)|n \leq n_{INFO}] = \alpha\theta_U\tau\mu.$$

In summary, information does not help (or hurt) these taxpayers, but neither does it affect tax revenues.

2. Taxpayers with $\boldsymbol{n} \in (\boldsymbol{n_{INFO}}, \boldsymbol{n_{REPORT}})$

These taxpayers will report $R = 0$ if they do not have information. If they have information they may still report $R = 0$, but only if their realized $I < I^*(n)$. If $I > I^*(n)$, then taxpayers would voluntarily pay their true liability. Uninformed taxpayers will suffer *ex post* regret from having underreported if their realized value of I is sufficiently large. Within this group information weakly but unambiguously promotes compliance; not everyone will voluntarily comply, but at least some will. That's better than none.

The taxpayer's expected utility with and without information is given by

$$\mathbb{E}[V_{\text{INFO}}(I,n)|n \in (n_{INFO}, n_{REPORT})] = P - \tau\mathbb{E}[I|I > I^*(n)]\left(1 - G\big(I^*(n)\big)\right)$$
$$- (\alpha\theta_U + n)\tau\mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) - c_R\left(1 - G\big(I^*(n)\big)\right);$$

and

$$\mathbb{E}[V_{\text{INACCURATE}}(n)|n \in (n_{INFO}, n_{REPORT})] = P - (\alpha\theta_U + n)\tau\mu.$$

The increase in taxpayers' utility from gaining information can in turn be written (using previous results) as

$$\mathbb{E}[V_{\text{INFO}}(I,n) - V_{INACCURATE}(n)|n \in (n_{INFO}, n_{REPORT})]$$
$$= (n - n_{INFO})\tau\big(\mathbb{E}[I|I > I^*(n)] - I^*(n)\big)(1 - G\big(I^*(n)\big).$$

It is weakly positive, and for $n > n_{INFO}$ strictly positive so long as $I^*(n)$ is strictly positive. $I^*(n) = 0$ occurs only if $c_R = 0$; therefore, taxpayers are strictly better off with information when there are effort costs associated with non-0 reports. If there are no effort costs, then taxpayers are no worse off.

Turning to the amount of expected tax revenues in both environments:

$$\mathbb{E}[T_{\text{INFO}}(I,n)|n \in (n_{INFO}, n_{REPORT})]$$
$$= \tau\mathbb{E}[I|I > I^*(n)]\left(1 - G\big(I^*(n)\big)\right) + \alpha\theta_U\tau\mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big);$$

and

$$\mathbb{E}[T_{\text{INACCURATE}}(n)|n \in (n_{INFO}, n_{REPORT})] = \alpha\theta_U\tau\mu.$$

The difference in expected revenues is given by

$$\mathbb{E}[T_{\text{INFO}}(I,n) - T_{\text{INACCURATE}}(n)|n \in (n_{INFO}, n_{REPORT})]$$
$$= \tau(1 - \alpha\theta_U)\mathbb{E}[I|I > I^*(n)]\left(1 - G\big(I^*(n)\big)\right).$$

This is strictly greater than 0, or in other words, government revenues necessarily increase with information. Even though only a portion of taxpayers become compliant (to be precise, the share who do is given by $1 - G\big(I^*(n)\big)$ given a value of n), more revenues will be collected from them since a voluntarily reported dollar of taxable income yields τ dollars of revenue while an unreported dollar of taxable income only yields $\alpha\theta_U\tau < \tau$ in expected tax revenue.[6]

Those who become compliant with information are not drawn at random from the population. Instead, those with relatively large values of I will comply, self-reporting on average $\mathbb{E}[I|I > I^*(n)]$ (which is strictly greater than μ) of taxable income. Therefore, the increase in tax revenues that arises from perfect information is greater than the increase that would occur if compliant taxpayers were drawn randomly from across the entire true income distribution.

It is no surprise that better information improves taxpayer welfare. What may be more surprising is that better information among this subset of taxpayers generates a Pareto

[6] In the U.S., the penalty rate is 20% for "substantial understatement" and 75% for "civil fraud." Even at the higher penalty rate of 75%, the audit rate would have to exceed 57% for $\alpha\theta_U\tau > \tau$. Audit rates are far lower than that.

improvement insofar as the government (or more generally, the broader population of taxpayers) also benefits from increased tax revenues.

This result strongly differentiates our theory of imperfect information from theories of taxpayer behavior that ignore effort. Voluntary tax payments and examination payments are transfers between taxpayers and the government. In that sense, the two sides are engaged in a zero-sum game. Better information leads to additional transfers to the extent that some taxpayers increase their voluntary compliance; however, these transfers are actually beneficial to taxpayers. Without information, they would have *ex post* regretted that they hadn't been more compliant when sufficiently high *I* were realized. Therefore, the additional compliance that occurs with better information can be to the mutual benefit of both taxpayers and the government's tax revenues.

3. Taxpayers with $\boldsymbol{n \geq n_{REPORT}}$

These taxpayers will report $R = X$ if they do not have information. If they do have information, they may report $R = 0$ or $R = I$, depending on whether $I \gtreqless I^*(n)$. Therefore, the relationship between information and voluntary reporting is ambiguous. If taxpayers realize sufficiently low I, then information will lead to $R = 0$ and voluntary tax payments will necessarily decrease. If taxpayers realize sufficiently high I, then information will lead to $R = I$. Whether this represents an increase in self-reported tax liability depends on whether $I \gtreqless X$.

Using previous results, it can be shown that for all taxpayers with $n \geq n_{REPORT}$:

$$I^*(n) < X - \left(\frac{n + \alpha(\theta_U - \theta_O)}{n - (1 - \alpha\theta_U)}\right)(X - \mathbb{E}[I|I < X])G(X).$$

Therefore, $I^*(n) < X$ for taxpayers with $n > n_{REPORT}$. There are three relevant categories of realized I values that need to be considered.

a. $I < I^*(n)$

Should an I in this range be realized, the informed taxpayer self-reports 0, the uninformed taxpayer self-reports $X,$ and voluntary tax payments necessarily go down with information. Whether or not this represents a change in "compliance" patterns depends on how one defines "compliance" since these taxpayers would have necessarily overreported by $X - I$ in the absence of information. With information, they underreport by I. It is worth noting however that this "replacement" of overreporting with underreporting is not occurring for the average taxpayer, but instead, only those with relatively small realizations of I. These are the taxpayers who were overreporting by the most without information, and conversely, have little income to underreport should they choose to do so.

b. $I \in (I^*(n), X)$

Should an I in this range be realized, the informed taxpayer self-reports I, the uninformed taxpayer self-reports $X,$ and voluntary tax payments necessarily go down with information. However, these taxpayers are unambiguously more "compliant" to the extent that each would have overreported in the absence of information. With information, they voluntarily self-report their true income; without information, they voluntarily self-report more than their true income. We consider it reasonable to assume that the government benefits from greater revenues, but not necessarily if those revenues are attained "illegitimately" via overpayment of statutory liability. Assuming for instance that the government's welfare function places zero weight on tax revenues that arise from overpayment, then lower self-reported incomes among these taxpayers does not actually represent a loss to the government.

c. $I > X$

These taxpayers voluntarily report more when informed than not. Furthermore, these increases in self-reported tax assessments uniformly reflect shifts from underreporting (by $I - X$) to accurate reporting.

Putting it all together, it is clear that a taxpayer's welfare increases with information. Should $I < I^*(n)$ be realized, the taxpayer will prefer to have underreported $R = 0$ rather than overreported $R = X$. Should $I \in (I^*(n), X)$ be realized, the taxpayer will prefer to have accurately reported $R = I$ rather than overreported $R = X$. Finally, should $I > X$ be realized, the taxpayer will prefer to have accurately reported $R = I$ rather than underreported $R = X$.

The taxpayer's expected utility with an without information is given by

$$\mathbb{E}[V_{\mathrm{INFO}}(I,n)|n > n_{REPORT}] = P - \tau\mathbb{E}[I|I > I^*(n)]\left(1 - G\big(I^*(n)\big)\right)$$

$$- (\alpha\theta_U + n)\tau\mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) - c_R\left(1 - G\big(I^*(n)\big)\right) - c_0 G\big(I^*(n)\big);$$

and

$$\mathbb{E}[V_{\mathrm{INACCURATE}}(n)|n > n_{REPORT}]$$

$$= P - \tau X - (\alpha\theta_U + n)\tau(\mathbb{E}[I|I > X] - X)(1 - G(X))$$

$$- \alpha\theta_O\tau(\mathbb{E}[I|I < X] - X)G(X) - c_R.$$

The effect of information on tax revenues is ambiguous for taxpayers with $n > n_{REPORT}$. The ambiguity arises from the fact that information both increases and decreases different taxpayers' voluntary reporting. Furthermore, total tax revenues in the uninformed environment benefit from the fact that taxpayers without information inadvertently overreport. With these factors in mind, we can unambiguously demonstrate that information increases "legitimate" tax revenues (i.e. total revenues net of overpayments).[7] Table 1 shows the expected "legitimate" tax revenues for the three categories of I realizations among taxpayers with a common $n > n_{REPORT}$.

Table 1. Revenues Predicted by Model, by Category of *I*

		Expected Revenues per Taxpayer by *I* Category		
***I* Category**	**Share of Taxpayers in Category**	**Uninformed Taxpayer Strategy**	**Informed Taxpayer Strategy**	**Difference**
$I < I^*(n)$	$G\big(I^*(n)\big)$	$\tau\mathbb{E}[I \mid I < I^*(n)]$	$\alpha\theta_U\tau\mathbb{E}[I \mid I < I^*(n)]$	$-(1-\alpha\theta_U)\,\tau\mathbb{E}[I \mid I < I^*(n)]$
$I \in (I^*(n), X)$	$G(X) - G\big(I^*(n)\big)$	$\tau\mathbb{E}[I \mid I \in (I^*(n), X)]$	$\tau\mathbb{E}[I \mid I \in (I^*(n), X)]$	0
$I > X$	$1 - G(X)$	$\tau X + \alpha\theta_U\tau(\mathbb{E}[I \mid I > X] - X)$	$\tau\mathbb{E}[I \mid I > X]$	$(1-\alpha\theta_U)\tau(\mathbb{E}[I \mid I > X] - X)$

Given a value of n, the net effect on "legitimate" tax revenues is given by

$$\mathbb{E}[T_{\text{INFO}}(I,n) - T_{\text{INACCURATE}}(n) \mid n > n_{REPORT}]$$
$$= (1-\alpha\theta_U)\tau\left(\left(\mathbb{E}[I \mid I > X] - X\right)\left(1 - G(X)\right) - \mathbb{E}[I \mid I < I^*(n)]G\big(I^*(n)\big)\right).$$

The precise value of this difference obviously depends upon the specific values of X and n; however, it is shown in the appendix that

$$\left(\mathbb{E}[I \mid I > X] - X\right)\left(1 - G(X)\right) - \mathbb{E}[I \mid I < I^*(n)]G\big(I^*(n)\big) > 0$$

[7] By "net of overpayments" we mean that the government places zero value on both overpayments that go unexamined as well as refunds of overpayments that are paid upon examination.

whenever $n \geq n_{REPORT}$. Therefore, depending on how the government places value on tax revenues attained via overreporting, it is possible that better information can actually yield a Pareto improvement where both taxpayers and the government are better off.

d. Exerting Additional Effort to Acquire Information

In order to capture the effort required to not only report, but report accurately, we introduce another cost, c_I. We assume this to be a fixed cost that taxpayers must pay if they wish to acquire information about, document, and report their true tax liability.[8] If they do not pay this cost, they must follow the uninformed strategy of Section 3b, reporting either $R = 0$ or $R = X$ depending on their idiosyncratic cost of noncompliance n. If they do pay the cost, then they can follow the informed I-dependent strategy of Section 3a, reporting either $R = 0$ or $R = I$ depending on whether the discovered value of I exceeds $I^*(n)$.

Of course, taxpayers don't know what value of I this additional effort will reveal if $\sigma > 0$. When they decide to pay this cost, they must do so based on their expectations of what the effort will reveal, and how they will strategically respond to different information revelations.

A taxpayers' willingness to pay for accurate information is given by the difference in his expected utility (where the expectation is across different possible values of I) when he acquires information and follows the informed taxpayer strategy versus his expected utility when he does not acquire information and follows the uninformed taxpayer strategy. These expected utilities were already provided in Section 3c. Taxpayers with $n \leq n_{INFO}$ have willingness to pay $\mathrm{WTP}(n) = 0$. They are going to report $R = 0$ regardless of the revelation, so why bother with

[8] It is possible that each taxpayer has a subjective limit to how much c_I he is willing to pay, but he may be able to pay less than that to optimally achieve some degree of "partial" accuracy. We ignore such possibilities to keep the model sufficiently straightforward.

the effort of figuring out precisely how much you're underreporting? In contrast, taxpayers with $n > n_{INFO}$ have $\mathrm{WTP}(n) > 0$, though the precise functional form of their willingness to pay depends upon whether $n \gtreqless n_{REPORT}$.

Taxpayers' willingness to pay for information is piecewise in n and (weakly) monotonically increasing. As n increases, the change in taxpayers' willingness to pay is given by

$$\frac{d\mathrm{WTP}(n)}{dn} = \begin{cases} 0, n < n_{INFO} \\ \tau\left(\mu - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big)\right), n \in (n_{INFO}, n_{REPORT}) \\ \tau\left(\big(\mathbb{E}[I|I > X] - X\big)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big)\right), n > n_{REPORT}. \end{cases}$$ [9]

Additionally, taxpayers' willingness to pay (weakly) increases at a (weakly) increasing rate:

$$\frac{d^2\mathrm{WTP}(n)}{dn^2} = \begin{cases} 0, & \text{if } n < n_{INFO} \\ \tau I^*(n) g\big(I^*(n)\big)\left(-\frac{dI^*(n)}{dn}\right), & \text{if } n \in (n_{INFO}, n_{REPORT}) \\ \tau I^*(n) g\big(I^*(n)\big)\left(-\frac{dI^*(n)}{dn}\right), & \text{if } n > n_{REPORT}. \end{cases}$$ [10]

Having established the monotonicity of the willingness to pay function, we can implicitly define the threshold $n_{ACCURATE}$ above which taxpayers pay the effort to acquire, document, and report accurate information, below which they do not:

$$\mathrm{WTP}(n_{ACCURATE}) = c_I.$$

It is important to note, and we believe realistic, that exerting the effort to accurately determine one's true taxable income does not necessarily imply that a taxpayer will accurately

[9] Due to the piecewise nature of the willingness to pay function, the derivative $d\mathrm{WTP}/d\mathrm{n}$ is not well defined at $n = n_{INFO}$ or $n = n_{REPORT}$.
[10] Again due to the piecewise nature of the willingness to pay function, the second derivative $d^2\mathrm{WTP}/d\mathrm{n}^2$ is not well defined at $n = n_{INFO}$ or $n = n_{REPORT}$.

report said income. All that $n > n_{ACCURATE}$ guarantees is that the taxpayer has sufficiently large noncompliance cost that he bothers to accurately determine his true taxable income. Once that is done, he follows the perfect information strategy of Section 1. If the discovered amount of taxable income is sufficiently small (i.e. if $I < I^*(n)$), then he will report $R = 0$. That being said, only high n taxpayers will bother to acquire information, and a high n simultaneously guarantees a low $I^*(n)$. The taxpayer who voluntarily elects to determine his true liability will be noncompliant only if a very small amount of statutorily taxable income is in play.

While the endogenous thresholds n_{INFO} and n_{REPORT} were ranked according to theory alone, the relative ranking of $n_{ACCURATE}$ and n_{REPORT} depends on the value of c_I. If c_I is sufficiently large, then $n_{ACCURATE} > n_{REPORT}$; otherwise, vice versa. Based on empirical observation, we consider the case of high c_I, and therefore $n_{ACCURATE} > n_{REPORT}$, more realistic.

The empirical observation we have in mind is that many, many taxpayers are found to have: a) overreported; or b) underreported, but by amounts that are sufficiently small that they *seem* to reflect inadvertent errors as opposed to willful misreporting. In the framework of our model, we would not observe such behavior if the cost of accuracy were sufficiently small such that $n_{ACCURATE} > n_{REPORT}$. In that case, all taxpayers who acquire information would follow the informed strategy given in Section 1. All taxpayers who do not acquire information would strictly follow the strategy $R = 0$. In net, we would observe that all taxpayers underreport either 100 percent or 0 percent of income. Such taxpayer behavior is in fact observed with great frequency, but not exclusively so.[11]

[11] The "all or nothing" prediction that arises in our theory is the result of several simplifying assumptions. For instance, taxpayers are risk-neutral; the audit probability, detection rate conditional upon examination, and penalty rates are all constant; and the costs of noncompliance are linear in the amount of underreporting. If any one of these do not hold, taxpayers may find it optimal to underreport a portion of their income strictly between 0 percent and

Accounting for both types of effort, taxpayers fall into four categories. We term the first category "never compliant" taxpayers. These are taxpayers with $n < n_{\text{INFO}}$ who have sufficiently low n to always follow the strategy $R = 0$ no matter their income and no matter how small the cost of compliance. We term the second category "noncompliant due to effort" taxpayers. These are taxpayers with $n \in (n_{\text{INFO}}, n_{\text{REPORT}})$ who follow the reporting strategy $R = 0$ and exert neither the c_R nor c_I effort costs; however, they would be compliant if they possessed sufficiently large income, could discern so with sufficiently little effort, and could also report with sufficiently low effort. We group these two categories in a broader category of "noncompliant" taxpayers since both end up following the $R = 0$ strategy. We term the third category "compliant but inaccurate" taxpayers. These are taxpayers with $n \in (n_{\text{REPORT}}, n_{\text{ACCURATE}})$ who follow the inaccurate reporting strategy $R = X$ and exert only the c_R effort cost. We term the fourth category "compliant and accurate" taxpayers. These are taxpayers with $n > n_{\text{ACCURATE}}$ who follow the reporting strategy $R = R_{INFO}(I, n)$, pay the c_I effort cost, and may or may not pay the c_R effort cost. While these taxpayers may report either accurately or not at all, we call these taxpayers "compliant" due to the fact that they have large values of n and therefore small critical values of $I^*(n)$; they will be compliant, report $R = I$, and pay the c_R effort cost for all but the smallest realizations of I.

Each taxpayer type's strategy, both with respect to underreporting and effort, are summarized in Table 2.

100 percent. (See Phillips (2014b).) That being said, we think that the US compliance data, along with basic intuition, are sufficient to warrant an assumption that the costs of accuracy are sufficiently high so as to deter some quasi-compliant taxpayers from exerting the effort to report accurately.

Table 2. Categories of Taxpayers Defined by Compliance Costs

	Category of Taxpayer			
	Never Compliant $n < n_{INFO}$	Noncompliant Due to Effort $n \in (n_{INFO}, n_{REPORT})$	Compliant but Inaccurate $n \in (n_{REPORT}, n_{ACCURATE})$	Compliant and Accurate $n > n_{ACCURATE}$
Reporting Strategies				
With Information	$R = 0$	$R = 0$ or I	$R = 0$ or I[i]	$R = 0$ or I[i]
Without Information	$R = 0$	$R = 0$	$R = X$	$R = X$
Effort Strategies				
Pay c_R?	No	No	Yes	Yes or No[ii]
Pay c_I?	No	No	No	Yes
Taxpayers observed (ex post) to have…				
Underreported?	Yes	Yes	Yes	Yes[ii]
Correctly reported?	No	No	Yes[iii]	Yes
Overreported?	No	No	Yes	No

Notes:

[i] With information, these taxpayers may report $R = 0$ or $R = I$ depending on whether I exceeds $I^*(n)$. Since these taxpayers have large values of n, they will report $R = I$ for all but the smallest values of I.

[ii] Having paid c_I, these taxpayers may report $R = 0$ or $R = I$ depending on whether I exceeds $I^*(n)$. Since these taxpayers have large values of n, they will report $R = I$ for all but the smallest values of I.

[iii] These taxpayers will follow the reporting strategy $R = X$. They are determined to have reported accurately only if it just so happens that $X = I$.

D. Comparative Statics and Empirical Hypotheses

We now use these theoretical results to predict how compliance and effort decisions are affected by changes in various parameters.

Proposition 1: All else equal, n_{REPORT} decreases (and therefore the number of noncompliant taxpayers decreases and the number of compliant but inaccurate taxpayers increases) when:

i. α increases;

ii. θ_U increases;

iii. X decreases;

iv. σ decreases;

v. c_R decreases.

Proposition 2: All else equal, $n_{ACCURATE}$ decreases (and therefore the number of compliant but inaccurate taxpayers decreases and the number of compliant and accurate taxpayers increases) when:

i. α *increases (assuming* X *is not too much larger than* μ *and* $I^*(n_{ACCURATE})$ *is sufficiently low);*

ii. θ_U *increases;*

iii. X *increases (assuming* c_I *is not too large);*

iv. σ *increases;*

v. c_R *increases;*

vi. c_I *decreases.*

The formal comparative static expressions that prove Propositions 1 and 2 are provided in the appendix.

4. Taxpayer Reporting Patterns and Evidence on the Relevance of Effort

We now provide some descriptive evidence on effort and taxpayer reporting patterns using data from the National Research Program (NRP). The Internal Revenue Service (IRS) randomly selects a stratified sample of tax returns for examination under the NRP.[12]

The NRP data contain two income measures for each line item – the taxpayer's self-reported income amount and the IRS-corrected amount. It is important to note that the IRS-corrected amount is not necessarily the true amount that should have statutorily been reported. The IRS is unable to detect all instances of underreporting, and therefore the raw NRP data tend to understate the actual extent of noncompliance. The IRS employs a detection-controlled estimation procedure to the raw NRP data in order to estimate the national tax gap.[13] The statistics presented herein do not account for detection; therefore, they are not directly comparable to official tax gap estimates. The results shown in this paper should be interpreted accordingly.

[12] All subsequent results apply population weights to the data in order to make the stratified sample representative of the entire population of taxpayers. Bloomquist et al. (2013) describe the NRP selection and examination processes.
[13] See for instance Feinstein (1990, 1991), Erard and Feinstein (2011), and Black, *et. al* (2012).

The NRP data also do not include nonfilers. In the context of our theory, the raw data therefore underestimate the number of taxpayers who are wholly noncompliant (i.e. $R = 0$ for each and every line item). However, the data do include taxpayers who filed a return but were detected to be wholly noncompliant on specific line-items of their tax returns.[14] Although imperfect detection implies that the IRS-corrected amount on these items may not reflect the true amount that should have been reported, we can nonetheless infer the taxpayer reported none of this amount.

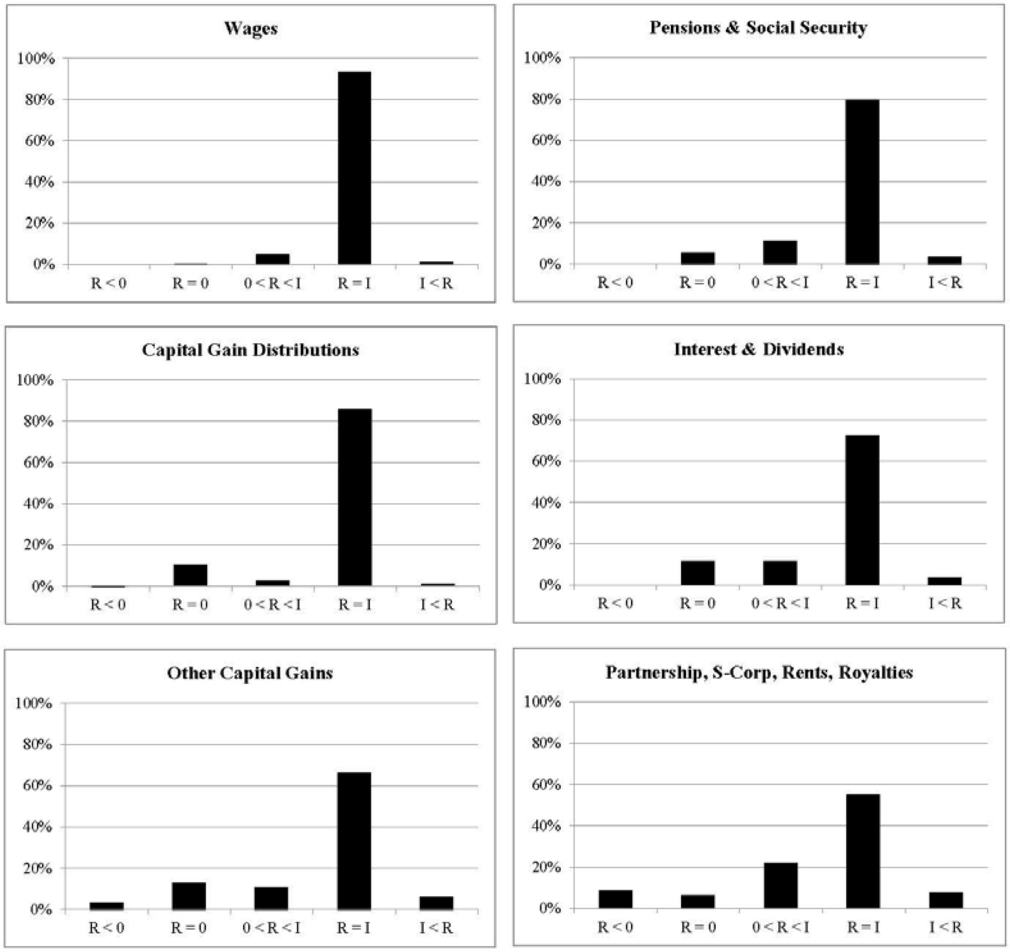
In 2006, the IRS switched from conducting infrequent NRP studies on a large number of taxpayers to conducting annual NRP studies on a smaller (per year) number of taxpayers. In order to increase the utilized sample size, we look at data from the 2006-2010 NRP studies. Cumulatively these studies examined just over 55,000 taxpayers.[15]

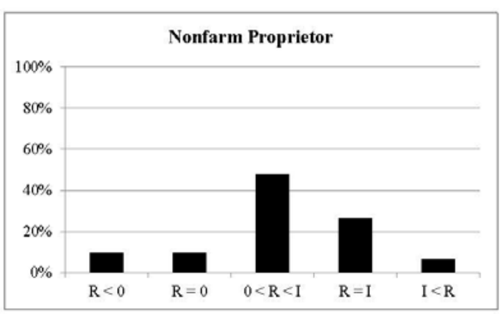
Figure 1 shows the frequency of observed reporting rates for seven types of income. For each type of income, we limit the data to taxpayers with a strictly positive IRS-corrected amount of income. We therefore omit taxpayers who truly possessed such income, reported none of it, and the IRS examination did not detect the noncompliance. The raw data therefore underestimate the relative frequency of 100 percent noncompliance (i.e. $R = 0$) reports relative to the other four categories of reporting rates.

The first four types of income in Figure 1 are those for which we expect the cost of compliance (both filing at all and filing accurately) are relatively low. These types are: wages, salaries, and tips; pensions and Social Security income; capital gain distributions; and interest and dividends. The other three types of income are those for which we expect the costs of

[14] Erard and Ho (2001) discuss "ghosts," taxpayers who fail to file at all.
[15] The last of the "infrequent" NRP studies was conducted on 2001 tax returns. That study examined roughly 44,000 taxpayers.

Figure 1
Frequency of Zero, Inaccurate, and Accurate Reporting by Income Type





Source: Raw 2006-2010 NRP data.
Notes: The raw NRP data do not account for income misreporting that was undetected during the NRP examination process, unlike the tax-gap-associated estimates that do account for that. The raw data are therefore not comparable to tax gap measures that employ a detection controlled estimation procedure. The sample in each histogram is limited to taxpayers with a strictly positive IRS-corrected amount for that income type. Population weights are applied to the raw data.

compliance to be larger. They are: other (i.e. non-distribution) capital gains; partnership, S-corporation, rent, and royalty income; and nonfarm sole proprietor income (i.e. Schedule C income).[16] Within this group, we expect the effort required for compliance to be lowest for other capital gains and highest for nonfarm proprietor income.

As predicted by our model, accurate compliance (i.e. $R = I$) is most common among the types of income with low compliance costs. Accurate compliance is detected for 93 percent of taxpayers with wage income. Among these four types, the lowest rate of accurate compliance is interest and dividends at 73 percent. Among the three types with higher costs of compliance, the rates of accurate compliance range from 66 percent for other capital gains down to 26 percent for nonfarm sole proprietor.

The relative ease of compliance for the first four line items stems from the "substantial information reporting" (per IRS (2012)) for each. The three higher effort income types are subject to less information reporting. IRS (2012) characterizes partnership income, S-corporation income, rents, royalties, and capital gains as subject to "some" information reporting, while nonfarm proprietor income is subject to "little or no" information reporting. Information reporting can affect a taxpayer's reporting decisions in two distinct ways. First, the information is given to the IRS. This implies that self-reported amounts that deviate (or at least deviate too much) from the third-party reported amount are more likely to be examined. Second, the information is given to the taxpayer himself. This implies that the effort required for compliance is smaller. Determining which effect "causes" accurate compliance is impossible if information is always provided to both parties (the IRS and taxpayers) or to neither party.

[16] Other capital gains are inferred as the difference between total capital gains and capital gains distributions using data from Schedule D.

Closer examination of other capital gains suggests that compliance costs play at least some role in explaining the frequency of accurate compliance. Prior to 2011, brokerages and other financial institutions reported the price of capital sales, but not the basis price; therefore, the IRS was not given sufficient information to determine the taxable gain. However, the taxpayers themselves were more likely to possess information on both sale and basis prices, and therefore the taxable gain could sometimes be determined with relatively little effort. Comparison of other capital gains to the other types of income therefore has the potential to distinguish between how information reported to the IRS affects taxpayer reporting vs. how information reported to the taxpayer affects taxpayer reporting. At 66 percent, the frequency of accurate compliance on other capital gains is quite large. If compliance costs did not play a role in the taxpayer's reporting decision, then we would expect other capital gains to have a lower frequency of accurate compliance—closer to that for partnership income, S-corporation income, rents, royalties, and nonfarm sole proprietor income.

The rates of full noncompliance (i.e., $R = 0$) do not vary as substantially across the income types. Fewer than 1 percent of wage income earners are fully noncompliant. The frequency of full noncompliance for the other low compliance cost income types are 6 percent (pension and Social Security income), 10 percent (capital gain distributions), and 12 percent (interest and dividends). The frequency of full noncompliance for higher compliance cost income types are similarly 6 percent (partnership, S-corporation, rents and royalties), 10 percent (nonfarm sole proprietor), and 13 percent (other capital gains). If reporting rates were determined solely by whether or not the IRS possesses information documents from third parties, we would expect full noncompliance to be much more prevalent among the latter three types of income.

Instead, we believe that the similarity of full noncompliance rates across income types is more consistent with our model. The effort required to file an inaccurate non-0 report is probably similar across these income types. The differences in compliance costs are instead related to the differential effort required to report accurately. In terms of our model, this is saying that c_R is likely to be fairly similar across income types while c_I varies more substantially. The threshold n below which taxpayers are wholly noncompliant is therefore predicted to be similar across income types. While accurate reporting is less common among the high compliance cost income types, taxpayers are not switching to full noncompliance, but instead appear to switch from full compliance to inaccurate "quasi"-compliance.

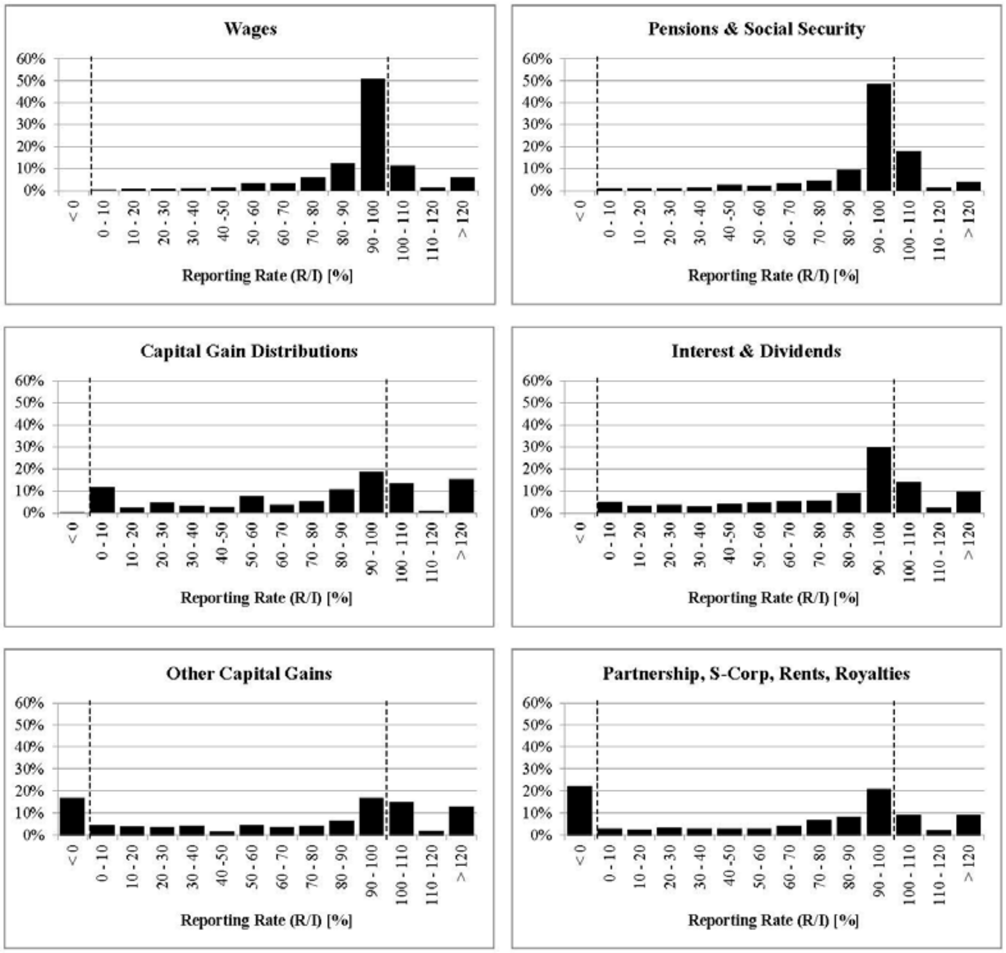
Figure 2 shows the distribution of reporting rates (i.e. reported income divided by the IRS-correct amount) for each income type. The sample in each figure is limited to taxpayers with a strictly positive amount of IRS-determined income who do not self-report accurately, nor do they self-report zero. Each income type's distribution has a qualitatively similar shape. Focusing first on reporting rates less than 1, reported income is most commonly between 90 percent and 100 percent of the IRS-corrected amount.[17] Smaller and smaller reporting rates are less and less common. [18]

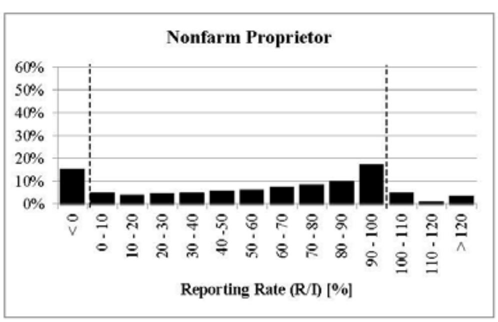
This feature is true even for those income types that lack information reporting. For instance, more than 10 percent of nonfarm sole proprietor taxpayers who inaccurately report a non-zero amount report somewhere between 95 percent and 100 percent of the IRS-corrected

[17] Among inaccurate taxpayers who report between 90 percent and 100 percent of the IRS-corrected amount, approximately three-quarters have a reporting rate in excess of 95 percent. The only income type for which this is not true is nonfarm sole proprietor income. Even for that income type, reporting rates between 95 percent and 100 percent are more common that reporting rates between 90 percent and 95 percent by a 3-2 margin.

[18] The relative "lumpiness" of the distribution for capital gains distributions likely stems from the small number of sampled taxpayers who have such income. Only 888 taxpayers satisfy the criteria necessary to be included in the histogram. Of these, 541 report less than 0 and 35 report more than 120 percent of the IRS-corrected amount. These counts do not account for population weights.

Figure 2
Frequency of Detected Reporting Rates for "Inaccurate" Taxpayers[1]





Source: Raw 2006-2010 NRP data.
Notes: The raw NRP data do not account for income misreporting that was undetected during the NRP examination process, unlike the tax-gap-associated estimates that do account for that. The raw data are therefore not comparable to tax gap measures that employ a detection controlled estimation procedure. Population weights are applied to the raw data.
[1] Each histogram is limited to the subsample of taxpayers who possessed a strictly positive amount of that type of income (per the IRS-corrected amount) and self-reported neither 0 nor the IRS-corrected amount.

amount. Approximately one-third of these taxpayers underreport between 75 percent and 100 percent of the IRS-corrected amount. If inaccurate (i.e. $R \neq I$) reports were purely motivated by the reduction in expected tax payments, then we would expect to see much a much higher frequency of low reporting rates. Instead, it appears that many "partially" compliant taxpayers were willing to report some amount of income, but not necessarily go through the effort necessary to accurately do so.

On the reverse side (i.e. reporting rates larger than 1), overreporting by somewhere between 0 percent and 10 percent of the IRS-corrected amount is most common.[19] Larger and larger overreporting rates are less and less common. While the semi-distributions to the left and right of $R = I$ look like the left and right tails of a typical distribution function, they are clearly not symmetric. If inaccurate reports were equally likely to occur across taxpayers, and inaccurate taxpayers were expected to report the correct amount "on average", then we would expect to see symmetry.

Instead, our theory with non-random, endogenous inaccuracy suggests that taxpayers are more likely to *choose* inaccuracy over exerting the effort to be accurate when the "easy-to-report" amount is relatively lower than the expected true amount. Hence, inaccurate taxpayers will systematically tend to report lower-than-correct amounts. Figure 2 clearly demonstrates this to be the case for all income types. For the four lower compliance income types, the median reporting rates (again conditioned on $R \neq I$ and $R \neq 0$) are all less than one, ranging from a low of 0.87 for capital gains distributions to a high of 0.98 for pension and Social Security income.[20] The median reporting rate for other capital gains (0.86) is quite close to that for capital gains

[19] Among taxpayers who report between 100 percent and 110 percent of the IRS-corrected amount, more than three-quarters have a reporting rate between 100 percent and 105 percent. This is true for each of the seven income types.
[20] The median reporting rate for wages is 0.97. The median reporting rate for interest and dividends is 0.94.

distributions. While the IRS is provided third-party information only for the latter, taxpayers are likely to have similar information on both and hence similar costs of compliance. The median reporting rates are significantly lower for partnership, S-Corp., rent, and royalty income (0.79) and nonfarm sole proprietor (0.65).

In summary, we believe this evidence is consistent with the notion that compliance costs, and the decision on whether or not bear them, are not set in stone. Rather, the taxpayers choose whether or not to bear these costs and follow strategies consistent with the predictions of our model. Furthermore, the decision on exerting effort is closely tied to the decision on whether to underreport. Compliance costs and reporting patterns do not exist in separate vacuums, but interact in such a way that each is necessary for a better understanding of the other.

5. Policy and Empirical Implications of Accounting for Compliance Effort

A. Tax System Reforms that Affect Effort

Our theory of effort has wide-ranging implications for thinking about real-world tax reforms. Compared to other tax code and tax administration reforms that may impact compliance, tax agencies may possess greater ability to impact effort. For instance, tax morale has been documented to impact taxpayers' compliance, but the notion is somewhat vague and it is difficult to translate into specific, actionable policies. Moreover, a tax agency may enjoy large returns to scale by expending resources on reforms that reduce the effort required to be compliant. Such a reform may impact the compliance behavior of many, many individuals at potentially little cost. In contrast, an increase in the number of audits may also improve taxpayers' compliance in the general population, but at much greater expense.

Increasing the burden of audits

Increasing the burden of responding to an audit can generate an increase in voluntary compliance. In terms of our model, this corresponds to an increase in a taxpayer's cost of noncompliance n. Taxpayers who would have been noncompliant would be incentivized to exert the effort to become compliant enough (though not necessarily accurate) in order to avoid paying these additional costs conditional upon audit. Similarly, taxpayers who would have been somewhat compliant but inaccurate may increase their compliance effort to actually report accurately.

From an efficiency and welfare perspective, reform that increases the burden of audits is unattractive, especially in comparison to other compliance-promoting reforms that reduce compliance costs. First, higher audit burdens would represent a real resource cost that is lost by taxpayers and more generally by society. This stands in contrast to reforms that reduce compliance costs and generate real resource gains. Second, increased audit burdens would negatively impact all taxpayers selected for examination, including those who are *ex post* discovered to have been compliant. This may violate several normative standards associated with fair tax administration. Third, increased audit burdens are not win-win. Examined taxpayers, both those who are noncompliant and those who are compliant, experience welfare losses. Taxpayers overall may gain to the extent that tax revenues, both those voluntarily paid as well as those recovered from audits, increase. However, we remind the reader of our earlier welfare results. Reductions in compliance costs (as opposed to increases in noncompliance costs) generate Pareto superior outcomes in which both the affected taxpayers and the general population stand to benefit.

Pre-filled tax forms

Another way to reduce compliance costs is to provide taxpayers, prior to filing, pre-filled forms that include the information the tax agency has already received from third-parties.[21] The collection of studies in Vaillancourt (2011a) examine different jurisdictions' experiences with pre-filled tax forms. Vaillancourt suggests two different mechanisms by which pre-filled tax forms may affect taxpayers' voluntary compliance. First, providing taxpayers with information and easing their compliance may promote "goodwill" that in turn promotes voluntary compliance. Second, taxpayers become aware of what the tax agency already knows. "Taxpayers with complicated personal affairs may find that the tax administration knows little about them" (information that presumably promotes noncompliance), "while other taxpayers may be surprised it knows so much about their financial affairs" (information that presumably promotes voluntary compliance).[22]

Our theory suggests that pre-filled tax forms may also promote voluntary compliance to the extent that compliance costs are inherently a disincentive to compliance. In the context of our model, we view pre-filled tax forms as a reduction in c_R. They lower the effort required for taxpayers to report non-0 amounts; however, they may do little to reduce the effort required to report accurately. Hence we expect that pre-filled tax forms may promote additional voluntary voluntary compliance—though not necessarily accurate compliance—among some taxpayers who are highly, or perhaps wholly, noncompliant in the absence of pre-filled forms. Our review of the NRP data suggests that these taxpayers are disproportionately those with lower amounts of true income. Therefore, the pro-compliance impact of pre-filled tax forms may be highest

[21] This is being done in some states, and is frequently suggested at the national level.
[22] The quotations are from page vii of Vaillancourt (2011a).

among lower income individuals—precisely the group that such programs have typically targeted.[23]

Tax Code Simplification

The complexity of the U.S. tax code is often cited as an important driver of tax compliance costs. Simplification of the tax code, for example by broadening the tax base and promoting "base integrity, that is whether the base is messy or clean" (Slemrod (2005)), would not only have direct impact on compliance costs, but may also promote additional voluntary compliance.

In the context of our model, we would expect a genuine simplification of the tax code to cause a reduction in c_I, the cost of accurate compliance. Hence, we expect that tax code simplification will promote more accurate compliance among taxpayers who may have otherwise been quasi-compliant but inaccurately so. As predicted in our model and verified in our empirical examination of NRP data, inaccurate taxpayers do not report the correct amount "on average." Instead, they systematically tend to underreport their true liability. These inaccuracies may contribute disproportionately to the aggregate tax gap if high income taxpayers disproportionately fall within this category. Our analysis of the 2006-2010 NRP data, along with the Phillips (2014a) analysis of the earlier 2001 NRP data, confirm that this is in fact the case.

Recognizing the interaction of tax code complexity, compliance costs, and voluntary tax compliance has important implications for fundamental tax reform proposals. In particular, it is often suggested that base broadening would allow for a revenue-neutral reduction in marginal tax rates. If base broadening also serves to promote additional voluntary compliance, then this

[23] See for instance the Erard (2011) and Vaillancourt (2011b) analyses of pre-filed tax return programs in California and Quebec, respectively.

implies that marginal tax rates could be reduced even further while maintaining revenue neutrality.

Increased Information Reporting

Several papers (e.g. Kleven et al. (2011), Phillips (2014a), Phillips (2014b)) have focused on the importance of third-party information reporting in promoting voluntary. However, these analyses have focused on how information provided to the tax agency impacts taxpayers' compliance. In particular, if the tax agency knows from a third-party that certain income has been received, then the taxpayer may be deterred from underreporting said income because of the very high probability that that underreporting would be detected.

We contend that third-party information reporting also has an important effect on compliance costs; as such, it provides a service to taxpayers. While the deterrence effect associated with information reporting stems from the fact that the tax agency has received the information, the compliance cost effect stems from the fact that the taxpayer himself has also received the information. In terms of our model, increased information lowers both c_R, the cost of reporting at all (though perhaps inaccurately), as well as c_I, the cost of reporting accurately. Additionally, increased information may bring the "easy-to-report" amount closer to the expected true amount (X and μ in our model, respectively), as well as reduce a taxpayer's uncertainty about the true amount (σ in our model). We expect each of these changes to promote accurate voluntary compliance.

Even if the deterrence effect of information reporting were to guarantee perfect compliance, we contend that its impact on compliance costs is still relevant. All else equal, reducing a taxpayer's costs of compliance improves that taxpayer's welfare and represents a real resource gain for society as a whole. Of course, increased information reporting may come at a cost to those parties required to generate these reports. While these third-parties to the tax administration process would face additional burden, we emphasize that such a burden will not only increase tax revenues, but can also yield welfare improvements for taxpayers by reducing their compliance costs.

B. Re-thinking Popular Taxpayer Segmentation Taxonomies

It is common to hypothesize that taxpayers fall naturally into several mutually exclusive groups that are defined by their compliance motivations—that is, each group has its own mechanism for producing accuracy or errors on a tax return. These segments are often thought of as falling along a spectrum ranging from the pathologically honest to fraudulent evaders.[24] We suggest that there may instead be just *one* model of compliance behavior among all taxpayers, but that it produces several behavioral categories due to differences in taxpayers' willingness to bear compliance and noncompliance costs, as captured by the parameters of our model. Our simple model yields four such groupings. (See Table 2 above.) One of the weaknesses of putting taxpayers into "buckets" is that a taxpayer's behavior may be significantly different in different contexts (such as for income tax vs. employment tax purposes, and for different lines on the income tax return); indeed, one's behavior may often be a blend of theoretical segments. Our model anticipates these nuances, predicting behaviors across the entire spectrum of compliance (and noncompliance) costs for each line on the return.

C. Interpreting Estimates of the Size and Determinants of Compliance Costs

We conclude with a discussion of how our analysis impacts the interpretation of empirical estimates of the size and determinants of compliance costs. First, compliance costs are

[24] See Erard and Ho (2003).

not solely dependent upon the tax code and tax administration procedures. They also depend on taxpayers' underlying compliance choices. For instance, taxpayers could pay virtually nothing in compliance costs by following a rather simple strategy—never filing a tax return. Of course, few taxpayers choose to do so because the benefits of filing outweigh the compliance costs associated with doing so.

When compliance costs increase or decrease, then, one must be cautious in asserting whether or not this is a good thing. In order to make any such judgment, one must understand *why* compliance costs changed. For instance, Blumenthal and Slemrod (1992) estimate that TRA86 had little impact on compliance costs. This may be surprising given that TRA86 is often regarded as having significantly simplified the tax code, and simplification presumably reduces compliance costs. However, our analysis suggests that some taxpayers may actually change their reporting behavior in response to such simplification. If the tax code was more complicated prior to TRA86, then some taxpayers may have received statutorily taxable income that they did not bother to report. Under TRA86's simplification, these taxpayers would now consider the (lesser) amount of effort required to comply worthwhile. In fact, one of Blumenthal and Slemrod's main takeaways is that between 1982 and 1989 "there was a sizable upward drift in the fraction of taxpayers with high compliance cost characteristics such as self-employment, capital gains, dividends, and pensions and annuities." (pg. 200) We cannot assert with any authority that these trends are attributable to reduced compliance costs as opposed to other changes in the economy over that time span. However, the trend is certainly consistent with our proposed theory.

Finally, we also note that several studies have used microlevel taxpayer data to examine how income levels and types of income received impact a taxpayer's compliance costs. There are certainly reasons to expect that higher amounts of income and receipt of certain types of income (e.g. sole proprietor income) raise a taxpayer's cost of compliance. In empirical analyses, however, these latter "explanatory" variables are amounts reported by taxpayers themselves. Our analysis suggests that these amounts are themselves endogenous outcomes that depend on compliance cost. Put another way, estimates of compliance cost that are based on income and other items *reported* by taxpayers do not generally reflect the compliance costs actually *faced* by them to achieve full compliance.

Empirical estimates of the determinants of compliance therefore cannot be interpreted as identifying the causal effect of, for instance, income on compliance costs. Instead, empirical estimates identify some reduced form relationship between two simultaneously determined variables. In the case of income amounts, we would generally expect its reduced form coefficient on compliance costs to underestimate the true causal effect on compliance costs. This is because higher amounts of (self-reported) income are more likely to be observed for taxpayers with lower idiosyncratic compliance costs. Similarly, voluntary reporting of more complex income types is more likely to be observed for taxpayers with lower idiosyncratic compliance costs. Reduced form estimation will partially capture these relationships. Having identified this potential for endogeneity, we hope that our analysis motivates a future empirical endeavor that uses instrumental or experimental methods to assess the causal effects of different compliance cost determinants.

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Appendix

- *Proof:* $(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) > 0$ *for all* $n \geq n_{REPORT}$

First, we rewrite

$$(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) = \int_X^\infty (I - X)g(I)dI - \int_0^{I^*(n)} Ig(I)dI.$$

Because $\int_X^\infty (I - X)g(I)dI$ decreases with X, $\int_X^\infty (I - X)g(I)dI \geq \lim_{X\to\infty} \int_X^\infty (I - X)g(I)dI$ and therefore

$$\begin{aligned}&(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big)\\ &\qquad \geq \lim_{X\to\infty}\Big((\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big)\Big)\end{aligned}$$

for all $n \geq n_{REPORT}$. Because $\int_0^{I^*(n)} Ig(I)dI$ increases in $I^*(n)$, and $I^*(n)$ decreases in n, $\int_0^{I^*(n)} Ig(I)dI \leq \int_0^{I^*(n_{REPORT})} Ig(I)dI$ for all $n \geq n_{REPORT}$. This implies then that

$$\begin{aligned}&(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big)\\ &\qquad \geq \lim_{X\to\infty}\Big((\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n_{REPORT})]G\big(I^*(n_{REPORT})\big)\Big)\end{aligned}$$

for all $n \geq n_{REPORT}$. Finally, we note that n_{REPORT} is itself an endogenous variable that depends on X. When X approaches ∞, n_{REPORT} also approaches ∞ -- only a taxpayer with infinitely large noncompliance costs would choose to inaccurately report infinite income rather than zero income. At the same time, $I^*(n)$ also approaches ∞ when n approaches ∞. Therefore, the limiting value on the right-hand side of the prior inequality equals zero and

$$(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) \geq 0$$

for all $n \geq n_{REPORT}$ and the inequality is strict, i.e.

$$(\mathbb{E}[I|I > X] - X)\big(1 - G(X)\big) - \mathbb{E}[I|I < I^*(n)]G\big(I^*(n)\big) > 0,$$

for all $n \geq n_{REPORT}$ so long as X is finite.

- *Proof: Proposition 1*

Here we provide the formal expressions for the n_{REPORT} comparative statics that yield Proposition 1. First, it will prove useful to define the X-dependent value

$$Z_1 = \left(\frac{X - \mathbb{E}[I|I < X]}{X}\right) G(X)$$

and note that $0 < Z_1 < 1$.

  - n_{REPORT} comparative static with respect to α

Using the implicit definition of n_{REPORT} it can be shown that

$$\frac{\partial n_{REPORT}}{\partial \alpha} = -(\theta_U - \theta_O) - \frac{\theta_O}{1 - Z_1}.$$

The right-hand side is necessarily negative; therefore $\frac{\partial n_{REPORT}}{\partial \alpha} < 0$. n_{REPORT} decreases when α increases.

  - n_{REPORT} comparative static with respect to θ_U

Using the implicit definition of n_{REPORT} it can be shown that

$$\frac{\partial n_{REPORT}}{\partial \theta_U} = -\alpha.$$

The right-hand side is necessarily negative; therefore $\frac{\partial n_{REPORT}}{\partial \theta_U} < 0$. n_{REPORT} decreases when θ_U increases.

- n_{REPORT} comparative static with respect to X

Using the implicit definition of n_{REPORT} it can be shown that

$$\frac{\partial n_{REPORT}}{\partial X} = \Big(G(X) - G\big(R^*(n_{REPORT})\big)\Big) \cdot \frac{\big(n_{REPORT} + \alpha(\theta_U - \theta_O)\big)}{X(1 - Z_1)}$$

where

$$R^*(n) = G^{-1}\left(\frac{n - (1 - \alpha\theta_U)}{n + \alpha(\theta_U - \theta_O)}\right)$$

is an uninformed taxpayer's (i.e. the taxpayer discussed in Section 3B) optimal reporting choice if he is free to choose any R, not just $R = 0$ or $R = X$.[25] $R^*(n)$ increases with n, and there exists some critical n^* reflect the taxpayer who would actually choose $R^*(n^*) = X$ in the environment of free choice of R. When the choice set is limited to just $R = 0$ and $R = X$, taxpayers with low n are drawn down to $R = 0$ while taxpayers with high n are drawn up to $R = X$. The threshold n that distinguishes these two groups of taxpayers, i.e. n_{REPORT}, must satisfy $n_{REPORT} < n^*$. This in turn implies that $R^*(n_{REPORT}) < R^*(n^*) = X$, which in turn implies that $G\big(R^*(n_{REPORT})\big) < G(X)$. The right-hand side of the $\frac{\partial n_{REPORT}}{\partial X}$ expression above is necessarily positive; therefore $\frac{\partial n_{REPORT}}{\partial X} > 0$. n_{REPORT} decreases when X decreases.

- n_{REPORT} comparative static with respect to σ

Using the implicit definition of n_{REPORT} it can be shown that

$$\frac{\partial n_{REPORT}}{\partial \sigma} = \frac{\partial\big((X - \mathbb{E}[I|I < X])G(X)\big)}{\partial \sigma} \cdot \frac{\big(n_{REPORT} + \alpha(\theta_U - \theta_O)\big)}{X(1 - Z_1)}$$

[25] More precisely, $R^*(n)$ is the interior solution R that maximizes $P - \tau R - (\alpha\theta_U + n)\tau(\mathbb{E}[I|I > R] - R)(1 - G(R)) - \alpha\theta_O\tau(\mathbb{E}[I|I < R] - R)G(R) - c_R$.

The sign of $\frac{\partial n_{REPORT}}{\partial \sigma}$ will therefore be the same as the sign of $\frac{\partial\left((X-\mathbb{E}[I|I<X])G(X)\right)}{\partial \sigma}$. In order to determine this latter sign, it is useful to employ integration by parts to rewrite $(X - \mathbb{E}[I|I < X])G(X) = \int_0^X (X - I)g(I)dI = \int_0^X G(I)dI$. By definition, a mean-preserving spread of the perceived true income distribution increases $\int_0^X G(I)dI$ and $\frac{\partial\left((X-\mathbb{E}[I|I<X])G(X)\right)}{\partial \sigma} > 0$. The right-hand side of the $\frac{\partial n_{REPORT}}{\partial \sigma}$ expression above is necessarily positive; therefore $\frac{\partial n_{REPORT}}{\partial \sigma} > 0$. n_{REPORT} decreases when σ decreases.

- n_{REPORT} comparative static with respect to c_R

Using the implicit definition of n_{REPORT} it can be shown that

$$\frac{\partial n_{REPORT}}{\partial c_R} = \frac{1}{\tau X(1 - Z_1)}.$$

The right-hand side is necessarily positive; therefore $\frac{\partial n_{REPORT}}{\partial c_R} > 0$. n_{REPORT} decreases when c_R decreases.

- n_{REPORT} comparative static with respect to c_I

Finally, it is worth noting that n_{REPORT} does not depend on c_I:

$$\frac{\partial n_{REPORT}}{\partial c_I} = 0.$$

- *Proof: Proposition 2*

Here we provide the formal expressions for the $n_{ACCURATE}$ comparative statics that yield Proposition 2. First, it will prove useful to define the X- and $n_{ACCURATE}$-dependent value

$$Z_2 = (\mathbb{E}[I|I > X] - X)\left(1 - G(X)\right) - \mathbb{E}[I|I < I^*(n_{ACCURATE})]G\left(I^*(n_{ACCURATE})\right).$$

In the first part of this Appendix, we proved that $(\mathbb{E}[I|I > X] - X)\left(1 - G(X)\right) - \mathbb{E}[I|I < I^*(n_{REPORT})]G\left(I^*(n_{REPORT})\right) > 0$. Assuming that

$n_{ACCURATE} > n_{REPORT}$ (the rationale for such an assumption is provided in the main text), then it is also the case that $Z_2 > 0$.

- $n_{ACCURATE}$ comparative static with respect to α

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial \alpha} = -(\theta_U - \theta_0) + \frac{\theta_O\left((X-\mu) + \mathbb{E}[I|I < I^*(n_{ACCURATE})]G\left(I^*(n_{ACCURATE})\right)\right)}{Z_2}$$

In principle this may be positive or negative. If the "easy-to-report" income X is systematically lower than the expected true income μ, or alternatively does not does exceed μ by very much, then $\frac{\partial n_{ACCURATE}}{\partial \alpha} < 0$ is more likely. Alternative, if $I^*(n_{ACCURATE})$ is sufficiently small, as is likely to be the case since $n_{ACCURATE}$ is relatively large, then $\frac{\partial n_{ACCURATE}}{\partial \alpha} < 0$. We note that the ambiguity of the sign of $\frac{\partial n_{ACCURATE}}{\partial \alpha}$ arises from the fact that higher α could feasible raise an informed taxpayer's expected utility if they follow the $R = X$ strategy and $X > \mu$. If the taxpayer self-reports more than what he thinks he owes (in expectation), then he may welcome an examination if it will reveal his overreporting (more likely than not) and lead to a refund of his overpaid liability.

- $n_{ACCURATE}$ comparative static with respect to θ_U

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial \theta_U} = -\alpha$$

The right-hand side is necessarily negative; therefore $\frac{\partial n_{ACCURATE}}{\partial \theta_U} < 0$. $n_{ACCURATE}$ decreases when θ_U increases.

- $n_{ACCURATE}$ comparative static with respect to X

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial X} = -\Big(G(X) - G\big(R^*(n_{ACCURATE})\big)\Big) \cdot \frac{\big(n_{ACCURATE} + \alpha(\theta_U - \theta_O)\big)}{Z_2}.$$

In our derivation of the sign of $\frac{\partial n_{REPORT}}{\partial X}$ we made use of the fact that $R^*(n_{REPORT}) < X$. However, theory alone does not dictate whether $R^*(n_{ACCURATE}) < X$ or $R^*(n_{ACCURATE}) > X$. If c_I is relatively low, then $n_{ACCURATE}$ is also relatively low and the former is more likely. If c_I is relatively large, then the latter is more likely. When c_I is relatively low then, an increase in X will decrease $n_{ACCURATE}$, otherwise it will increase $n_{ACCURATE}$.

- $n_{ACCURATE}$ comparative static with respect to σ

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial \sigma} = -\left(\frac{\partial\left(\int_0^X G(I)dI\right)}{\partial \sigma} \cdot \frac{\big(n_{ACCURATE} + \alpha(\theta_U - \theta_O)\big)}{Z_2}\right) - \left(\frac{\partial\left(\int_0^{I^*(n_{ACCURATE})} G(I)dI\right)}{\partial \sigma} \cdot \frac{\big(n_{ACCURATE} - (1 - \alpha\theta_U)\big)}{Z_2}\right)$$

By definition, a mean-preserving spread of the perceived true income distribution increases $\int_0^X G(I)dI$ and $\int_0^{I^*(n_{ACCURATE})} G(I)dI$. The right-hand side of the $\frac{\partial n_{ACCURATE}}{\partial \sigma}$ expression above is necessarily negative; therefore $\frac{\partial n_{ACCURATE}}{\partial \sigma} < 0$. $n_{ACCURATE}$ decreases when σ increases.

- $n_{ACCURATE}$ comparative static with respect to c_R

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial c_R} = \frac{-G\big(I^*(n_{ACCURATE})\big)}{\tau Z_2}.$$

The right-hand side is necessarily negative; therefore $\frac{\partial n_{ACCURATE}}{\partial c_R} < 0$. $n_{ACCURATE}$ decreases when c_R increases. That being said, this effect may negligible. Since $n_{ACCURATE}$ is relatively large, $I^*(n_{ACCURATE})$ may be quite close to zero. In that case, the numerator of the right-hand side is zero and $\frac{\partial n_{ACCURATE}}{\partial c_R} = 0$.

- $n_{ACCURATE}$ comparative static with respect to c_I

Using the implicit definition of $n_{ACCURATE}$ it can be shown that

$$\frac{\partial n_{ACCURATE}}{\partial c_I} = \frac{1}{\tau Z_2}.$$

The right-hand side is necessarily positive; therefore $\frac{\partial n_{ACCURATE}}{\partial c_I} > 0$. $n_{ACCURATE}$ decreases when c_I decreases.