

Targeting in Tax Compliance Interventions: Experimental Evidence from Honduras

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Abstract

The use of letters and emails to directly influence taxpayers' behavior is popular among tax authorities (TA) and has been shown to positively impact tax compliance. A challenge for governments with low capacity is how to target these interventions: informing taxpayers about knowledge of their wrongdoing and not following up by punishing non-compliers erodes their credibility. We partner with the Honduras Revenue Administration Service (SAR) to randomize approximately 32,000 taxpayers into receiving information about the tax authorities' knowledge on their transactions before the filing deadline. Our experiment will allow us to estimate the impact of the intervention on compliance measures such as probability of filing and declared taxable income. Using rich administrative data on taxpayers' previous characteristics and behavior, we will use a causal forest algorithm to estimate heterogeneous treatment effects and assess how these compare to ex-ante risk assessments currently used for targeting.

Keywords: Tax compliance, Tax evasion, Firms & Productivity, Governance, Targeting

JEL Codes: H26, O17

Study pre-registration: This study has been enrolled in the AEA Trial Registry (RCT ID: [AEARCTR-0005285](#))

Proposed timeline

- March/May 2020: Emails sent to experimental sample (intervention)
- June 30th 2020: Tax filing deadline (affected by COVID-19, see more below)
- August 15th 2020: Tax filing data available for analysis.

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1 Introduction

State capacity is intimately linked to governments' ability to enforce taxation. Tax collection in low-income countries, in that sense, looks very different from what is observed in higher income settings. Tax revenue in OECD countries are equivalent to about 16% of GDP, while that ratio is less than 12% in low-income countries. The composition of collected taxes is also very different: while high-income countries collect over 50% of its total taxes through income taxes, this number is less than 30% for low and middle-income countries, where taxes on goods and services are much more important.

One reason for that disparity in tax composition is likely informational constraints (Gordon & Li, 2009): broad sales taxes, for example, only require information on total sales of business. Contrast that with personal income taxation, which requires knowledge of all income sources of individuals (wages, other labor compensations, capital income, etc), or corporate taxation, which requires the correct assessment of both firms' revenues and costs.

The capacity to obtain and process the type of information needed to assess income tax liabilities, however, seem to be rapidly increasing in several low- and middle-income countries. International organizations are committed to improve tax capacity: approximately \$200 million in Official Development Assistance (ODA) were aimed at improving tax capacity in 2014 (International Monetary Fund et al., 2016). These improvements in "government intelligence", nonetheless, do not translate automatically into higher compliance, but require other actions by the authorities. First, providing taxpayers with knowledge on the new information set of the authorities might trigger increased "voluntary" compliance, if their beliefs about the probability of punishment is updated. Second, authorities need to explore this new information to target their policies: audits, for example, are very expensive and labor-intensive, and should be targeted to maximize revenue recovery.

In this paper we partner with the Tax Authority (TA) in Honduras (SAR, for *Servicio de Administración de Rentas*) to experimentally estimate the impact of providing information to taxpayers about SAR's knowledge on their transactions. Using a recently developed risk model to assess non-compliance, we conduct an experiment with approximately 32,000 taxpayers considered to be at-risk. Taxpayers in the control group receive a regular reminder about the

income tax filing deadline - an usual communication provided by the tax authority. Those in the treatment group, on the other hand, receive examples of specific third-party information about their income available to the TA. In that sense, we see our experimental treatment as providing taxpayers with data about the information set available to the TA. That allows us to estimate the average effect of treatment assignment on a range of compliance outcomes of interest, measured using administrative data on tax declarations.

While there is strong evidence that the average effect of these types of intervention is positive, increasing compliance (see [Mascagni \(2018\)](#) for a recent review), this is not inconsistent with negative or null impacts on some subset of taxpayers ([De Neve et al., 2019](#)). We argue that measuring this heterogeneity is crucial for authorities to better target this kind of intervention. While the return on investment of these studies is often perceived to be extremely high given the close to zero marginal costs of letter or email communications, a less discussed potential hidden cost is the credibility of the TA. When capacity is low, it is often not possible to follow-up on this type of low cost communications by performing more expensive interventions, such as in-person audits. That poses a reputational risk for the TA: revealing knowledge about potential misreporting and not acting might lead taxpayers to believe (perhaps accurately) that the expected punishment for non-compliance is low.

While we present some heterogeneity analysis on key dimensions built into the experimental design, our intention is to use the experiment and rich data on taxpayers past behavior to predict which subjects are most responsive to the intervention. In other words, we have a targeting problem: our goal is to predict, upon observing a taxpayer's characteristics, what is their expected response to a communication intervention such as the one we implement in this study.

In order to do so we will use a causal forest algorithm ([Athey & Imbens, 2016](#); [Wager & Athey, 2018](#)) to estimate conditional average treatment effects (CATE) across the sample of taxpayers. With those estimates at hand, we can assess how the treatment effects compare to the perceived risk level of each taxpayer, estimated by the TA using non-experimental data from before the intervention. This is informative about future communication interventions: currently those with higher assessed risk are more likely to be targeted, but it's not clear

whether these are the most responsive taxpayers⁴.

Our study contributes new evidence to the now large literature on communication interventions aimed at increasing taxpayers compliance, reviewed by [Mascagni \(2018\)](#) and [Hallsworth \(2014\)](#). Our experiment is particularly informative about exploring third-party information in communication interventions, similar to the work of [Brockmeyer et al. \(2019\)](#) in Costa Rica and [Carrillo et al. \(2017\)](#) in Ecuador. Since the third-party information available focuses on reported revenues, we explicitly acknowledge the risk that taxpayers might increase both declared revenues and deductions, as documented by [Carrillo et al. \(2017\)](#), and will test whether that is the case.

In addition to informing taxpayers about the TA's knowledge of their transactions, we also randomly vary, among treated subjects, how we frame the importance of compliance. One third of the treatment group is reminded that non-compliance carries monetary penalties; another third is reminded that the TA can deny documents necessary for their operations; while the final message is a call to tax morale, claiming that "with your taxes we build a better country". The effects of appealing to tax morale ([Luttmer & Singhal, 2014](#)) in these type of letter or email interventions have so far been mixed. [De Neve et al. \(2019\)](#) finds that appeals to the social norm of payment or the importance of public goods have null or negative effects across the compliance spectrum in Belgium, while [Castro & Scartascini \(2015\)](#) find null effects in Argentina for local property taxes. [Kettle et al. \(2016\)](#), on the other hand, find that informing late filers in Guatemala that they were in a minority of non-compliers was as effective as a threat message. Although the exact treatments are not the same, it is somewhat surprising that appeals to tax morale are more effective in Guatemala than in Argentina or Belgium, given low levels of confidence in the government: according to Latinobarometro, only 22% of Guatemalans answer having some or a lot of confidence in the government between 2015-2018, lower than the 30% reported by Argentinians. That figure is less than 24% in Honduras, which highlights the possible challenge of harnessing tax morale to improve compliance.

Finally, we see our exercise using the causal forest algorithm contributing to a recent literature exploring heterogeneity analysis in experimental settings to inform program targeting,

⁴In appendix B, we present a simple model of heterogeneous treatment effects in tax compliance and illustrate the value of additional experimental information on targeting.

ranging from cash and asset transfers to the poor (Alatas et al., 2012) to the use of cellphones to monitor agricultural extension workers (Dal Bó et al., 2021). In a similar exercise but different setting, Hussam et al. (2020), working with experimental grants to entrepreneurs in India, show that the causal forest algorithm can do no better in predicting returns to the program than assessment by other community members. We will compare our treatment effect estimates with the baseline risk assessment of each taxpayer, investigating whether the experimental results are a useful tool for the tax authority to improve its targeting.

2 Context - Taxation in Honduras

Honduras is a lower middle-income country in Central America, with a population of approximately 9 million people and GDP per capita of \$5,100 PPP in 2018. At 18.4%, taxes as a share of GDP are similar to other countries with similar income levels. The composition of taxes collected is also similar to other lower income countries: income taxes make up less than one third of total taxes collected, while taxes on goods and services (mostly VAT) make up over 50% of total taxes (International Monetary Fund, 2018).

The fiscal year runs from January 1st to December 31st, and taxpayers must file an income tax declaration by April 30th of the following year. Corporations are taxed at a flat rate of 25% on profits (gross revenues minus cost deductions). Since 2003, corporations must also assess a 1% tax on its net assets over L3 million⁵, and pay the largest amount between asset and income taxes⁶. Non-incorporated taxpayers face a progressive tax schedule: net income below L152,000 is exempt from taxation and higher incomes are taxed with increasing marginal taxes in three brackets of 15%, 20% and 25%⁷. All taxpayers with commercial activities (both corporations and non-incorporated) are also liable for monthly sales taxes of 15% over total goods and services sold.

Between 2014-2019, the Honduran Tax Administration underwent a series of reforms and institutional changes that strengthened the country's fiscal system. These included improve-

⁵Equivalent to USD121,500, based on an average exchange rate of 25 Lempiras per US dollar for 2018.

⁶In our experimental sample only 10% of corporations (3% of all taxpayers) paid the asset tax in FY2018.

⁷The law also allows for a L40,000 deduction of medical costs. In practice this deduction is applied to all non-incorporated taxpayers, regardless of claiming the deduction, such that the exemption threshold is higher.

ments in operational management, recruitment of personnel, a new billing regime, adoption of new technologies for data processing, among others. This resulted in greater efficiency in management, improvement in service coverage, a larger tax base and ultimately more tax revenues. Between 2014-2018, tax revenues increased from 15% of GDP to over 18%, contributing to a decrease in the fiscal deficit of nearly 5 percentage points of GDP (7.9% in 2013 vs. 2.1% in 2018) ([International Monetary Fund, 2018](#)). Furthermore, SAR has been working to consolidate these institutional reforms and implement new tools to ensure fiscal compliance, including a sophisticated internal risk model⁸.

3 Research design

3.1 Intervention

Jointly with the tax authority in Honduras, we sent emails to approximately 32,000 taxpayers seven weeks before the income tax filing deadline for FY2019⁹. Since our main goal is to estimate the effect of the email content, focused on the information set available to the TA, we decided to contact all taxpayers in the experimental sample. This allows us to attribute any differential behavior among treated units to the messages' content, and not the simple fact of being contacted by the government¹⁰.

The control group received an email¹¹, presented in Figure 2, with a reminder about the filing deadline for 2019 and the importance of truthfully reporting their tax liabilities¹². It also includes a link to the tax administration's website with detailed information on how to declare taxes online.

Taxpayers in the treatment group received emails containing the same informational con-

⁸See subsection Experimental sample and design for more details on SAR's internal risk model.

⁹Due to the Covid-19 crisis, the tax filing date was postponed from April 30th to June 30th. More details on how we deal with those changes are provided below.

¹⁰The TA sends on average 200,000 emails every month to taxpayers, notifying them about various fiscal procedures. Taxpayers in our experimental sample only received the intervention communications.

¹¹All emails, for treatment and control taxpayers, included the same subject "Important: Notice of Tax Obligation" and were sent from an institutional email address used by the tax authority.

¹²The main part of the email reads, in English: "The Revenue Administration Service (SAR) reminds you that the obligation to file and pay the Sworn Declaration of Income Tax period 2019 expires on April 30, 2020. You are reminded that the Declaration must contain exact and truthful information, reporting all income obtained and that deductions will have to be supported by valid tax documents.

tent offered to control units, but were additionally provided with i) information available to the TA regarding their transactions and ii) slightly different framing messages on why they should comply with their obligations. For the majority of our experimental sample (71%) some third-party information on their transactions in FY2019 is available, and that fact is included in the message. For the remaining taxpayers, no third-party information is available but their previous reporting behavior raised flags about non-compliance, and that is the information included in the email. Since our treatment group includes three arms with different framings on the importance of compliance, we have in total six different types of messages, illustrated in Figures 3 through 8¹³.

For those for whom third-party information was available (Figure 3 through Figure 5), the email informed that "In the sources of information available in the Tax Administration, your following commercial transactions for FY2019 period have been identified", followed by up to four types of transactions: sales to other taxpayers; sales through debit/credit cards; sales or services to the State; and exports¹⁴. These messages are personalized, so that each taxpayer is only informed of categories for which the TA observes their transactions (i.e. there is no deceit or bluffing involved).

Taxpayers flagged for risk of non-compliance but for whom third-party information was not available were notified (Figure 6 through Figure 8) that "In the sources of information available in the Tax Administration, the following behavior has been identified in your tax returns", followed by up to three "anomalies" in their past filings: declaring three or more years with losses in the previous five fiscal periods; financial transactions incompatible with declared revenue; and declared tax liability "atypical" for tax units in similar industries and revenue size.

As seen in the messages, we have three different treatment arms in which we change a small part of the emails' contents, highlighting different reasons why taxpayers should comply with their tax obligations.

¹³To further strengthen the intervention, the content of messages were informed by previous experiments using insights from behavioral economics (Dalton et al., 2019), such as making the text simpler, personalized to each taxpayer and including actionable information (link to SAR's website). The messages were also analyzed in focus group discussions with SAR officials (including communication experts) and policy-makers in Honduras.

¹⁴Unlike Brockmeyer et al. (2019) or Carrillo et al. (2017), the emails did not include monetary values on specific transactions or information on trading partners due to legal restrictions.

Sanctions treatment: these messages highlight the sanctions associated with non- or late-filing, by stating that "In case of not fulfilling your obligation, you will be subject to the sanctions established by the Tax Code in Articles 160 and 163."¹⁵ These are similar to other "threat" messages used in the literature, explaining or making more salient to subjects the monetary costs of non-compliance.

Procedure denial treatment: this treatment arm also includes a threatening message, but instead of mentioning possible fines it invokes the right of the TA to withhold important documents necessary for business' operations in case they are non-compliant. The additional message reads "In case of not fulfilling your obligation, you will be affected in obtaining proofs of "pagos a cuenta", solvency and fiscal documents"¹⁶.

Tax morale treatment: in this treatment arm the email contains two pieces of additional content: a motto upfront stating "For you, for your kids, for Honduras, pay your taxes!" and a paragraph stating "The Honduras we all want for our children with education, health, infrastructure and security is the fruit of the efforts of all its good citizens, thanks to their taxes we build a better country". This message appeals to the fact that taxes are used to finance public goods and it's the duty of "good citizens" to pay their taxes.

All emails were sent between March 11th-12th 2020, approximately seven weeks before the original FY2019 tax filing deadline. Due to the Covid-19 crisis the filing date was postponed to June 30th, 2020. In order to reinforce the treatment, we will resend the emails, with the updated filing dates, in early May. The email service used by the tax authority to send mass communications allows us to observe the "outcome" of every email sent, whether they reached the taxpayers' mailbox, if they ever opened it and if they clicked on the link to SAR's website. We consider taxpayers to be compliant, that is effectively receiving the treatment, if they either open the email or click on the link.

¹⁵The two articles mentioned determine fines for non-presentation or late presentation, as well as non- or late payments of tax obligations (see <https://www.sar.gob.hn/leyes/>).

¹⁶"Pagos a cuenta" refers to a special regime in which clients do not have to withhold income taxes on services offered by independent professionals - this is a benefit to these professionals since it preserves their cash flows until the tax payment date. "Solvency" is a statement by the TA that the taxpayer is up to date with their obligations and is required to perform transactions with state entities. "Fiscal documents" is understood to be fiscal receipts, which need to be approved and provided by the tax authority so that firms can legally issue them.

3.2 Hypotheses

This paper contributes new evidence to an established literature exploring how the provision of information to taxpayers affects their compliance behavior (Mascagni (2018)). Exploring the fact that the TA in Honduras has just recently started using third-party information and other compliance indicators in a systematic way to assess each taxpayer's risk profile, the first hypothesis we test refers to the effect of communication on compliance:

Hypothesis 1: Communicating to taxpayers the information available to the tax authority about their transactions will increase tax compliance.

As discussed above, we will be careful to separate the effect of reaching out to taxpayers, which could by itself improve compliance by making tax obligations more salient or simply increasing perception of being watched (Bergolo et al., 2017), with the content of the messages. We will measure "tax compliance" using administrative data on the FY2019 income tax filing. Our primary outcomes, as specified in our pre-registration plan, will be whether the taxpayer filed income tax declaration; the amount of gross revenue declared; the amount of deductions declared; and the taxable income declared.

While our first hypothesis considers the main content of our messages, the information set available to the tax authority, our second hypothesis regards the impact of the different treatment arms:

Hypothesis 2: Taxpayers will respond differently to each of the framings in the separate treatment arms.

The three messages, which we refer to as "Sanctions", "Procedures denial" and "Tax morale", frame in different ways the reason why taxpayers should comply. We will use the same primary outcomes discussed above to test whether each of the treatment interventions causally change compliance, and whether these effects are different among themselves. There exists extensive evidence that threats of sanctions are particularly efficient in increasing compliance, while the evidence is much more mixed for tax morale appeals (De Neve et al., 2019; Kettle et al., 2016; Ortega & Scartascini, 2015).

Our final hypothesis refers to the differential causal effects of the intervention for taxpayers with different ex-ante assessed risk-levels. We design the experiment with the goal of assessing whether the risk-level perceived by the tax authority is informative about taxpayers responses, which we intend to test:

Hypothesis 3: Taxpayers in different risk-level brackets will respond differently to the intervention.

3.3 Experimental sample and randomization

The experimental sample is comprised of 31,396 taxpayers considered to be at-risk of non-compliance in FY2018. The risk was assessed using SAR's internal risk model (*Modelo de Gestion de Riesgo de Honduras, MGR-H*)¹⁷ that considers both discrepancies between declared income by taxpayers and information reported by third-parties, as well as anomalies, defined as outcomes that seem inconsistent with other similar tax units. The model utilizes risks of non-compliance identified throughout a taxpayers life-cycle (registration, presentation, payment and truthfulness) in order to maximize tax compliance. It combines probability variables (frequency with which the risk occurs) and consequence (materiality or economic damage caused by the risk). An aggregate tax score is generated that determines the level of risk associated with each taxpayer. Based on the risk management model, SAR determines which treatment actions should be implemented to mitigate risks and prioritizes the allocation of resources to the highest risks.

The Revenue Administration Services has five main sources of information on taxpayers' revenues provided by third-parties. First, the Monthly Declaration of Purchases (*Declaración Mensual de Compras, DMC*) is an informative declaration filed monthly by a subset of taxpayers. They can use declared purchases from other registered taxpayers as credits against their liabilities on sales taxes (effectively a VAT system). The Monthly Declaration of Withholding (*Declaración Mensual de Retenciones, DMR*) is also filed monthly by taxpayers designated

¹⁷The model follows the ISO 31000 risk management standard and international best practices regarding fiscal procedures as established by the International Monetary Fund (IMF), Organization for Economic Cooperation and Development (OECD) and the Center Inter-American Tax Administrations (CIAT).

as "withholding agents", such as firms that retain and pay income taxes of their employees. Third, the Declaration of Credit Card Administrators (*Declaración de Retenciones de las Administradoras de Tarjetas de Débito y Crédito*, ATC) is filed by credit and debit card companies about point-of-sales purchases using their system. Credit and Debit Card administrators are also withholding agents, paying a share of sales taxes due in each transaction. Finally, two sources of third-party information are provided by other government agencies: the Integrated System of Financial Administration (*Sistema de Administración Financiera Integrada*, SIAFI) provides information on all revenue made by sales to government entities, and all export sales are also informed to the tax authority.

The TA's risk model also performs a series of risk analyses in the absence of third party information. These include, but are not limited to, flagging taxpayers reporting repeated losses and performing cluster analyses that group "similar" units and flag those with reported outcomes (such as tax liabilities) that are inconsistent with their peers. The Tax Authority also has access to information about financial transactions such as loans, and uses that to flag taxpayers that declare revenues inconsistent with their financial activities.

To arrive at the final experimental sample of 31,396 taxpayers, two main restrictions were applied to a broader set of at-risk taxpayers. First, in order to avoid spillovers between treatment and control units, we only include in the experimental sample taxpayers with a unique primary email address¹⁸. Second, power calculations exercises suggest we can significantly increase minimum detectable effects (MDE) by dropping extremely large taxpayers. Figure 1 reports MDE for our four main outcomes of interest when we trim our sample at different percentiles. By simply trimming the top 1% of taxpayers in terms of declared revenue in 2018, for example, we can reduce the MDE of percentage change in taxable income from almost 20% to less than 15%. Considering all primary outcomes, we decided to trim the sample at the 97th percentile of declared revenue distribution, arriving at our final sample of 31,396 taxpayers¹⁹.

We implement a stratified randomization, at the taxpayer level, using 60 strata defined by

¹⁸Approximately 4,400 taxpayers were also deemed at-risk of non-compliance but shared a primary contact email with other units, either due to joint ownership or an accounting firm as primary contact. We excluded these taxpayers from our main sample and will run a separate, smaller experiment with those in order to estimate spillover effects.

¹⁹Details about power calculations used in Figure 1 are discussed below. We exclude taxpayers with declared gross revenue above L19.4 million (approximately USD 780,000) in either FY2017 or FY2018.

whether third-party information was available or not; whether the taxpayer was a corporation; municipality of operations defined as Distrito Central (capital Tegucigalpa), San Pedro Sula (second largest city, often referred as the industrial capital) or other; and five risk levels as defined by the tax authority ($2*2*3*5 = 60$ strata). In each strata we allocated 49 percent of taxpayers to the control group and the remaining 51 percent in three equally sized treatment arms. Following Bruhn & McKenzie (2009) we deal with "misfits" (remaining taxpayers in each strata) by randomly assigning them to one of the four groups (control + 3 treatments) using the above weights as assignment probabilities²⁰.

3.4 Minimum detectable effects

We calculate Minimum Detectable Effects (MDE) of an experiment with 80% power and 5% significance level for our four primary outcomes: probability of filing income taxes; amount of declared gross revenues; amount of declared deductions; and amount of declared taxable income. Using data from FY2018 and FY2017 filings, we first calculate the residual variance of outcomes of interest after estimating regressions of the form:

$$y_{i,2018} = \alpha + \beta'X_i + \epsilon_i \quad (1)$$

where $y_{i,2018}$ are one of the three continuous primary outcomes described above and X_i are the same covariates that we plan to use as controls when estimating treatment effects²¹.

Table 2 presents the results of these estimates for each of the three continuous primary outcomes in 2018. We are able to explain between 55% (for taxable income) and 75% (for gross revenues) of total variance by using these controls, highlighting the importance of using past filing information to increase the precision of our estimates. In our power calculations, we also assume that compliance with treatment is 60%, under the assumption that 60% of taxpayers assigned to the treatment group will open the email sent²².

²⁰The randomization was implemented in Stata using the *randtreat* command to deal with misfits.

²¹These are strata dummies; dummy for presenting tax declaration in the previous year; amount of declared gross revenue, third-party informed gross revenue and declared taxable income in the previous year; and amount of declared sales tax revenues in the same year.

²²This figure was informed by a pilot discussed below.

Under these hypotheses and using our sample of 31,396 taxpayers, our MDE for the pooled treatment vs. control comparison, presented in the first panel of Table 3, is 2 percentage points for the probability of filing declaration; L71,000 of gross revenues (5.5% of the baseline mean); L78,000 of deductions (6.2% of the mean); and L8,800 of taxable income (8.8% of the mean). For each of the individual treatment arms (second panel) our MDEs are 2.5 p.p. for filing probability; L100,000 of gross revenues; L110,000 for deductions and L12,400 for taxable income.

4 Data

4.1 Baseline descriptive and balance

We present baseline descriptive statistics of our experimental sample in Table 1. Since taxpayers whose only source of income are wages or capital are directly withheld and do not have to present a declaration, all taxpayers in the study have some type of commercial activity. One-third of taxpayers are corporations, 40% are individual business (non-incorporated firms) and 6% are self-employed service providers (often professionals like lawyers or doctors)²³. Half of all taxpayers are located in the two largest municipalities in the country, Distrito Central and San Pedro Sula.

On Panel B we present descriptive statistics of variables related to past tax declarations. The majority of taxpayers were flagged to be at-risk for sub declaration of their tax liabilities, not for non-declaration: 86% of the sample filed an income tax declaration for FY2018. Conditional on declaring, average gross revenue was L1.5 million (USD 60,000) while median gross revenue was L 381,000 (USD 15,200) - even after excluding outliers the gross revenue distribution presents a long right-tail. Almost 50% of taxpayers were not liable to pay income taxes in FY2018, either because they declared gross revenues below the minimum threshold to pay taxes (for non-incorporated entities) or because they declared losses. Conditional on declaring, the average taxable income was L115,000 (median = L41,000) and the average tax liability L15,000.

²³The remaining 21% are not incorporated and also not registered as individual businesses or service providers. The nature of their transactions suggest these are mostly small businesses that never officially registered as such.

We also provide information on the indicators used by the tax authority to assess risk on Panel C. Third-party information on revenues is available for 71% of the experimental sample and, among those, 88% are informed on sales to other parties, 22% by credit/debit cards (point-of-sales, or POS) operators; 3% by the government and 1% by customs authority²⁴. Considering "anomalies", almost half of our experimental sample is flagged for having "atypical declared revenues" when compared to peers. A much smaller share is flagged for declaring three or more losses in the last five fiscal periods (8%) or having financial transactions inconsistent with declared revenues (7%). These indicators, among others, are then aggregated by the TA in a global "risk factor", which is used to classify every taxpayers in five risk levels. Our sample is fairly evenly divided among the four lowest levels, with only 10% deemed to be "high-risk" by the tax authority's risk model.

In Table 4 we present balance tests between our control and treatment samples. Columns (1) and (2) present the mean and standard deviation of each variable in the control group, respectively. In Column (3) we present the difference in means between control and the pooled treated sample, and test whether we can reject the null hypothesis of equal means. Overall our sample is balanced and the few statistically significant differences are very small in magnitude. Columns (4) through (6) present differences between each of the treatment arms and the control group, and again indicate balance in observables.

4.2 Endline data and compliance in pilot study

Outcomes of interest will be compiled from administrative data using income tax declarations for FY2019. The deadline for filing is April 30th, 2020²⁵, and around 80% of taxpayers filed electronically the previous year²⁶. The remaining declarations are done in paper, submitted to banks and processed electronically before being sent to the tax authority, a process that usually takes around a month. Using a conservative timeline, we expect to have access to endline data by mid-to-late August.

²⁴These are the categories used to fill in the message sent to taxpayers and they are not exclusive: some taxpayers are informed in these four categories.

²⁵Now postponed to June 30th.

²⁶Taxpayers have the option of filing their electronic declaration directly from their computers and paying their liabilities using credit cards. They also can bring their declarations to banks and pay in person, and bank submit their declaration to the tax authority.

As briefly mentioned in the section on power calculations, we expect a compliance with treatment of around 60%, meaning that 60% of taxpayers assigned to treatment groups will read the email. In a pilot study, described in detail in Appendix A, 35% of taxpayers contacted in the treatment group opened the email sent, but we believe that to be a lower bound of compliance for two reasons. First, after the pilot study the tax authority underwent a significant effort to check the validity of emails and clean incorrect ones, such that our sample should only include taxpayers with at least one valid email address. Most importantly, the pilot study was aimed at subjects that had not filed income taxes in FY2018 and therefore are considered to have less updated information in the tax authorities' databases. As presented above, 86% of our experimental sample filed in FY2018.

5 Analysis

5.1 Primary outcomes

To obtain Intention-to-Treat (ITT) estimates on the effect of our experimental intervention on compliance, we will estimate regressions of the following form:

$$Y_i = \beta_0 + \beta_1 T_i + \beta_2 X_i + \gamma_s + \epsilon_i \quad (2)$$

where Y_i is one of the four primary outcomes of interest in FY2019 (indicator for tax filing, amount of gross income, amount of deductions and amount of taxable income); T_i is a dummy that takes value 1 if the unit was assigned to treatment and 0 otherwise; X_i are baseline controls and γ_s are strata fixed-effects. Baseline controls will include a dummy for presenting tax declaration in FY2018; amount of declared gross revenue, third-party informed gross revenue and declared taxable income in FY2018; and amount of declared sales tax revenues in FY2019. Our main coefficient of interest is β_1 , measuring the difference in mean outcomes between units in treatment and control groups, which is a direct test of Hypothesis 1. Reported outcomes for non-filing taxpayers are considered to be zero. While our continuous outcome variables are highly skewed, controlling for previous FY outcomes should reduce

residual variance and diminish the influence of outliers. We do not intend to treat outliers in our main specification but will perform robustness tests using winsorized outcome variables at the 99th percentile.

To account for partial compliance, we also intend to present instrumental variable regressions (Local Average Treatment Effect or LATE estimates) where we instrument opening the email with treatment assignment. We will estimate regressions of the form

$$Y_i = \delta_0 + \delta_1 \text{Open}_i + \delta_2 X_i + \gamma_s + v_i \quad (3)$$

$$\text{Open}_i = \lambda_0 + \lambda_1 T_i + \lambda_2 X_i + \gamma_s + \mu_i \quad (4)$$

where Open_i is an indicator of whether the taxpayer opened the email sent to them and the remaining variables are the same as above. Our parameter of interest is δ_1 , which measures the LATE on taxpayers that complied with treatment assignment.

We will present these results in the form of Table 5, where Panel A will present ITT estimates and Panel B will present LATE estimates.

While the previous results pool all taxpayers assigned to the three different treatment arms together, we will also present similar results where we estimate separately the effect of each of the treatment arms, augmenting equation (2) to estimate ITT as:

$$Y_i = \alpha + \beta_1 T_1 + \beta_2 T_2 + \beta_3 T_3 + \beta_2 X_i + \gamma_s + v_i \quad (5)$$

where T_j are the dummy indicators for each of the treatment arms and we are interested in the coefficients $\beta_1, \beta_2, \beta_3$. We will test Hypothesis 2 of whether each of the treatment arms cause a change in tax compliance behavior when compared to the control group, as well as whether we can reject that the treatment effects are indistinguishable from one another. We will similar estimate LATE using the different treatment arms, and present both ITT and LATE in the form of Table 6.

5.2 Secondary outcomes

While the four outcomes listed above are of primary interest, we also intend to estimate the impact of the email intervention in other dimensions of compliance with tax obligations, as pre-specified in the study registration. As discussed by [Brockmeyer et al. \(2019\)](#), it is an empirical question whether interventions focused on increasing tax compliance on a specific dimension (truthful income tax declarations) will affect other behavior. On the one hand it is possible that the intervention shifts taxpayers' beliefs about the tax authority's capacity, increasing their perception of risk and inducing more compliance across all their obligations. On the other hand, if the intervention is seen as signaling an increased oversight on a narrow dimension, taxpayers might increase compliance on that specific dimension while decreasing compliance in others.

We intend to assess, first, whether subjects in the treatment group were more likely to file their taxes by the deadline - this is an important measure of compliance since it's costly for the tax authority to follow late filers. We will also assess the impact on the amount of taxes actually paid, since taxpayers might declare tax liabilities but not pay, also generating costs for the TA to recover those due taxes. The intervention might also impact compliance with sales taxes, a higher frequency outcome since it's filed and paid monthly. We will estimate the impact on total reported sales in the April-August period. Finally, [Brockmeyer et al. \(2019\)](#) also document that their treatment changed compliance with income tax declaration and payment in previous years: treated firms were more likely to file late income tax declarations and pay overdue taxes. We will estimate whether the intervention caused a difference in rectifications of previous years income or sales taxes. All these results will be presented in the form of Table 7.

5.3 Heterogeneity analysis

While the average effect of the email intervention across the experimental sample is of much interest, understanding which taxpayers are most responsive to interventions of this nature is of crucial importance from a policy standpoint. Under limited capacity to audit and follow-up on low-cost interventions like emails, the tax authority wants to target those units that will

adjust their behavior in response to the intervention, and avoid losing credibility by targeting non-responsive units.

The first exercise in assessing heterogeneous responses to the intervention will be to estimate models similar to equation (2) and interacting the indicator of (pooled) treatment assignment with taxpayers' characteristics. In our main set of heterogeneity results, we interact treatment assignment with the four variables used to stratify the experimental sample: indicator for corporations; indicators for location (Distrito Central, San Pedro Sula and others); indicator of whether third-party information is available for that taxpayer; and the five risk-levels. These results will be presented in the form of Table 8.

We will start by investigating whether taxpayers for which third-party information is available respond differently from those not informed. [Pomeranz et al. \(2014\)](#) document in Chile that all the response from a similar communication intervention is driven by transactions not subject to paper trail, suggesting third-party information is sufficient to assure compliance. In an intervention similar to ours in Costa Rica, [Brockmeyer et al. \(2019\)](#), on the other hand, document that taxpayers for which third-party information is available respond to emails at least as strongly as those without information. As discussed above, third-party information seems to cover only a fraction of total revenues declared by taxpayers, which suggests there might be scope to improve compliance. Whether this effect is larger or smaller among not-informed taxpayers is an empirical question which we will be able to answer²⁷.

A second key heterogeneity dimension is whether taxpayers at different risk levels, as defined by the tax authority, respond differently to the intervention. The current practice in the tax authority is to send communications similar to emails in this experiment to those taxpayers considered to be at higher risk, both because that is seen as leading to maximize revenue collection and in order not to "rattle the boat" with taxpayers that are seen as compliant. In this experiment we include subjects in the entire range of positive perceived risk, from very low levels to very high, allowing us to empirically assess whether the intervention's effects are heterogeneous across the distribution of risk. We discuss below how the findings from

²⁷While [Brockmeyer et al. \(2019\)](#) include a smaller treatment arm with similar messages to both groups, we cannot disentangle whether differential responses by these two groups is driven by different email content of the communication or by heterogeneity between the groups.

this exercise could be interpreted.

Finally, we will explore heterogeneity in two highly salient dimensions of taxpayers characteristics: corporate form and location. Corporations face a distinct income tax regime (flat rate of 25% on profits instead of a progressive schedule), are larger and often seen as much more sophisticated entities than non-incorporated taxpayers, so a "soft" touch intervention such as communication emails might be less effective to induce compliance. Geographical differences in responses to compliance are also of relevance for the tax authorities: San Pedro Sula is the industrial center of Honduras and Distrito Central, where the capital Tegucigalpa is located, is the most populated municipality in the country. Jointly they host almost half of the taxpayers in the experimental sample.

5.4 Targeting interventions: causal forest model

While the heterogeneity dimensions analyzed in the previous section were built into our experimental design, the tax authority has access to much richer data that can be explored to answer the question: which taxpayers are more responsive to email interventions? As discussed above, improving targeting for these types of interventions is crucial even if the monetary marginal cost of one extra email is zero, since there are reputation costs associated with revealing information to taxpayers and not following up with oversight.

In order to explore a larger set of possible predictors of differential treatment effects, we will use a causal forest algorithm (Athey & Imbens, 2016; Wager & Athey, 2018) to predict conditional average treatment effects (CATE) on subgroups in our experimental sample (De Neve et al., 2019)²⁸. Causal forests average CATE estimated from several *causal trees*: similarly to decision trees, which partition data in order to find best predictions of some observed label, causal trees partition data in order to maximize heterogeneous effects across partitions (leaves). Since treatment effects are not observed but estimated from the data, Athey & Imbens (2016) recommend using "honest trees", which use separate sub samples to perform partition and estimate treatment effects.

We will present two main results from our causal forest algorithm. The first will be a

²⁸For a detailed explanation of the causal forest algorithm and application in economics, see Davis & Heller (2017)

variable importance graph describing the most relevant dimensions of heterogeneity. We use the usual metric of "importance" defined as a weighted sum, across all trees, of the proportion of times that the variable was used in the k th split. Higher values of importance mean that the feature was often one of the first to be used to split trees' nodes due to its importance in explaining heterogeneous effects in the sample.

The second result will be a comparison between each taxpayers risk level, as defined by the tax authorities own model, and the CATE estimated using the causal forest algorithm. A strong correlation between the two measures implies that the TA's risk model captures the relevant dimensions for targeting: taxpayers with high perceived risk are also those that respond more strongly to the intervention. On the other hand, finding zero or negative correlation between these variables suggests that "risky" taxpayers are not necessarily the most responsive to email interventions, and therefore a better targeting can be achieved by using the causal forest's results.

6 Interpreting Results and cost-benefit analysis

6.1 Forecast survey: what is expected?

One important tool we will use to benchmark our experimental results and inform interpretation is comparing our estimates with forecasts from experts. Following [DellaVigna & Pope \(2018\)](#) and [DellaVigna et al. \(2020\)](#), we will survey academics and policy-makers on their predictions about the impacts of this experiment. We will focus on collecting forecasts from three groups of subjects: academic economists (Faculty, PhD students and researchers at academic institutions); public sector workers in Honduras, in particular those working at the tax authority; and policy-makers or researchers in international development organizations²⁹.

We present our full survey questionnaire on Appendix C. We focus on predictions for local average treatment effects (LATE) of the pooled treatment sample and each treatment arm on three primary outcomes: probability of filing, gross revenue and taxable income. We also collect forecasts about heterogeneous treatment effects across risk-levels defined by the tax

²⁹We sent the invitation to take the survey to approximately 120 academics, 100 practitioners and 50 public sector workers.

authority, directly assessing perceptions about our Hypothesis 3.

6.2 Discussion of possible results

Given the available evidence in the literature, our strong prior is that we will observe increase in compliance among treated units when compared to control (Hypothesis 1). Since we also contact those in the control group with an informative email about the filing deadline, any null treatment effect suggests that the content of the treatment emails was not effective in changing taxpayers behavior. If that is the case, the underlying reason might be lack of credibility: even if the tax authority is perfectly informed about taxpayers' transactions, they might believe there's very low probability of punishment for non-compliance and not change their behavior. We believe this is unlikely, nonetheless, since this type of communication has been proven effective in other countries with similar capacity levels and, in our pilot described in Appendix A, we observed strong reactions to a similar intervention.

In terms of magnitudes, it is harder to benchmark using previous studies since specific interventions and contexts are always different. To take one example of a very similar intervention, [Brockmeyer et al. \(2019\)](#) document a 23 percentage point increase in the probability of filing among firms with third-party information available, but their experimental sample consists of taxpayers that had not filed two months after the filing deadline. [De Neve et al. \(2019\)](#), on the other hand, test different messages with late filers in Belgium and find only a 3 p.p. treatment effect, but on a much shorter horizon (3 weeks). In order to take into account the specificities of our context, therefore, we will collect experts' forecasts on our experimental results, as discussed above, and use that to benchmark our findings.

In terms of the different treatment arms, our reading of the literature is that the effect of threats, such as in our "Sanctions" and "Procedure denial" interventions, has often been positive while appeals to tax morale have had more mixed results. Given the low trust in government prevailing in the country, appealing to tax morale might be particularly challenging. Again, we will be able to benchmark our results against the forecasts of experts who will be given specific information about our context, as well as prediction of workers in the tax authority who deal with tax compliance issues in Honduras everyday.

In light of our model on tax compliance discussed in Appendix B, the heterogeneous effect across the risk levels will be informative about the current targeting strategy used by the tax authority. If the treatment effect is increasing in assessed risk-level, for example, that suggests using risk to target taxpayers is an optimal strategy: riskier taxpayers are exactly those that respond more strongly and therefore should be the focus of any such intervention. On the other hand, if riskier taxpayers are the least responsive, the conclusion must be that the risk model is not ideally suited for targeting email communications. One possible reason is that the risk model is not correctly assessing true risk: it is possible that "low-risk" taxpayers are indeed high risk, and that was not captured by the model. Another possibility, in line with the discussion in the model, is that "compliance risk" is just one dimension that matters for targeting, and the use of the causal forest model might be informative in highlighting which other dimensions are predictive about responsiveness to interventions.

6.3 Cost-benefit analysis

While the marginal cost of sending emails is zero, any campaign involving thousands of taxpayers requires several activities from dozens of workers in the tax authority³⁰. These include meetings to define the content of messages, time to prepare databases, train frontline workers who might receive calls or visits from taxpayers, among others. Using back-of-the-envelope calculations of time invested and hourly wage of involved workers, SAR estimates that the intervention cost approximately L155,000 or USD 6,200. Since there were 31,396 taxpayers receiving emails, the per email costs is less than USD 0.20.

7 Conclusion

In this study, in partnership with the tax authority in Honduras, we randomize approximately 32,000 taxpayers into receiving different messages before the FY2019 tax filing deadline. We will assess whether receiving information about the TA's knowledge on their transactions af-

³⁰While the intervention discussed in this paper required further time from researchers outside the tax authority (e.g. developing experts' forecast survey, preparation of the pre-analysis plan and pre-registration), this cost-benefit analysis focus on what an "usual" intervention, developed entirely by the tax authority, would cost.

fects compliance behavior, which type of message is more effective and how taxpayers with different perceived risk respond to the intervention. With the goal of benchmarking our experimental results, we will also collect forecasts from experts on their expectations about magnitudes of our treatment effects.

8 Impacts due to COVID-19

The ongoing COVID-19 global pandemic impacted the timeline of our study. Our original treatment was sent to taxpayers on March 11th and 12th 2020, seven weeks before the original April 30th filing deadline. As in many other countries³¹, Honduras is currently in quarantine and economic activity has most likely sharply dropped. In order to preserve jobs and help firms survive the shock, the government has decided to postpone the filing date to June 30th 2020 for all small and medium firms³², including a provision that taxpayers who file by the original date will receive an 8.5% discount.

While the situation is still uncertain, our plan is to resend the emails to all taxpayers, both in control and treatment, in early May. Since the original emails were sent in the week of the first COVID-19 case in Honduras, we believe that the salience of the treatment was most likely diminished and will try to correct that.

Even though there is no reason to believe the internal validity of the experiment is affected, since the shock affects both control and treatment units similarly, there are important implications for the external validity of the experiment. It will be hard to assess what the intervention would have looked like in the absence of COVID-19. The economic damage could affect firms' behavior regarding tax payments, thus emails might still be less salient even after a second round of reinforcement.

³¹In the United States, for example, deadlines to file and pay income taxes were extended to July 15, 2020.

³²The categories of small, medium and large are not revenue based but based on a decree last updated in 2011. Our experiment does not include any firms deemed to be large.

9 Administrative information

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Table 1: Descriptive Statistics - Final Sample

	Mean	SD	p25	p50	p75	N
<i>Taxpayers' characteristics</i>						
Corporations	0.33	0.47				31,396
Individual Business	0.41	0.49				31,396
Self-employed service providers	0.06	0.23				31,396
Corporations, IB or self-employed	0.79	0.41				31,396
Distrito Central	0.27	0.45				31,396
San Pedro Sula	0.22	0.41				31,396
<i>Sales Tax 2019</i>						
Reported revenue (Sales) (2019) (L1,000s)	617.79	2,876.15	0.00	39.60	323.57	31,396
Declared revenue (Sales) (2019) (L1,000s)	1,432.67	9,745.31	0.10	190.36	959.19	31,396
<i>Income Tax 2018</i>						
Declared income tax in 2018	0.86	0.34	1.00	1.00	1.00	31,396
Reported revenue (Income) (2018) (L1,000s)	544.36	2,477.44	0.00	46.78	331.31	31,396
Declared revenue (Income) (2018) (L1,000s)	1,305.15	2,670.35	49.02	274.22	1,081.95	31,396
Declared revenue 2018 declaring (L1,000s)	1,509.82	2,817.80	134.47	381.22	1,382.78	27,140
Not liable for taxes	0.47	0.50	0.00	0.00	1.00	27,140
Liable for income taxes	0.50	0.50	0.00	1.00	1.00	27,140
Liable for asset taxes	0.03	0.16	0.00	0.00	0.00	27,140
Taxable base 2018 declaring (L1,000s)	115.47	265.81	0.00	41.47	158.59	27,140
Tax liability 2018 declaring (L1,000s)	15.34	75.74	0.00	0.14	4.92	27,140
Effective tax rate	0.12	0.11	0.01	0.06	0.25	14,374
<i>Income Tax 2017</i>						
Declared income tax in 2017	0.81	0.40	1.00	1.00	1.00	31,396
Reported revenue (Income) (2017) (L1,000s)	483.26	2,538.67	0.00	5.40	215.91	31,396
Declared revenue (Income) (2017) (L1,000s)	1,233.77	2,499.54	23.26	256.28	1,010.26	31,396
Declared revenue 2017 declaring (L1,000s)	1,532.62	2,702.42	177.27	421.76	1,439.35	25,274
Taxable base 2017 declaring (L1,000s)	121.47	260.80	0.00	62.22	153.37	25,274
Tax liability 2017 declaring (L1,000s)	16.57	71.99	0.00	0.29	5.28	25,274
<i>Third-party information</i>						
Third-party information available (2019)	0.71	0.45				31,396
Revenue reported by other taxpayers	0.88	0.33				22,423
Revenue reported by POS operators	0.22	0.42				22,423
Revenue reported by government	0.03	0.17				22,423
Revenue reported by customs	0.01	0.09				22,423
<i>Anomalies</i>						
Declared losses for five years	0.08	0.27				31,396
Atypical financial transactions	0.07	0.26				31,396
Atypical declared revenue	0.49	0.50				31,396
<i>Risk assessment</i>						
Low risk	0.21	0.40				31,396
Medium-low risk	0.28	0.45				31,396
Medium risk	0.23	0.42				31,396
Medium-high risk	0.19	0.39				31,396
High risk	0.10	0.30				31,396

Note: This table presents descriptive statistics for the entire experimental sample. The first panel presents taxpayers characteristics such as type (corporation, individual business or self-employed service providers) and location. The second panel presents descriptive statistics on past tax paying behavior, for both income and sales taxes, in FY2017 and FY2018. Finally, the last panel describes the sources of third-party information and behavioral anomalies used in the tax authority's risk model, and also the distribution of taxpayers across the five broad risk-levels used by the TA.

Table 2: Power Calculations - Residual Variance

	2018 primary outcomes		
	(1) Revenue	(2) Deductions	(3) Taxable Income
Taxable income 2017	-0.005 (0.069)	-0.868*** (0.065)	0.742*** (0.036)
Reported revenue (Income) (2017) (L1,000s)	-0.306*** (0.048)	-0.284*** (0.048)	-0.014*** (0.003)
Declared revenue (Income) (2017) (L1,000s)	0.857*** (0.015)	0.870*** (0.015)	0.005*** (0.002)
Declared income tax in 2017	13.722 (15.653)	26.889 (16.440)	-7.314** (3.264)
Reported revenue (Sales) (2018) (L1,000s)	0.395*** (0.047)	0.371*** (0.047)	0.017*** (0.003)
Constant	-44.950 (41.024)	-54.516 (41.848)	16.175** (7.056)
Observations	31,396	31,396	31,396
R-Squared	0.742	0.701	0.554
Strata FE	Yes	Yes	Yes

Note: In this table we present the result of regressions used to obtain residual variance in the power calculations. The dependent variables are Gross Revenue, Deductions and Taxable Income in FY2018 in Columns (1), (2) and (3), respectively. All regressions include strata fixed-effects. Robust standard errors in parentheses. (* p<0.1, ** p<0.05, *** p<0.01)

Table 3: Power Calculations - Final Sample

Outcome	Levels	Percent
<i>MDE of pooled treatment</i>		
Gross Income	71.47	0.055
Deductions	77.94	0.062
Taxable Income	8.81	0.088
Filing probability	0.02	0.021
<i>MDE of treatment arms</i>		
Gross Income	100.79	0.077
Deductions	109.92	0.088
Taxable Income	12.42	0.010
Filing probability	0.02	0.029

Note: In this table we present Minimum Detectable Effects (MDE) for our primary outcomes. The first panel presents MDEs for the experiment comparing pooled treatment arms with control, while the second panel presents MDE for the experiment comparing a single treatment arm with control. The first column presents the MDE in levels, the units are thousand Lempiras for Gross Income, Deductions and Taxable Income; and percentage points for filing probability. The second column presents the MDE in levels as percentage of the baseline mean.

Table 4: Balance Table - Baseline Characteristics

	Difference in Means (t-test)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Control mean	Control s.d.	Treatment v. Control diff.	Sanctions v. Control diff.	Procedures v. Control diff.	Moral duty v. Control diff.
Individual Business	0.40	(0.49)	-0.01**	-0.02**	-0.01	-0.01
Self-employed service providers	0.06	(0.24)	0.01**	0.01	0.01**	0.01
Corporations, IB or self-employed	0.79	(0.41)	-0.01	-0.01*	0.00	-0.01
Reported revenue (Sales) (2019) (L1,000s)	615.33	(3142.60)	-4.83	32.59	-46.69	-0.22
Declared revenue (Sales) (2019) (L1,000s)	1391.46	(4749.50)	-80.87	-264.16	13.36	6.86
Declared income tax in 2018	0.86	(0.35)	-0.01	-0.01*	-0.01	0.00
Reported revenue (Income) (2018) (L1,000s)	533.62	(1830.09)	-21.08	26.93	-68.67	-21.25
Declared revenue (Income) (2018) (L1,000s)	1303.26	(2672.35)	-3.70	11.18	-9.87	-12.30
Declared revenue 2018 declaring (L1,000s)	1512.46	(2823.38)	5.18	30.78	0.89	-16.18
Not liable for taxes	0.47	(0.50)	0.01	0.01	0.00	0.01
Liable for income taxes	0.50	(0.50)	-0.01	-0.01	-0.00	-0.01
Liable for asset taxes	0.03	(0.16)	0.00	-0.00	0.00	0.00
Taxable base 2018 declaring (L1,000s)	116.40	(270.68)	1.82	0.32	3.56	1.58
Tax liability 2018 declaring (L1,000s)	15.52	(73.46)	0.36	0.14	0.25	0.70
Effective tax rate	0.12	(0.11)	0.00	0.00	0.00	0.00
Declared income tax in 2017	0.80	(0.40)	-0.00	-0.01	-0.00	0.00
Reported revenue (Income) (2017) (L1,000s)	466.91	(1709.31)	-32.10	3.91	-64.74	-35.28
Declared revenue (Income) (2017) (L1,000s)	1230.89	(2513.12)	-5.64	-30.70	9.53	4.07
Declared revenue 2017 declaring (L1,000s)	1531.06	(2719.64)	-3.05	-22.44	14.46	-1.11
Taxable base 2017 declaring (L1,000s)	122.99	(272.04)	2.98	2.32	2.49	4.14
Tax liability 2017 declaring (L1,000s)	17.11	(76.76)	1.06	1.46	1.07	0.65
Revenue reported by other taxpayers	0.88	(0.33)	0.01**	0.01*	0.01*	0.00
Revenue reported by POS operators	0.22	(0.42)	-0.01	-0.00	-0.00	-0.01*
Revenue reported by government	0.03	(0.17)	-0.00	-0.00	-0.00	-0.00
Revenue reported by customs	0.01	(0.09)	0.00	0.00	0.00	0.00
Declared losses for five years	0.08	(0.27)	-0.00	0.00	-0.00	0.00
Atypical financial transactions	0.07	(0.26)	0.00	0.00	-0.00	0.00
Atypical declared revenue	0.48	(0.50)	-0.01**	-0.02**	-0.01	-0.01
Observations	15399	15399	31396	20705	20731	20758

Note: This table compares average characteristics between control and treatment arms. Column (1) presents average taxpayer characteristics and previous filing behavior in FY2018 and FY2017, while Column (2) standard errors. Column (3) presents the difference in averages between the pooled treatment group and control, while columns (4) through (5) presents the differences between taxpayers in control group and each of treatment arms (Sanctions, Procedures and Tax morale arms, respectively) and indicate whether we reject the null of equal averages. (* p<0.1, ** p<0.05, *** p <0.01)

Table 5: Primary Outcomes - Estimating Program Effects

	(1)	(2)	(3)	(4)
	Filed declaration	Gross Revenue	Deductions	Taxable Income
ITT estimates				
Treated	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2
LATE estimates				
Opened Email	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2

Note: In this table we will present the estimated impact of the intervention on primary outcomes. The first panel will present Intention-to-Treat (ITT) estimates using the specification in Equation 2; while the second will present Local Average Treatment Effect (LATE) estimates using the specification in Equation 3. The dependent variables are an indicator equal to 1 if the taxpayer filed a declaration (Column (1)), the amount of gross revenue declared (Column (2)), the amount of deductions declared (Column (3)) and the amount of taxable income declared (Column (4)). Robust standard errors will be presented in parentheses. (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$)

Table 6: Primary Outcomes - Different Treatment Arms

	(1) Filed declaration	(2) Gross Revenue	(3) Deductions	(4) Taxable Income
ITT estimates				
Sanctions treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Procedure denial treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Tax morale treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2
$\beta_1 = \beta_2$	pvalue	pvalue	pvalue	pvalue
$\beta_1 = \beta_3$	pvalue	pvalue	pvalue	pvalue
$\beta_2 = \beta_3$	pvalue	pvalue	pvalue	pvalue
LATE estimates				
Opened sanctions email	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Opened procedure email	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Opened tax morale email	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2

Note: In this table we will present the estimated impact of each of the treatment arms on primary outcomes. The first panel will present Intention-to-Treat (ITT) estimates using the specification in Equation 5; while the second will present Local Average Treatment Effect (LATE) estimates. The dependent variables are an indicator equal to 1 if the taxpayer filed a declaration (Column (1)), the amount of gross revenue declared (Column (2)), the amount of deductions declared (Column (3)) and the amount of taxable income declared (Column (4)). Robust standard errors will be presented in parentheses. (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$)

Table 7: Secondary Outcomes

	(1)	(2)	(3)	(4)	(5)
	Timely declaration	Amount taxes paid	Sales Taxes	Rectified previous years	Paid previous years
ITT estimates					
Treated	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
Observations	31,396	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2	R2
LATE estimates					
Opened email	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
Observations	31,396	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2	R2

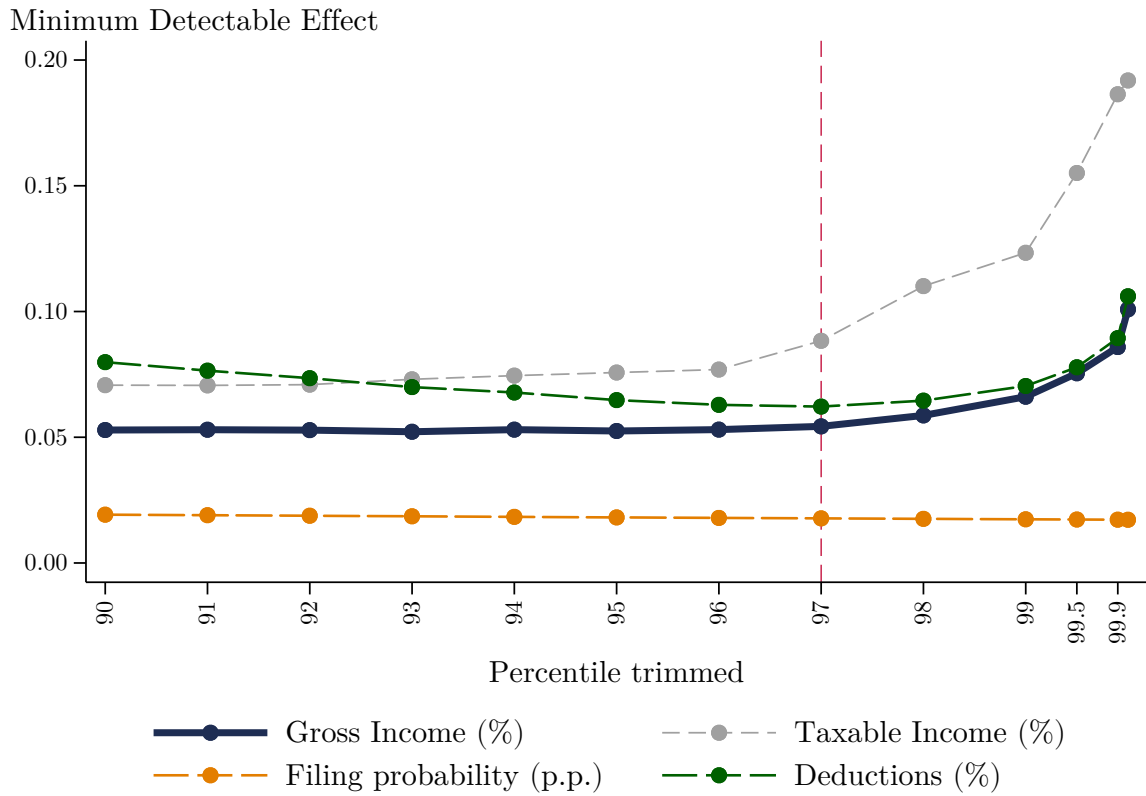
Note: In this table we will present the estimated impact of each of the treatment arms on secondary outcomes. The first panel will present Intention-to-Treat (ITT) estimates using the specification in Equation 2; while the second will present Local Average Treatment Effect (LATE) estimates using the specification in Equation 3. The dependent variables are an indicator equal to 1 if the taxpayer filed a declaration by the deadline (Column (1)), the amount of taxes paid (Column (2)), the amount of sales taxes declared between April and June (Column (3)); an indicator equal to 1 if the taxpayer rectified sales or income tax declarations for previous years (Column (4)) and in indicator equal to 1 if the taxpayer paid sales or income taxes due for previous years (Column (5)). Robust standard errors will be presented in parentheses. (* p<0.1, ** p<0.05, *** p <0.01)

Table 8: Heterogeneity Analysis

	(1) Filed declaration	(2) Gross Revenue	(3) Deductions	(4) Taxable Income
Third-party informed	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Third-party informed	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2
Medium-low risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Medium risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Medium-high risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
High risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Medium-low risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Medium risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Medium-high risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times High risk	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2
Corporations	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Corporations	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2
Districto Central	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
San Pedro Sula	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times Districto Central	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Treatment \times San Pedro Sula	coef (s.e.)	coef (s.e.)	coef (s.e.)	coef (s.e.)
Observations	31,396	31,396	31,396	31,396
R-Squared	R2	R2	R2	R2

Note: In this table we will present the estimated impact of the intervention for different sub-populations of the experimental sample. Columns (1) through (4) use each of the primary outcomes as dependent variable and all estimates are ITT, using the same specification in Equation 2 augmented by interacting the treatment dummy with the characteristics of interest. The first panel will present estimates of differential treatment by availability of third party information; the second panel will present estimates by risk-levels; the third panel will present estimates for corporations and non-incorporate entities; and the last panel will present estimates by three different geographical regions. Robust standard errors will be presented in parentheses. (* p<0.1, ** p<0.05, *** p <0.01)

Figure 1: Minimum Detectable Effect - Final Sample



Note: This figure presents Minimum Detectable Effects (MDE) of experiments with 80% power and 5% significance level for each of our primary outcomes. Each point is the MDE if we trim the experimental sample at the Xth percentile of the FY2018 declared gross revenue distribution. MDEs are calculated considering the residual variance of primary outcomes obtained from the estimation of Equation 1.

Figure 2: Letter 1 - Control group



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXX

El Servicio de Administración de Rentas (SAR) le recuerda que la obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020.

Se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

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Figure 3: Letter 2 - Sanctions treatment arm for available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

En las fuentes de información disponibles en la Administración Tributaria se han identificado sus transacciones comerciales del período 2019, relacionadas a:

Ventas realizadas a otros obligados tributarios

Ventas realizadas por medios de tarjetas de crédito/débito

Ventas y/o servicios realizados al Estado de Honduras

Exportaciones identificadas en aduanas

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

En caso de no cumplir su obligación, será objeto de las sanciones establecidas por el Código Tributario en los Artículos 160 y 163.

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Figure 4: Letter 3 - Procedure denial treatment arm for available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

En las fuentes de información disponibles en la Administración Tributaria se han identificado sus transacciones comerciales del período 2019, relacionadas a:

Ventas realizadas a otros obligados tributarios

Ventas realizadas por medios de tarjetas de crédito/débito

Ventas y/o servicios realizados al Estado de Honduras

Exportaciones identificadas en aduanas

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

En caso de no cumplir su obligación, será afectado en la obtención de constancias de pagos a cuenta, solvencias y documentos fiscales.

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Figure 5: Letter 4 - Tax morale treatment arm for available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

*Por ti, por tus hijos, por Honduras,
¡Paga tus Impuestos!*

En las fuentes de información disponibles en la Administración Tributaria se han identificado sus transacciones comerciales del período 2019, relacionadas a:

Ventas realizadas a otros obligados tributarios

Ventas realizadas por medios de tarjetas de crédito/débito

Ventas y/o servicios realizados al Estado de Honduras

Exportaciones identificadas en aduanas

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

La Honduras que todos queremos para nuestros hijos con educación, salud, infraestructura y seguridad es fruto del esfuerzo de todos sus buenos ciudadanos, gracias a sus impuestos construimos un país mejor.

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Figure 6: Letter 5 - Sanctions treatment arm for non-available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

En las fuentes de información disponibles en la Administración Tributaria, se ha identificado el siguiente comportamiento en sus declaraciones fiscales:

Ha declarado pérdidas fiscales en los últimos cinco periodos de forma consecutiva o alterna

Mantiene movimientos financieros no acorde al nivel de ingresos declarados

Se identifican valores atípicos de sus montos declarados en concepto de Impuesto Sobre la Renta con relación a su industria y nivel de ingresos

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

En caso de no cumplir su obligación, será objeto de las sanciones establecidas por el Código Tributario en los Artículos 160 y 163.

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Figure 7: Letter 6 - Procedure denial treatment arm for non-available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

En las fuentes de información disponibles en la Administración Tributaria, se ha identificado el siguiente comportamiento en sus declaraciones fiscales:

Ha declarado pérdidas fiscales en los últimos cinco periodos de forma consecutiva o alterna

Mantiene movimientos financieros no acorde al nivel de ingresos declarados

Se identifican valores atípicos de sus montos declarados en concepto de Impuesto Sobre la Renta con relación a su industria y nivel de ingresos

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

En caso de no cumplir su obligación, será afectado en la obtención de constancias de pagos a cuenta, solvencias y documentos fiscales.

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Figure 8: Letter 7 - Tax morale treatment arm for non-available third-party information



Señor Obligado Tributario

JUAN PEREZ

RTN: XXXXXXXXXXXXXXXX

*Por ti, por tus hijos, por Honduras,
¡Paga tus Impuestos!*

En las fuentes de información disponibles en la Administración Tributaria, se ha identificado el siguiente comportamiento en sus declaraciones fiscales:

Ha declarado pérdidas fiscales en los últimos cinco periodos de forma consecutiva o alterna

Mantiene movimientos financieros no acorde al nivel de ingresos declarados

Se identifican valores atípicos de sus montos declarados en concepto de Impuesto Sobre la Renta con relación a su industria y nivel de ingresos

La obligación tributaria de presentar y pagar la Declaración Jurada del Impuesto Sobre la Renta período 2019, vence el 30 de abril de 2020. Además, se le recuerda que la Declaración debe contener información cierta y veraz, reportando la totalidad de los ingresos obtenidos y los gastos tendrán que estar sustentados con documentos fiscales válidos.

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10 Appendix

A Pilot study with non-filers

In preparation for our main experiment, we implemented a pilot intervention jointly with our partners in the Honduran Tax Authority. Since our experiment aims at measuring the impact of email messages on compliance in FY2019 income tax filing, we could not "pilot" the same intervention before the filing deadline. Our approach was to focus on taxpayers who were believed to be at risk for non-filing in FY2018, i.e., the tax authority believes they should have filed an income tax declaration in April 2019 but they had not.

Our pilot experimental sample was comprised of 2,599 taxpayers, 1,000 of which were assigned to the treatment group and 1,599 to the control³³. Taxpayers in the treatment group received an email similar to the main experiment, describing which third-party information was available on their transactions, stating the tax authority believed they should have filed income taxes and giving them 10 days to do so. There were no different treatment arms, and the message included a threat of audit in case they did not file. Unlike our main experiment, the control group did not receive any notification, so we see the (differential) treatment in the pilot as much stronger.

The main impact of the experimental intervention on filing probability is illustrated in Figure A1, which presents the cumulative share of taxpayers in control and treatment status that filed a (late) declaration for FY2018 by each date. The gap between treatment and control is zero by the date of the intervention but steadily increases in the weeks after, so that six weeks post-intervention slightly more than 10% of taxpayers in the treatment group have filed a declaration vs. less than 4% among control. The impact of the intervention can also be observed in the amount of tax liability declared, presented in Figure A2: taxpayers in the treatment group declared, in aggregate, L250,000 more in tax liabilities (approximately 30% increase).

We present these results in regression form in Panel A Table A1. Odd columns present

³³We decided to assign most taxpayers to the control group so that they could still be part of the main experiment, while those in the treatment group were excluded.

simple differences between treatment and control, while even ones include controls. For filing probability, the Intention-to-Treat (ITT) estimation is a 6 p.p. increase in the probability of filing, from a baseline probability of only 4% among control units. For the amount of tax liability declared, the point estimate indicates an increase of approximately L500, or 100% from the control mean, but standard errors are very large and we cannot reject a null effect.

The share of taxpayers who actually clicked on the email sent to the treatment group, nonetheless, was only 33%, implying that the effect of compliers must have been even larger. We present LATE results in Panel B of Table A1, where we instrument opening the email with treatment assignment. The results suggest that clicking on the email increase filing probability by 19 p.p. The same result can be seen in non-parametric form in Figure A3, where we see that the entire increase in filing among units assigned to treatment come from those that clicked the email.

Table A1: Pilot Results

	Presented declaration		Tax liability (L)	
	(1)	(2)	(3)	(4)
<i>ITT estimates</i>				
Treatment	0.0598*** (0.01)	0.0596*** (0.01)	484.5 (413.77)	500.0 (405.89)
Constant	0.0410*** (0.01)	0.0241*** (0.01)	576.7** (280.02)	190.4 (159.09)
Observations	2544	2544	2544	2544
R-Squared	0.0142	0.0212	0.000504	0.00433
Controls?	No	Yes	No	Yes
Control average	0.041	0.041	576.69	576.69
<i>LATE estimates</i>				
Clicked on email	0.183*** (0.03)	0.181*** (0.03)	1482.3 (1260.95)	1523.0 (1231.04)
Constant	0.0410*** (0.01)	0.0250*** (0.01)	576.7** (279.91)	197.9 (159.71)
Observations	2544	2544	2544	2544
R-Squared	0.0618	0.0680	0.00453	0.00797
Controls?	No	Yes	No	Yes
Control average	0.041	0.041	576.69	576.69

Note: This table reports ITT (first panel) and LATE (second panel) results of our pilot experiment. Controls include a dummy for corporations, whether the taxpayer presented income tax declaration for FY2017 and the amount of gross revenue declared in 2017. Robust standard errors in parentheses (* p<0.1, ** p<0.05, *** p<0.01)

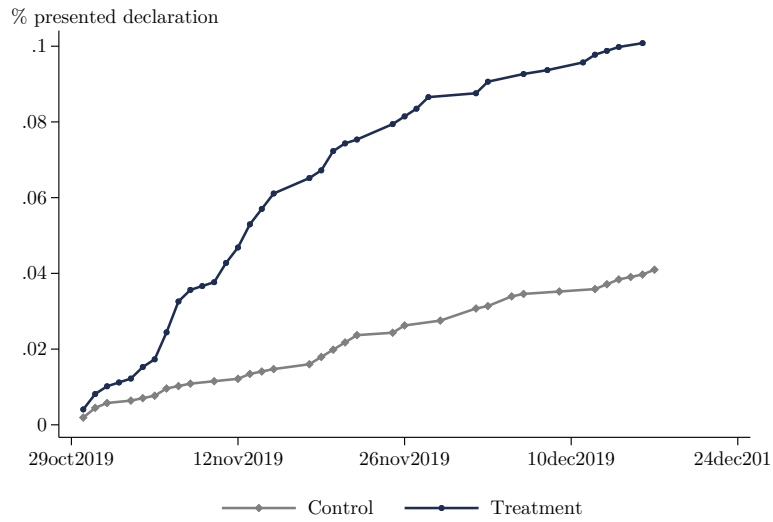


Figure A1

Note: This figure presents the cumulative share of taxpayers in treatment and control groups that have filed a late income tax declaration by each date.

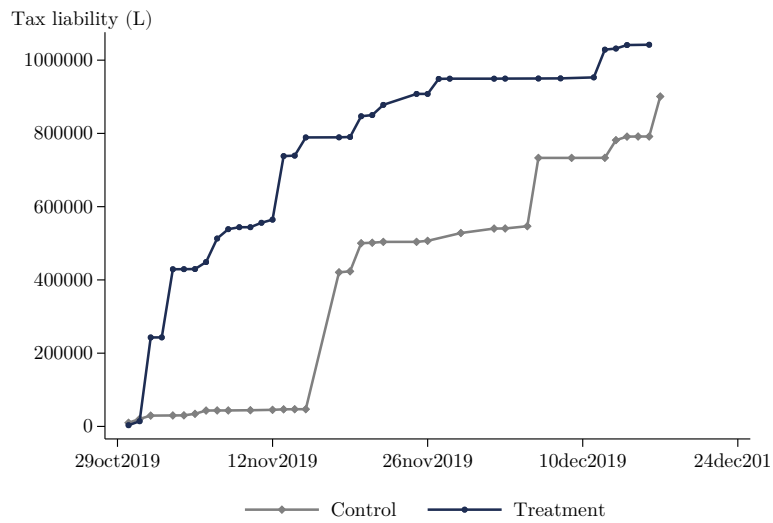


Figure A2

Note: This figure presents the cumulative amount of tax liability declared by taxpayers in treatment and control groups by each date.

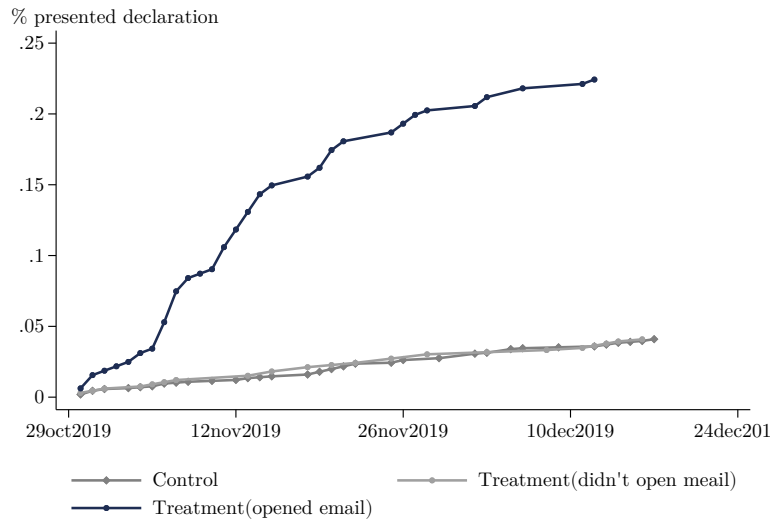


Figure A3

Note: This figure presents the cumulative share of taxpayers in treatment and control groups that have filed a late income tax declaration by each date, distinguishing between those in treatment that clicked on the email sent and those who did not.

B A model on the value of targeting

In this section we present a highly simplified model that we believe illustrates the value of experimentally acquiring information on taxpayers when targeting interventions. Consider a model in which agents must decide whether to pay their taxes (Alingham and Sandmo, 1978). In our setting agents only choose the extensive margin, whether paying or not, and not the intensive margin - conditional on paying they truthfully report their tax liability.

Agents are characterized by a vector (θ_i, γ_i) , with some joint distribution $F(\theta, \gamma)$. θ_i measures how much disutility an agent gets from not reporting their taxes. It can be interpreted as a psychological cost of non-compliance, or as how costly it is for some agents to go through the hurdles of misreporting instead of simply reporting their book numbers. γ_i captures how intensely agents update their beliefs about being caught cheating upon receiving a letter/email from the tax authority (noted by the treatment indicator variable T_i). It might capture other traits such as fear (Bergolo et al., 2017) or just knowledge about how credible the threat is. Regardless of interpretation, it reflects the fact that the treatment will have heterogeneous effects depending on agents' type (Dal Bó et al., 2021).

If agents file their taxes, they do so truthfully and pay a tax rate τ on their profits π , receiving payoff $(1 - \tau)\pi$. If they decide not to file, they pay the cost θ_i regardless of being caught or not, and with an exogenous probability p they are caught and must pay their taxes plus a penalty f , and with probability $(1-p)$ they simply don't pay any taxes.

Given this setting, agents will pay their taxes whenever

$$\begin{aligned} \text{Payoff}_{\text{pay}} &\geq \text{Payoff}_{\text{notpay}} \\ (1 - \tau)\pi &\geq (1 - p - T_i\gamma_i)\pi + (p + T_i\gamma_i)((1 - \tau)\pi - f) - \theta_i \\ \theta_i &\geq \tau\pi - (p + T_i\gamma_i)C \end{aligned}$$

where $C = \tau\pi + f$ is the cost incurred by the taxpayer if caught in non-compliance.

Consider first what happens in the absence of treatment, or with the control group. Since

$T_i = 0$, the expression above simplifies to

$$\theta_i \geq \tau\pi - pC$$

There's a minimum value for θ_i such that all individuals with values above that threshold will comply, since their non-compliance cost $pC + \theta_i$ is larger than their benefit of non-filing $\tau\pi$; and all with θ_i below that threshold will not file taxes.

The parameter θ_i , in this model, fully characterizes the compliance behavior in the absence of treatment. Suppose the tax authority needs to deploy audits, a costly investment that once deployed fully reveals whether the taxpayer cheated or not (some taxpayers don't need to file, so their not filing is not cheating). The only thing the TA needs to know is θ_i , and it can target those taxpayers who should have filed, but didn't.

Now consider that audits are not available to the tax authorities, which needs to rely on sending letters that hopefully will encourage some taxpayers to comply. Taxpayers in the treatment group will comply if

$$\theta_i \geq \tau\pi - (p + T_i\gamma_i)C$$

For taxpayers with $\gamma_i = 0$, the condition remains the same as in the treatment group: they will not update their beliefs upon receiving the letter, and the threshold on θ_i is the same as in the treatment group. For any positive value of γ_i , on the other hand, the threshold is now lower: now agents with a somewhat lower cost θ_i will start to comply since they increased their belief on the probability of punishment. For a large enough γ_i (and fine), potentially all agents could comply regardless of their fixed cost, since they see punishment as certain.

In Figure ?? below we present a summary of taxpayer behavior arising from the model. In the absence of treatment, the only thing that matters is taxpayer's cost θ_i : if it's above the threshold, they will file, otherwise not. When the treatment is introduced, however, taxpayers' heterogeneity in how they react to the letter start to play a role: even for those with low cost θ_i , if the update in beliefs is large enough the taxpayer will file their taxes.

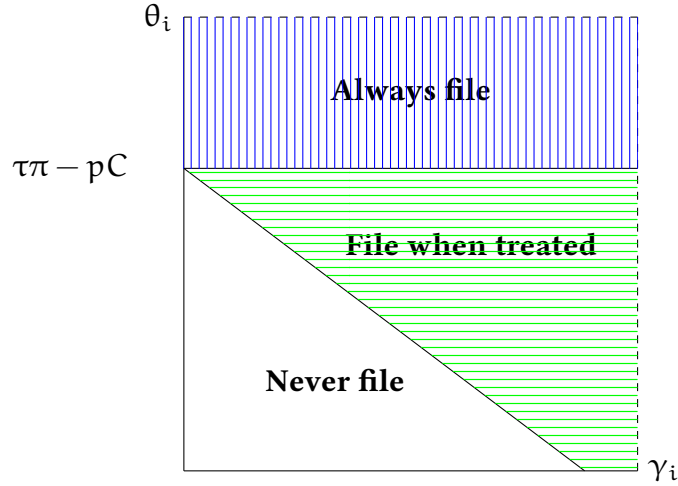


Figure A4: Taxpayer behavior according to types

Now suppose that the TA must choose which taxpayers to target with emails/letters. Since this intervention is virtually costless, it could be argued that the TA doesn't face a targeting problem: they should send emails to all taxpayers and, under the assumptions of this model, are guaranteed to have a positive return, the magnitude of which depends on the distribution of (θ_i, γ_i) in the population, as well as on other parameters.

But consider the case in which contacting taxpayers which will not file is costly for the TA for credibility reasons: if taxpayers are informed of non-compliance and still are not punished they might (correctly) update their beliefs about the capacity of the authority, and be even less compliant in the future. Whatever the underlying reason, the TA now faces a targeting problem: it would like to contact only those taxpayers in the green region of the graph, who will change their behavior in response to the letter, and not contact those in the white region³⁴. Under incomplete information, however, the TA does not observe γ_i so cannot perfectly target.

Let $Z = \theta_i + \gamma_i C$ and consider the distribution $G(Z)$ with support $[Z_l, Z_H]$. If the TA sends emails to all individuals, the total effect of this intervention will be

$$\int_{\tau\pi - pC}^{Z_H} BG(Z) dz - \int_{Z_l}^{\tau\pi - pC} \delta G(Z) dz$$

³⁴That doesn't mean the TA should not take some action regarding those taxpayers in the white area above, but simply that emails/letters are not the right tool for those taxpayers.

where δ is the per taxpayer reputation cost when they are treated and don't file, and B is the benefit received when the taxpayer files.

Under perfect information the TA would simply target those with $Z \in [\tau\pi - pC, Z_h]$. Absent that, they can do better than universal intervention by acquiring some information that is predictive about taxpayers Z . Our goal of using the experimental variation in letters with the causal forest algorithm is precisely to approximate this information using conditional average treatment effects (CATE), or treatment effects for groups of taxpayers that share some (observable) characteristics.

C Forecast survey questionnaire

Targeting in Tax Compliance Interventions: Experimental Evidence from Honduras

Start of Block: Consent page

Targeting in Tax Compliance Interventions: Experimental Evidence from Honduras (Del Carmen, Espinal Hernandez and Scot; 2020)

Welcome!

This survey aims to collect predictions on the results of a randomized control trial (RCT) studying how taxpayers change their compliance behavior when notified about the information available to the tax authority regarding their transactions. We will then compare these forecasts to actual experimental results. You can learn more about our experiment [here](#) [this link will open in a new tab].

The survey should take around 10 minutes to complete. We appreciate your time and help, and thank you in advance for participating!

You might find more information on consent in participating in this survey on the [consent form](#). Please click the consent button below to proceed to the survey.

End of Block: Consent page

Start of Block: Survey introduction

About you

Before you start we'd like to know what's your profession. Choose the option below that best fits your career:

- Academic economist (Faculty, PhD student, Researcher in academic institution) (1)
 - Public sector employee in Honduras (2)
 - Researcher or officer in policy-oriented organization (IDB, World Bank, IMF, OECD, other) (3)
 - Other (4)
-

Based on your knowledge about other studies with taxpayers and/or your knowledge about tax administration, how confident are you about your ability to predict the results of this experiment?

- Not confident at all (1)
- Not very confident (2)
- Somewhat confident (3)
- Confident (4)

Page Break

Study overview

We are implementing a randomized control trial to study the impact of providing personalized messages to taxpayers about the information available to the Tax Authority (TA) regarding their transactions. Our experimental sample consists of **31,396 taxpayers** in Honduras considered to be at-risk of non-compliance according to the TA's risk model. The distinguishing feature of RCTs is the **random assignment** of subjects to different groups, which allow us to compare behavior between groups and determine the **causal effect of policy interventions**.

Approximately 7 weeks before the deadline for taxpayers to file their FY2019 income tax declaration, we send emails to all taxpayers in our sample. Subjects assigned to the **control group** receive a message with a reminder about the filing deadline and the importance of truthfully reporting their tax liabilities.

While this is all information provided to subjects randomly assigned to the control group, emails to those in the **treatment group** additionally include information available to the Tax Authority (TA) regarding their transactions. The emails are personalized for each taxpayer and include either the sources of third-party information the authority possess on their revenue (sales to other taxpayers, debit/credit card sales, exports or sales to the government) or indicators about their operations flagged by the authority (repeated reported losses, financial transactions inconsistent with reported revenue or low declared revenues compared to peers) for taxpayers with no third-party information available. For legal reasons, no specific amounts or partners are mentioned - only the knowledge of specific categories of transactions.

We will measure the intervention's impact using administrative data on taxpayers' filing, including whether they filed their income tax declaration or not, and amount of revenue and taxable income declared.

We are aware that the results of the experiment may be affected by the impact of COVID-19 in the country, particularly if the period for filing taxes is extended. In that case we plan to re-send the emails to make the intervention more salient. We are monitoring the situation to adjust the experiment going forward.

Page Break

Baseline measures

We have information on baseline outcomes of interest using taxpayers' **FY2018 filings** which might be useful to illustrate magnitudes. Among the 31,396 taxpayers in our experimental sample:

- 86% filed income taxes in 2018.
- The average declared gross revenue was 1.3 million Lempiras (s.e. L 15,000), or approximately USD 52,000 using 2018 average exchange rate (1 USD = L 25).
- The average taxable income (gross revenue net of deductions) was L 100,000 (s.e. L 1,400), or approximately USD 4,000.

End of Block: Survey introduction

Start of Block: Survey questions

In this section we ask you to predict **how** opening an email from the Tax Authority mentioning specific information about your past transactions affects **taxpayers'** compliance with tax obligations.

Since not all taxpayers assigned to treatment actually open the emails sent (due to possibly incorrect email addresses, full mailboxes or simply not clicking on it), we ask you to predict what's the **causal effect of opening the email** (i.e. we estimate an instrumental variable (IV) regression where clicking on the email is instrumented by the random treatment assignment).

Question 1

What do you predict will be the effect of opening the email on the probability of filing income taxes, in **percentage points**?

As a reminder, 86% of our sample filed income taxes in 2018.

Page Break

You answered $\${Q8/ChoiceTextEntryValue}$ percentage points in the last question. As an illustration, if 86% of taxpayers in the control group file their taxes (as in FY2018), the intervention would change the filing rate to $\$e\{86+\${Q8/ChoiceTextEntryValue}\}\%$.

If this is correct, please proceed to the next question. Otherwise feel free to go back and adjust your answer.

Page Break

You answered $\{Q8/ChoiceTextEntryValue\}$ percentage points in the last question. As an illustration, if 86% of taxpayers in the control group file their taxes (as in FY2018), the intervention would be (more than) enough to induce 100% of taxpayers opening the email to file.

If this is correct, please proceed to the next question. Otherwise feel free to go back and adjust your answer.

Page Break

Question 2

What do you predict will be the **percentage change** effect of opening the email on (unconditional) declared gross revenue? [If you believe it will increase revenue by X%, please type X].

As a reminder, in 2018, the average declared gross revenue was 1.3 million Lempiras (s.e. L 15,000), or approximately USD 52,000.

Page Break

You answered $\{Q11/ChoiceTextEntryValue\}$ % in the last question. As an illustration, if the average declared gross revenue among the control group is L 1,300,000 (as in FY2018), the intervention would change average gross revenue to L mynumber .

If this is correct, please proceed to the next question. Otherwise feel free to go back and adjust your answer.

Page Break

Question 3

What do you predict will be the percentage change effect of opening the email on declared taxable income (gross revenue net of deductions)? [If you believe it will increase revenue by X%, please type X].

As a reminder, in 2018, the average taxable income (gross revenue net of deductions) was L 100,000 (s.e. L 1,400), or approximately USD 4,000.

Page Break

You answered $\${Q13/ChoiceTextEntryValue}\%$ in the last question. As an illustration, if the average declared taxable income among the control group is L 100,000 (as in FY2018), the intervention would change average gross revenue to L mynumber.

If this is correct, please proceed to the next question. Otherwise feel free to go back and adjust your answer.

Page Break

Effects of different treatments

Among the treated sample, taxpayers were further randomized into receiving **three slightly different messages** in addition to the information available to the TA.

One-third of the treatment group will see a message reminding them that non-compliance makes them **subject to fines and sanctions according to the law ("Sanctions message")**. One-third will see a message reminding them about other **administrative sanctions ("Procedure denial")**, such as the denial of documents necessary for firms' operations. Finally a last group will receive a call to "moral duty", reminding them that **good citizens pay taxes that finance public goods for the kids ("Tax morale message")**.

Question 4

Using the sliders below, please predict the effect of each of these treatments on the **probability of filing**.

As a reminder, you previously stated that the effect for the pooled treated sample (i.e. pooling all treatments below together) would be $\${Q8/ChoiceTextEntryValue}$ p.p..

- _____ Sanctions message (1)
- _____ Procedure denial message (2)
- _____ Tax morale message (3)

Question 5

Using the sliders below, please predict the effect of each of these treatments on the (unconditional) declared gross revenue?

As a reminder, you previously stated that the effect for the pooled treated sample would be

$\{Q11/ChoiceTextEntryValue\}\%$.

- _____ Sanctions message (4)
 - _____ Procedure denial message (5)
 - _____ Tax morale message (6)
-

Question 6

Using the sliders below, please predict the effect of each of these treatments on the (unconditional) declared taxable income?

As a reminder, you previously stated that the effect for the pooled treated sample would be $\{Q13/ChoiceTextEntryValue\}\%$.

- _____ Sanctions message (4)
 - _____ Procedure denial message (5)
 - _____ Tax morale message (6)
-

Page Break

Treatment heterogeneity - how different taxpayers respond?

One specific question we are interested in is how different taxpayers will respond to the intervention. As the main dimension of heterogeneity, we ask you to predict **how taxpayers of different risk levels will respond**. The tax authority categorizes taxpayers in five different risk levels, according to i) discrepancies between self-reported and third-party informed data and; ii) anomalies in self-reported information, such as repeated losses and revenue inconsistent with volume of financial transactions.

In the table below we provide some descriptive statistics on each of those five groups, and then ask you to predict what will be the treatment effect in each of them for one outcome: **declared gross revenues**.

<i>Risk-level</i>	<i>Number of taxpayers</i>	<i>Corporations (%)</i>	<i>Filed income taxes (2018) (%)</i>	<i>Third-party information available (%)</i>	<i>Declared gross revenue (2018) (L1,000s)</i>
Low	6,460	10%	78%	74%	708.87
Medium-low	8,658	19%	80%	67%	1,480.60
Medium	7,270	40%	91%	72%	1,342.67
Medium-high	5,839	61%	93%	66%	1,777.21
High	3,169	48%	99%	87%	1,085.41

Question 7

Using the sliders below, please predict the **effect of being assigned to the treatment group** (i.e. we ask you to predict the Intention-to-Treat effect), in percentage change, on the (unconditional) declared gross revenue for each risk-level.

As a reminder, you previously stated that the effect for the full treated sample would be **#{Q11/ChoiceTextEntryValue}%**.

- _____ Low risk group (1)
- _____ Medium-low risk group (2)
- _____ Medium risk group (3)
- _____ Medium-high risk group (4)
- _____ High risk group (5)

End of Block: Survey questions

Start of Block: Block 3

You have reached the end of the survey.

If you want to change any of your answers you might click the back button below and review your forecasts.

If you have any comments about this survey or about the experiment, we would very much appreciate you leaving your thoughts below. Otherwise, please click the "Submit" button to submit your final answers.

End of Block: Block 3