

TAXATION, INFORMATION AND WITHHOLDING: EVIDENCE FROM COSTA RICA*

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Abstract

Withholding of taxes by employers and by firms' trading partners is common around the world, but absent in public finance theory. We demonstrate the surprising power of withholding as a tax collection instrument, studying a scheme in Costa Rica where credit-card companies withhold tax on card sales. Doubling the withholding rate increases sales tax remittance among treated firms by 32 percent and aggregate revenue by 8 percent, although the statutory tax rate and third-party reporting requirements remain unchanged. We identify the mechanisms driving this effect and show that the current withholding rate is below the welfare-maximizing rate.

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1 Introduction

Governments commonly rely on withholding agents to collect taxes. Withholding of the personal income tax by employers is almost universal, and withholding is often applied to firms' transactions, to ensure compliance with corporate income and consumption taxes.¹ Large firms and financial institutions are common withholding agents. Figure 1 shows that the use of such withholding schemes is particularly prevalent in lower-income countries, and that lower-income countries apply withholding schemes more broadly and impose higher withholding rates. These facts suggest that withholding may be a desirable policy tool in a context with limited tax compliance. In standard public finance theory, however, tax compliance is modeled as a function of audits, penalties and third-party reported information about the tax base.² The fact that the third party may also withhold tax at source has been largely ignored.³

This paper studies the surprising power of withholding and its mechanisms. In our main application in Costa Rica, credit- and debit-card companies⁴ report firms' card-machine sales, withhold a fraction of the transaction amount, and remit this to the tax authority as an advance on the firms' sales tax. Withholding applies to transactions that are also third-party reported to the tax authority and the withheld tax is fully creditable against a taxpayer's final tax liability. Standard models would hence suggest that withholding is irrelevant to tax compliance. However, our empirical evidence rejects these models. We exploit variation in firm-specific withholding rates in a difference-in-differences design to show that a doubling of the withholding rate increases sales tax remittance⁵ among treated firms by 32 percent, although third-party reporting requirements and statutory tax rates do not change. The mechanisms are a default payment effect and a change in enforcement perceptions. This result rationalizes the use of with-

¹In this case, the payer in a transaction withholds tax from the payee, sending the tax withheld to the tax authority as an advance tax remittance by the payee.

²Formal employment contracts (Kleven et al. 2011, Jensen 2022), modern accounting systems (Kleven et al. 2016), financial transactions (Gordon and Li 2009), electronic receipts (Naritomi 2019) and firm-to-firm transaction records (Pomeranz 2015) all generate third-party information, which allow the tax authority to verify a taxpayer's self-reported income and deter evasion.

³Slemrod (2008) and Slemrod and Boning (2018) discuss the importance of withholding qualitatively, without specifically modeling it.

⁴Henceforth referred to as credit-card companies for simplicity.

⁵We use the term "remittance" rather than "payment" to refer to transfers from taxpayers or other economic agents to the tax authority. The purpose of this term is to distinguish these transfers from transactions between economic agents and to avoid confusion between the transfer of money to the tax authority and bearing the burden of the tax (Slemrod 2008).

holding as a tax collection instrument, as we show in an [Allingham and Sandmo \(1972\)](#) style model.⁶

Evaluating the impact of withholding empirically and disentangling it from the impact of third-party reporting is challenging, as withholding and third-party reporting typically go hand in hand. To overcome this challenge we exploit a unique reform of the withholding-rate schedule applied by credit-card companies in Costa Rica. Withholding rates in Costa Rica are firm specific. The tax administration updates the rates each semester, using as inputs firms' sales tax declarations from two semesters prior. Before the reform, withholding rates were an increasing step function of firms' value-added rates. In August 2011, the government changed the schedule to be an increasing step function of firms' share of domestic sales. The reform was announced only a few weeks before entering into effect, so there was no scope for firms to manipulate withholding rates at the time, especially since rate calculations are based on firms' sales tax declarations from semester $s-2$. As a result of the reform, firms with a low value-added rate and a high share of domestic sales experienced an increase in their withholding rate. Firms in an intermediate range of value-added and the share of domestic sales were unaffected by the reform. These firms serve as the control group for a difference-in-differences estimation. The pre-reform trends in key outcome variables are identical in the treatment and control group, even in terms of seasonal fluctuations.⁷

Importantly, the reform allows us to isolate the impact of withholding from other determinants of compliance, as the statutory tax rate did not change and the information reporting environment was unaffected. Specifically, credit-card companies were required to report all card transactions both before and after the reform, and card machine usage hardly responded to the reform. Our analysis relies on the universe of income tax and sales tax records over a ten year period, matched with over 20 million third-party information and withholding reports.⁸ In an innovation compared to most previous studies, we use

⁶Withholding in this context does not reduce transaction costs for the taxpayer, as withholding is incomplete and most taxpayers still have an outstanding tax liability to remit. Withholding reduces administrative costs for the tax authority, which may be a reason for the attractiveness of withholding schemes, but this cannot explain why withholding increases compliance, as we show in this paper.

⁷The setting is also advantageous because withholding agents remit the tax withheld monthly or even daily, and their pricing is highly standardized, meaning that the incidence of withholding is most likely on the retailers or their consumers rather than on the withholding agents.

⁸In appendix B, we provide event study and bunching evidence suggesting that third-party information reporting independently of withholding increases firms' tax compliance. Yet, in appendix C, we show that despite the presence of third-party information, compliance gaps remain widespread and sizable. This points to the need for an alternative (and stronger) compliance instrument: withholding.

not only reported tax liabilities but also actual tax payments to capture compliance outcomes.

We find that doubling the withholding rate leads to a 32 percent increase in total sales tax remittances from taxpayers subject to the rate change. This is due to a 14 percent increase in the share of firms that remit any sales tax and a 0.8 log point increase in remitted amounts on the intensive margin. In the aggregate, the withholding-rate reform increased sales tax revenue by 8 percent.⁹ This is a large effect compared other tax compliance interventions. For instance, [Naritomi \(2019\)](#) finds that the successful e-receipts program in São Paulo, Brazil, increased aggregate tax revenue by only 3.5 percent.¹⁰ Our estimates are robust to different ways of controlling for seasonality, different levels of clustering and considering longer or shorter pre- and post-reform periods. Our preferred specification relies on the sample of firms that use a credit card machine, but the results are very similar when including firms that did not use a card machine in the control group.

Using detailed information from all line items on the sales tax return, we can show that the treatment effect on sales tax remittance is driven by two mechanisms, which each explains roughly half of the total effect. First, a substantial share of the tax withheld — 27 percent before the reform and 38 percent after the reform — is not reclaimed by firms. We call this the default remittance effect. Second, the reform led to a 21 percent increase in the reported tax liability, an effect that emerges sharply at the time of the reform. This tax liability increase is fully driven by a reduction in input tax credits, suggesting it is likely a reduction in misreporting. We argue that this is because withholding increased firms' perceived likelihood of enforcement. Consistent with this, we show that the tax liability increase is larger among firms that are most likely to update their enforcement perceptions in response to the withholding rate reform: first time withholders (i.e. firms for which the withholding rate increased from zero to greater than zero), firms that reclaim the tax that was withheld from them (and hence pay attention to withholding)

⁹While the withholding rate change affected firms' tax compliance, we find little evidence for an effect on real firm growth, as proxied by the wage bill and number of employees.

¹⁰Another way to gauge the size of the effect is to consider that tax withheld constitutes 15 percent of total tax payment for firms subject to withholding prior to the reform, and 30 percent thereafter. Put differently, for each CRC in tax withheld, more than two additional CRC in tax are recovered.

and firms that had previously under-reported their tax liability.¹¹

We also replicate our results using other sources of variation in withholding rates in Costa Rica. We exploit the biannual updating of withholding rates in an event study and the introduction of withholding for the income tax in a difference-in-differences estimation. We find that an increase in withholding always leads to an increase in the reported tax liability.

To examine the optimal design of withholding, we extend a simple tax evasion model with third-party information reporting based on [Allingham and Sandmo \(1972\)](#). We allow the third party to both report a taxpayer's sale and withhold a share of the transaction amount as an advance tax remittance for the taxpayer. In this model, withholding is irrelevant to taxpayers' compliance decisions if the tax withheld can be fully reclaimed and if withholding does not affect taxpayers' perceptions of enforcement. When we relax these two assumptions, however, withholding can increase tax remittance through two channels: incomplete reclaiming of the tax withheld and a reduction in misreporting.¹² We then consider how a social planner would set the welfare-maximizing withholding rate. We show that this rate depends on the elasticity of the reported tax liability to the withholding rate and the marginal cost of evasion which withholding generates for the taxpayer. Under reasonable assumptions on this cost, our estimates imply that the current withholding rate in Costa Rica is below the optimal rate.

Our paper contributes to several strands of the literature. First, we contribute to a large body of work on tax compliance surveyed in [Slemrod \(2018\)](#) and [Slemrod and Yitzhaki \(2002\)](#).¹³ We present withholding as an empirically important compliance mech-

¹¹We also show that audit rates do not change during the period we study and that there is hardly any bunching of reported tax liabilities at the amount of tax withheld. Besides, firms with below-median profitability, which are more likely to be liquidity constrained, and bunchers do not exhibit a stronger response to withholding than other firms. This suggests that the increase in the reported tax liability is not a mechanical effect due to bunching or liquidity constraints.

¹²We also discuss how withholding would impact compliance if firms are liquidity constrained, but find no empirical evidence for such an effect.

¹³Previous studies have identified the key drivers of tax compliance as (i) audits and other enforcement mechanisms ([Allingham and Sandmo 1972](#)), (ii) third-party reporting and information trails more generally ([Kleven et al. 2011](#), [Kleven et al. 2016](#)), and (iii) social motives, such as the desire to conform to social norms ([Singhal and Luttmer 2014](#), [Slemrod et al. 2022](#)).

anism which has been almost absent from the literature until recently.¹⁴ Withholding is not only less costly to implement than audits or other forms of enforcement, but it is also conceptually distinct from standard enforcement, as it abandons the idea of incentivizing taxpayers to correctly report their income, and instead establishes a default tax remittance, based on a proxy of the tax liability. As withholding agents are usually firms, our work also connects to [Kopczuk and Slemrod \(2006\)](#), who have emphasized the important role of firms in tax enforcement, and [Slemrod \(2008\)](#), who emphasized firms' role as withholding agents in particular. Related work by [Garriga and Tortarolo \(2022\)](#) studies the role of firms as tax enforcement agents in Argentina, but their policy variation combines third-party reporting and withholding. Our study is the first to estimate the impact of withholding on compliance and identify the mechanisms through which it works.

Our study is related to but more general than [Kopczuk et al. \(2016\)](#) who show that shifting tax remittance responsibility from downstream retailers to upstream suppliers increases compliance and passthrough of the diesel tax. Our setting is more general in that withholding does not necessarily shift the entire remittance responsibility from one agent to another, as in [Kopczuk et al. \(2016\)](#), but rather shifts the *share* of the tax liability that is remitted by the withholding agent. This distinction between full and partial withholding matters, as firm withholding regimes are almost always partial. With partial withholding, shifting more remittance responsibility to a more compliant agent does not necessarily increase overall compliance. Compliance increases only if tax withheld is not fully reclaimed or if withholding changes the withholder's reporting behavior. We argue that these mechanisms drive our results.¹⁵

Since withholding is always accompanied by third-party information reporting (but not vice-versa), our study also relates to the empirical literature on third-party reporting ([Pomeranz 2015](#), [Jensen 2022](#), [Naritomi 2019](#)). While these papers show that information trails increase compliance, it remains unclear to what extent compliance gaps remain, and

¹⁴A few policy reports ([Samanamud 2013](#), [OECD 2009](#)) and legal studies ([Soos 1990](#)) anecdotally describe the relationship between withholding and tax compliance among small firms. More recently, [Waseem \(2022\)](#) argues that withholding is key to explaining the self-enforcement mechanisms of the VAT and [Pessina \(2020\)](#) shows that when the responsibility to remit VAT is shifted from sellers to buyers in Italy, firms are more likely to cease trading, which increases market concentration. Another literature has analyzed personal income tax withholding with a special focus on the United States, examining why individuals voluntarily over-withhold ([Barr and Dokko 2008](#), [Gandhi and Kuehlwein 2014](#), [White et al. 1993](#), [Highfill et al. 1998](#)).

¹⁵Besides, compared to [Kopczuk et al. \(2016\)](#), our study relies on very finely grained and credibly exogenous variation and the nature of this variation and our data allow us to dissect the mechanisms of the response to withholding.

how large they are. There are also studies highlighting the limits of third-party reporting if firms can adjust less easily verifiable margins (Carrillo et al. 2017, Slemrod et al. 2017). We argue that asking third parties to not only report a transaction but to withhold tax on this transaction achieves much better compliance results. This findings is highly policy-relevant, as we show that even in a context where third-party information is routinely used for enforcement, there are still sizeable compliances gaps on all margins: on the extensive, intensive and payment margin.¹⁶

Third, our study relates to the literature on state capacity and development, and the optimal mix of tax instruments in a low-capacity setting (Besley and Persson 2013, Gordon and Li 2009, Keen 2008). Similar to the minimum tax studied in Best et al. (2015), withholding on firms can increase tax compliance but can also distort production efficiency. Both minimum taxes and withholding are instruments predominantly used in lower-income countries and low-compliance settings. We provide evidence that rationalizes the use of withholding in these contexts.¹⁷

The remainder of the paper is organized as follows. We start by presenting a simple conceptual framework in Section 2. Section 3 describes the context and data and Section 4 explains our empirical strategy. Section 5 evaluates the impact of withholding on compliance and its robustness and Section 6 examines the mechanisms of this result. Section 7 uses our empirical estimates to examine the optimal withholding rate. Section 8 provides evidence for the external validity of our results. Section 9 concludes.

2 Conceptual Framework

To guide our empirical analysis, we present a model of behavioral responses to withholding that allows us to examine how withholding affects compliance and to derive sufficient statistics for the optimal withholding rate. Our model is based on the canonical tax-

¹⁶In supplementary analysis in the appendix, we also reconcile previous findings on the effect of third-party information by presenting empirical evidence from a novel setting. We examine firms' responses not to intensive-margin increases in information reporting or to the use of preexisting reports (as in previous studies), but to extensive-margin changes in being reported, which is arguably where the largest compliance response should be expected. We find large increases in reported tax liability in response to information reporting, despite some offsetting adjustments on the cost margin.

¹⁷Lastly, by identifying the default mechanism as one of the two channels through which withholding raises compliance, our study complements the behavioral economics literature on defaults (Chetty et al. 2014, Thaler and Benartzi 2004, Madrian and Shea 2001). Our setting differs from other default studies in that the agents we study (firms) are likely rational, and that the cost that discourages agents from abandoning the default may be a monetary rather than a psychological cost.

evasion model by [Allingham and Sandmo \(1972\)](#), extended by [Kleven et al. \(2011\)](#) and [Carrillo et al. \(2017\)](#) to include third-party reporting for individuals and firms, respectively. We begin by describing the basic setup of the model, then introduce withholding, discuss the mechanisms through which withholding can impact compliance and finally consider the optimal design of withholding.

2.1 A Tax-Evasion Model with Third-Party Reporting

The basic setup of our model follows [Carrillo et al. \(2017\)](#). Firms have revenue $R = R_T + R_S$, where revenue can be either third-party-reported or self-reported, indexed by T and S , and firms declare \hat{R} . Firms have costs $C = C_T + C_S$ and choose to report \hat{C} . The government levies tax at rate τ on declared profits $\hat{\pi} = \hat{R} - \hat{C}$. The tax liability is $T = \tau\hat{\pi}$. With probability p , firms are audited, in which case any evasion is certain to be detected, and evaders pay a fine θ , which is proportional to the evaded liability. Firms maximize expected after-tax profit in the audited and non-audited states Y_A and Y_N .¹⁸ To account for the tax authority's use of risk scores and third-party information to target audits, we assume that the audit probability is decreasing in the reported profit rate, $p = p((\hat{\pi} + \xi)/\hat{R})$ with $p' < 0$.¹⁹ Misreporting against third-party information is automatically flagged and triggers the maximum audit probability: $p = \bar{p} = \max(p)$ if $\hat{R} < R_T$.²⁰

As previous research has shown that misperceptions about tax enforcement parameters are common ([Erard and Feinstein 1994](#), [Scholz and Pinney 1995](#)), we allow firms' perceptions of the enforcement parameters p and R_T to diverge from the truth, without imposing any structure on how these perceptions are formed. Consider first a firm whose perceptions of the enforcement environment correspond to the truth, that is $\tilde{p} = p()$ and $\tilde{R}_T = R_T$. As $\xi \rightarrow 0$, the firm reports $\hat{R}^* = R_T$ and sets $\hat{C}^* \geq C$ to satisfy the first-order condition. Now, consider a firm that misperceives the enforcement environment, so that $\tilde{p}() \geq p()$ and $\tilde{R}_T \geq R_T$. This is reasonable for many firms, as audits are rare and the audit function is not public knowledge. Third-party reporting mechanisms usually require

¹⁸Modeling firms in a middle-income country as risk-averse is reasonable, since more than half of the firms in our sample are unincorporated, and most firm owners are vulnerable to income volatility.

¹⁹The inclusion of ξ , a small positive number, ensures that firms declaring zero profits on a large revenue base incur a higher audit probability than firms declaring zero profits on a small revenue base, thus differentiating the two corner cases where $\hat{\pi} = 0$.

²⁰As is standard in the literature, we ensure that the second-order condition on the firm's maximization problem is met and avoid non-concavities by imposing $p'' \geq 0$.

third parties to report transactions to the tax authority, but not directly to the taxpayer, so taxpayers may be unaware of the exact value of R_T . If this is the case, firms with $\tilde{R}_T < R_T$ underreport sales compared to third-party reports: $\hat{R}^* \leq \tilde{R}_T < R_T$. Consistent with the existence of misperceptions, we show in appendix C that a significant share of firms misreports their sales compared to third-party reports, and reports costs lower than third-party reported costs. This happens despite the fact that third-party information is systematically used in tax enforcement such that firms should expect a discontinuously higher audit probability when misreporting.²¹

2.2 Modeling Withholding

We introduce withholding into the model by assuming that tax is withheld at a rate μ on third-party reported revenue R_T . The information reporting agent thus also acts as withholding agent. As revenue R_T is already reported to the tax authority by the third party, the introduction of withholding leaves the government's information set unchanged. For now we assume that the tax withheld can be fully reclaimed upon filing. This means that firms' net tax liability (tax to remit) is $P = T - \mu R_T$, where the tax withheld is deducted from the gross tax liability. We further assume that firms always pay their tax in full, meaning that the actual tax payment $\hat{P} = P$. There are no restrictions on the sign of P , $P \geq 0$, so that firms can request a refund if the reported tax liability is smaller than the tax withheld. In this model, firms' after-tax income in the audited and non-audited state of the world are identical to after-tax income in the model without withholding:

$$\bar{Y}_N = \pi - \mu R_T - [\tau \hat{\pi} - \mu R_T] = Y_N, \quad (1)$$

$$\bar{Y}_A = \pi - \mu R_T - [\tau \pi - \mu R_T] - \theta[(\tau \pi - \mu R_T) - (\tau \hat{\pi} - \mu R_T)] = Y_A. \quad (2)$$

Withholding should thus be irrelevant to firms' evasion decisions. This naive prediction, at odds with our empirical results, relies on assumptions which we relax in the next section.

²¹Note that the possibility that $p(\cdot)$ is bounded below 1 is not enough to explain misreporting. If the audit probability discontinuously increases when firms report sales lower than third-party reported sales, it is always optimal for firms to match self-reported sales to third-party reported sales and manipulate costs to meet the first order condition.

2.3 Withholding Impact Mechanisms

This section examines firm behavior when relaxing some of the assumptions in the naive model of withholding to bring it closer to reality. In this case, withholding can impact compliance.

Default Mechanism. The naive model assumes that taxpayers subject to withholding can fully and costlessly reclaim the tax withheld. In reality, firms may incur administrative or monetary costs to credit the tax withheld against their liability. It has been shown that tax compliance costs can be substantial, especially for small firms, and an important determinant of firm behavior (Slemrod and Gillitzer 2014, Coolidge 2012). A simple way to model the compliance cost is to consider that firms incur a firm-specific fixed cost f_i , distributed according to a cumulative distribution function $H(f)$, to deduct the tax withheld μR_T from the gross tax liability T . This could represent the administrative or mental cost of tracking how much tax has been withheld during each transaction and then adding up those amounts when preparing the tax return. The presence of the fixed cost generates a cutoff $\bar{f} = \mu R_T$ such that firms with $f_i < \bar{f}$ reclaim the tax withheld, and firms with $f_i \geq \bar{f}$ do not reclaim. This yields the testable predictions that (i) reclaiming of the tax withheld is incomplete if reclaiming costs are sufficiently high, $H(\bar{f}) < 1$; and (ii) firms with larger amounts of withheld tax (either due to higher R_T or higher μ) are more likely to reclaim, $\partial H(\bar{f})/\partial R_T > 0$ and $\partial H(\bar{f})/\partial \mu > 0$.²²

Enforcement-Perceptions Mechanism. Our baseline model implicitly assumes that taxpayer perceptions of enforcement, \tilde{R}_T and $\tilde{p}()$, are not affected by withholding. Yet withholding agents must inform the taxpayer of the amount of tax withheld to enable the taxpayer to reclaim it. For instance, credit-card companies provide client firms with a monthly statement listing the volume of transactions processed, the commission due, and the tax withheld, if any.²³ Such a statement can prompt taxpayers to update their enforcement perceptions either because it provides new information or because it makes known information more salient (Chetty et al. 2009, Finkelstein 2009). Specifically, the statement conveys that an amount μR_T of tax was withheld and remitted to the tax

²²A cap on reclaims or an increase in the audit probability for reclaimers would similarly generate incomplete reclaim, but these features are empirically not relevant, as we discuss below. These features also would not generate the pattern of reclaiming behavior that we observe, where firms with larger amounts of tax to reclaim are more likely to reclaim. Instead, a cap on claims and an audit probability increasing in reclaims would generate the opposite behavior.

²³See Figure E.1 and section 3.2 for more details on reporting requirements.

authority, hence the value of R_T was communicated to the tax authority, and the tax authority employs credit-card companies for tax compliance purposes. Even though the true R_T and $p()$ do not change, withholding can thus lead taxpayers to update \tilde{R}_T and $\tilde{p}()$, and increase reported sales \hat{R}_T and tax liability $\hat{\pi}$ accordingly.

For example, for taxpayers that are initially unaware of third-party reporting, the introduction of withholding raises \tilde{R}_T from 0 to R_T and moves reported profits from $\hat{\pi}^*(0)$ to $\hat{\pi}^*(R_T)$, where $\hat{\pi}^*(R_T) > \hat{\pi}^*(0)$ if $\tilde{p}' \neq 0$. As another example, taxpayers may have a perceived audit probability of \tilde{p} , which is an increasing function of the number of times they have witnessed tax enforcement in practice. When confronted with tax withholding, these taxpayers may revise \tilde{p} upwards and hence increase $\hat{\pi}$.

Updating of \tilde{R}_T and \tilde{p} is more likely among the following groups of firms: firms that have previously misreported their taxable income compared to third-party reports R_T (and hence must misperceive $p()$ or R_T or both); firms that are subject to withholding for the first time (and hence experience tax remittance through a credit-card company for the first time); and firms that reclaim the tax remitted (and hence must have taken note of the information on the credit-card statement). We thus test the predictions that (i) an increase in the withholding rate prompts firms to increase their reported tax liability, and (ii) that this effect is larger among the aforementioned subsamples.

Alternative Mechanisms. In our empirical analysis, we consider and refute two potential alternative mechanisms. In a dynamic model with liquidity constraints, withholding could influence tax compliance behavior if taxpayers suffer unexpected shocks between the time of income receipt and the time of tax remittance, or if they myopically consume income before taxes are due. Such taxpayers earn taxable income, but find themselves without liquidity to remit tax at the end of the period. In this case, they would report $\hat{\pi} = 0 \leq \pi$.²⁴ The introduction of withholding could then increase compliance. It would allow taxpayers to report a positive tax liability, even if they have no liquidity to remit the tax at the end of the period, as (part of) the tax has already been withheld. In this case, the reported tax liability would equal the amount of tax withheld: $\hat{\pi} \cdot \tau = \mu R_T$, still

²⁴Note, however, that the nature of shocks or myopia that would generate this result needs to be very specific, affecting only disposable but not taxable income. An example could be an owner-manager using business income to pay for a family emergency. A shock to taxable income would affect also true tax liabilities, and would thus not necessarily generate non-compliance. Also note that, for taxpayers who find themselves without liquidity to remit tax, and whose sales are partially covered by third-party reporting, non-payment or non-filing would not be optimal in our model, unless the taxpayers mis-perceive the enforcement parameters $p()$ and R_T .

ensuring $P = 0$. This mechanism thus predicts bunching of reported tax liabilities at the amount of tax withheld.²⁵ Another model of firm behavior which could generate such bunching is one in which firms interpret the amount of tax withheld as a signal about the appropriate tax liability to declare (e.g. rule-of-thumb reporting behavior or targeting as in Tourek (2022)). In either model, an increase in withholding would increase tax compliance, because it would mechanically move firms to report higher tax liabilities. We will thus examine the presence of bunching in reported tax liabilities, and any changes in bunching with the withholding rate.²⁶

2.4 Optimal Withholding

We now consider how a policymaker would set the withholding rate to maximize welfare. Withholding involves a trade-off between collecting government revenue and maximizing firms' real (pre-tax) profits. Firms' production decisions can be distorted by withholding, for instance because withholding reduces firm liquidity. To remain as general as possible, we do not model specific channels through which withholding affects firm productivity. We consider a firm producing revenue R at cost $c(R, \mu)$. We thus let withholding affect firms' productivity by increasing production costs. The firm evades part of its net revenue, e , at a cost $\gamma(e, \mu)$. The dependence of the evasion cost on μ captures in the most general form the idea that withholding increases the cost of evasion. For simplicity, and to focus on the revenue-efficiency trade-off, we assume that the tax withheld is fully reclaimed by the firm, so withholding enters the firm decision only via the cost functions. The firm's objective function is

$$\max_{R,e} R - c(R, \mu) - \tau[R - c(R, \mu) - e] - \gamma(e, \mu). \quad (3)$$

Note that this formulation is equivalent with the model presented above.²⁷ We assume that c is strictly increasing, strictly convex and differentiable with respect to R and μ .

²⁵In a more complicated model where only part of firms' taxable income is lost between the receipt of income and tax remittance, the distribution of (reported tax liability-tax withheld)/(reported tax liability) would exhibit excess mass just above 0, and an increase in the withholding rate would lead to an increase in bunching at 0.

²⁶We also test whether firms with low profit margins, for whom liquidity constraints are more likely to bind, exhibit a larger response to the withholding rate.

²⁷In particular, if we let γ depend on the proportional fine θ and the perceived audit probability \tilde{p} , we have $\gamma(e, \mu, \tilde{p}, \theta) = \tilde{p}\tau[(\pi - \hat{\pi})(1 + \theta)] = \tilde{p} * \tau * e(1 + \theta)$. In that case, $E(Y) = (1 - \tilde{p})Y_N + \tilde{p}Y_A = \pi - \tau(\pi - e) - \gamma(e, \mu, \tilde{p}, \theta)$.

We assume that γ is strictly increasing, strictly convex and differentiable with respect to e and μ . The firm's first order conditions are the following:

$$[R] \quad 1 - c_R(R, \mu) = 0 \implies R^*(\mu) \quad (4)$$

$$[e] \quad \tau - \gamma_e(e, \mu) = 0 \implies e^*(\tau, \mu) \quad (5)$$

The government provides a public good g which generates benefit $v(g)$ for firms, which is strictly increasing and concave. The government maximises welfare of firms subject to its budget constraint $\tau(\pi - e) = \tau[R - c(R, \mu) - e] \geq g$:²⁸

$$\max_{\mu, \tau} W(\tau, \mu) = R - c(R, \mu) - \tau[R - c(R, \mu) - e] - \gamma(e, \mu) + v(\tau(\pi - e)) \quad (6)$$

Taking the derivatives of the welfare function with respect to the policy instruments yields the following envelope conditions:

$$W_\tau = -\hat{\pi} + v'(\tau\hat{\pi}) * [\hat{\pi} + \tau\hat{\pi}_\tau] = 0 \quad (7)$$

$$W_\mu = -\gamma_\mu + v'(\tau\hat{\pi}) * \tau\hat{\pi}_\mu = 0 \quad (8)$$

where $\hat{\pi} = R^* - c(R^*, \mu) - e^*(\tau, \mu)$. We rearrange the envelope condition for μ to obtain

$$\varepsilon_{\hat{\pi}, \mu} = \frac{\gamma_\mu \mu}{\tau \hat{\pi} v'} \equiv \frac{\gamma_\mu(e^*, \mu) \mu}{\tau \hat{\pi} v'(\tau \hat{\pi})}, \quad (9)$$

where $\varepsilon_{\hat{\pi}, \mu}$ is the elasticity of the reported tax liability $\hat{\pi}$ with respect to the withholding rate μ and γ_μ is the partial derivative of the evasion cost function with respect to μ .

The optimal withholding rate is increasing in the marginal value of public goods and in the elasticity of the reported tax liability to the withholding rate, and decreasing in the marginal cost of evasion generated by withholding, scaled by the reported tax liability. The elasticity of the reported tax liability captures the net effect of withholding on tax liability, balancing the positive reporting effect and the negative real effect. The marginal cost of evasion captures the fact that withholding generates a welfare loss by making evasion more costly. While the marginal cost of evasion is difficult to estimate, the

²⁸Note that the substitution is possible under the assumption that $v(\cdot)$ is strictly increasing. Therefore, the government's budget constraint will always hold with equality.

elasticity of the reported tax liability to the withholding rate is an estimable parameter in our setting.

3 Context and Data

We test the predictions of our conceptual framework and estimate the parameters to assess the optimal withholding rate using policy variation and administrative tax records from Costa Rica. This section describes the relevant taxes, the compliance mechanisms used to enforce them, and the data we use.

3.1 Relevant Taxes

Our main analysis leverages variation in Costa Rica’s monthly sales tax, which constituted 37 percent of total tax revenue in 2010. The sales tax is effectively a VAT with an invoice-credit system, i.e. deductability of tax paid on inputs. The tax base includes most goods and some retail services (e.g. hotels and tailors), but it excludes professional services (e.g. lawyers and doctors). Only firms remitting tax on their sales can deduct tax paid on their inputs. The sales tax rate was constant at 13 percent for the entire period of our study, with reduced rates of 10 percent and 5 percent levied on wood and residential electricity, respectively.

In a secondary analysis, we also leverage the introduction of withholding in Costa Rica’s business income tax system. Business income taxes contributed 26 percent of tax revenue in 2010. Table B.1 shows the income tax schedules. Unincorporated businesses face a kinked income tax schedule with marginal tax rates of 0, 10, 15, 20, and 25 percent on profits. Corporations face a notched tax schedule whereby the average tax rate depends on gross revenue while the tax base is profits. The average tax rates are 10, 20, and 30 percent. Income tax declarations are filed annually by December 15, with three quarterly advance remittances due in March, June, and September.²⁹

Retailers in certain sectors and below certain size thresholds³⁰ can opt into a simplified

²⁹Fiscal year t in Costa Rica starts on October 1 in year $t - 1$ and ends on September 30 in year t . Taxpayers can request to remit taxes according to a different fiscal schedule, which we account for in our analysis. Each quarterly advance remittance is a quarter of either the previous year’s tax liability or of the average liability over the last three years, whichever is higher.

³⁰These include having annual purchases of less than 150 base salaries, owning fixed assets of less than 350 base salaries, and employing fewer than six workers. The base salary is a national accounting unit equivalent to CRC 446,200 (US\$764) in calendar year 2019.

regime that unifies the sales tax and the income tax. This regime levies taxes on inputs at sector-specific rates that vary from 3 percent to 9.8 percent. Firms file and remit tax quarterly and are not subject to tax withholding by credit-card companies. We use the revenue trend in this regime as a counterfactual when studying the aggregate revenue impact of withholding.

3.2 Third-party Reporting and Withholding

The natural experiment our study exploits occurs in the credit-card reporting and withholding system. Card companies report all sales processed through card machines to the tax authority and withhold taxes at a firm-specific rate which varies from 0 percent to 6 percent. The withheld tax is creditable against the firm's sales tax liability. Withholding agents remit the withheld tax to the tax authority the day after the transaction takes place and thus receive almost no liquidity benefit. Compliance with withholding obligations is high, as discussed in section 4.1.

Table 1 shows the withholding-rate schedule. Prior to August 2011, the withholding rate was increasing in the reported value-added rate. Value added is defined as tax-liable sales net of tax-liable purchases and imports, where tax-liable refers to the sales tax. In August 2011, in an effort to better align withholding rates with sales tax liability, the authorities changed the rate-determination methodology, while also consolidating the withholding-rate schedule to three rates of 0, 3, and 6 percent. As exports are exempt from the sales tax, the rates are now increasing in the share of domestic sales in total sales, with notches at 0 percent and 50 percent.

Importantly, firms were not able to manipulate the withholding rates assigned to them at the time of the reform. This is because withholding rates for semester t are always based on domestic sales reported in firms' tax declarations in semester $t - 2$.³¹ Each semester, the tax authority calculates the firm-specific withholding rates and communicates them to the withholding agents. Only in special circumstances (e.g. consecutive annual losses) are firms able to request a reduction in their withholding rate before the end of the semester. In this case, the realized withholding rate may differ from the rate predicted by value added or share of domestic sales reported in semester $t - 2$.

Withholding agents are required to provide firms with a receipt confirming the amount

³¹The two semesters extend from January to June and from July to December.

of tax withheld, as illustrated in Appendix Figure E.1. This receipt lists the volume of transactions processed, the commission charged, and the tax withheld. Taxpayers should thus know whether or not they are subject to withholding, and a change in the withholding rate from 0 percent to any positive rate should be very salient.

Taxpayers can deduct (henceforth “reclaim”) the amount of tax withheld from their gross tax liability by simply filling in one additional box on their tax return. Taxpayers only need to keep track of the amount of tax withheld. If the taxpayer has reported zero tax liability for three consecutive months, and therefore has no liability from which to deduct withheld taxes, the taxpayer can submit a “refund request” form. Such a request requires detailed information on the withholding agent, including the amount of tax withheld and the timing of withholding, and may take several months to be processed. While taxpayers reclaiming the tax withheld are not subject to higher audit rates than other taxpayers, taxpayers requesting a refund are often subjected to a desk audit. Refund requests are, however, very rare, as the amount of tax withheld is smaller than the tax liability for most taxpayers in our context. We will show below that the difficulty of obtaining refunds is not the key driver of our results.

For completeness, we should mention that there are two other categories of third party reporting agents in Costa Rica’s tax system. First, state institutions report all purchases from the private sector and withhold 2 percent of the transaction amount, which is remitted to the tax authority and creditable against the taxpayer’s income tax liability. Second, firms report firm-to-firm sales if the annual transaction value reaches 2.5 million Costa Rican colones (CRC), equivalent to US\$4,365.³² The payment of rent, commissions, professional-service fees, or interests must be reported if annual transactions with a single transaction partner reach CRC 50,000 (US\$87). These reports are purely for information purposes and are not linked to tax withholding. Table E.1 provides an overview of the third-party reporting and withholding declarations. The tax authority uses the third party and withholding reports, as well as customs declarations on imports and exports, to automatically cross-check taxpayers’ self-reported tax declarations. Enforcement actions are informed by these cross-check, though the exact algorithm is not public knowledge and changes over time. Non-compliant taxpayers face monetary sanctions, temporary

³²As of October 5, 2017, US\$1 was equal to CRC 573.

firm closure and in exceptional cases even prison sentences.³³

3.3 Data and Summary Statistics

Our main analysis uses the universe of monthly sales tax declarations and credit card withholding reports for 2008-2015. These data feature all line items, including VAT on different revenue categories, VAT on different cost categories, deductions, gross and net liability, amount of tax withheld, reclaim of tax withheld and final tax to pay, in addition to firm characteristics such as sector and firm type (incorporated vs unincorporated). Importantly, we merge the tax returns with the corresponding tax remittance (payment) receipts to observe the actual payments made, which is still rarely done in this literature.

Table 2 presents summary statistics of the samples used in the analysis. The data contains roughly 67,700 sales tax filers in 2010 (panel 1). The average firm has a turnover of 260 million colones and a profit rate of 10 percent. Slightly over half of all firms are incorporated. A quarter of sales tax filers use a credit card machine and a fifth are subject to withholding. While there are over 14,000 withholders in 2010, there are less than 150 withholding agents.

Our main analysis relies on the subsample of sales taxpayers that already used a credit card machine in the beginning of 2010 and that file regularly during 2010-2013 (panel 2). The restriction to regular filers means that this sample captures predominantly larger firms. The fact that we focus on firms using a credit card machine means that we capture a larger share of retailers that have lower profit rates. Indeed the average profit rate in this sample is about half the profit rate in the full sample. In an extended analysis sample, we also include irregular filers, defined as firms that file at least once per semester during 2010-2013 (panel 3). This sample is of interest because irregular filers might be

³³Relatively minor non-compliance such as non-filing, non-payment, non-filing of third-party reports, or non-emission of receipts is subject to monetary sanctions of up to three base salaries (one base salary was CRC 446,200, i.e. USD 764, in calendar year 2019). For repeated non-filing or non-payment, the tax authority can close a business for five days. Misreporting is sanctioned with a 25 percent or 75 percent penalty on the unreported tax liability, with the higher sanction applying in cases where misreporting with the intention to evade taxes can be proven and unintentional errors ruled out. The sanction for misreporting also applies to incorrect reclaims of tax withheld and to refund requests. Taxpayers who evade tax of an amount higher than 200 base salaries (USD 152,800) can be imprisoned for up to ten years. Prison sentences are applied in rare cases of extraordinary levels of fraud, and the judicial proceedings can take many years: <https://www.nacion.com/sucesos/judiciales/empresario-ira-15-anos-a-prision-por-fraude/4TVYNLZZ2BDMDKDDTZKU57EQBU/story/>. As of September 2016, 24 judicial proceedings were ongoing. On the other hand, the number of firm closures is usually in the hundreds each year (Brockmeyer et al. 2019)

disproportionately more affected by withholding. Irregular filers are slightly smaller than regular filers but have a similar profit rate and are similarly likely to be corporations. Finally, we also consider a sample in which firms that did not use a card machine in the beginning of 2010 are included in the analysis (panel 4). Firms in this sample are smaller than firms in our main analysis sample, but larger than the average sales tax filer. This makes sense, as we are still restricting the sample to firms that file at least once per semester in 2010-2013.

Columns 6-10 in Table 2 display summary statistics for the treatment groups in our analyses (see Section 4 for details on how treatment is defined). We find that the treatment groups are very similar to the control groups in terms of their turnover, profit rate and the share of incorporated firms. An exception is the extended analysis in which we include firms without a card machine in the control group (panel 4). Here, treated firms have on average 40 percent higher turnover than control firms and are slightly less profitable. The fact that our results are robust to the different samples suggests that differences between treatment and control group firms are not driving our results.

In our secondary analyses, we use data from the income tax for 2006-2016, including again all line items on the tax return. These data contain information for 154,00 corporations and 227,000 unincorporated businesses in 2011 (panel 5). As this sample includes a much larger share of service sector firms and small unincorporated firms, the average turnover (77 million colones) is much smaller and the profit rate (33 percent) higher than among the sales tax filers. Only 7 percent of income tax filers used a card machine in 2011.

When analyzing the causal effect of the introduction of withholding for the income tax, we restrict the analysis to firms that filed income tax every year during 2011-2016 (panel 6). In 2011, firms in this sample are similar in size and profit rate to the typical income tax filer. Treated firms, i.e. those that used a card machine prior to 2015 and hence were affected by the introduction of withholding in 2015, are only slightly larger and less profitable than the average income tax filer (columns 6-10). Given the later timing of this reform and the balancing restrictions imposed on the samples of analysis, there is little overlap in the treatment groups for the 2011 sales tax reform and the 2015 introduction of income tax withholding: only 38 firms are in the treatment group for both reforms.

In the appendix, we conduct an anatomy of compliance by merging the sales tax and income tax records with all the different third-party reports mentioned in Table E.1, as well as with tax remittance records and registration and deregistration reports. Appendix B uses heterogeneity in bunching at kinks and notches and event studies of firm behavior around the first time they are subject to third-party reporting to show that third-party reporting is associated with increased compliance. Appendix C shows that, despite the tax authority’s systematic use of third-party information in enforcement, compliance gaps remain widespread. About 50 percent of firms fail to file their taxes, another 13-16 percent under-report their sales, 35-50 percent under-utilize their deductible costs, and 15-25 percent remit outstanding tax liabilities with several months of delay.³⁴ The persistence of large compliance gaps despite third-party reporting is consistent with taxpayers misperceiving tax enforcement parameters R_T and $p()$. This suggests that there is need for another mechanism to enhance compliance. We hence turn to study the effect of withholding.

4 Empirical Strategy

We now describe how we use the August 2011 reform of the sales tax withholding-rate schedule to estimate the compliance impact of withholding. We first provide descriptive evidence on the policy change and then present our estimation strategy.

4.1 Policy Change

As discussed in section 3.2, the government revised the withholding-rate schedule for the sales tax in August 2011. Panel A in Figure 2 shows that the reform roughly doubled the average withholding rate applied to sales tax payers. Before the reform, 40 percent of firms using a credit/debit card machine faced a withholding rate of 0 percent, and only 22 percent faced the maximum rate of 6 percent. Since the reform, over 60 percent of firms using a card machine have faced a withholding rate of 6 percent. The graph also displays small jumps every semester, when the withholding rates are revised by the tax authority and the new rates are communicated to the withholding agents. This suggests

³⁴Perfect enforcement could increase income tax revenue by over 30 percent. Yet, the observed effect of desk audits is orders of magnitude smaller than would be necessary to achieve full compliance.

that withholding agents (card companies) tend to comply with the government-assigned withholding rates.

To better understand the relationship between the assigned and realized withholding rates, we predict each firm’s withholding rate based on its past tax returns and the withholding-rate schedule (Table 1). As panel B in Figure 2 shows, the predicted rate tracks the realized rate very closely among firms for which we can observe both rates. The realized withholding rate is slightly higher, though only prior to the reform. This is consistent with the fact that firms can request a lower withholding rate from the tax authority if, for instance, they experience losses for several consecutive months.³⁵

Panels C and D investigate whether the reform reduced firms’ propensity to file their sales tax declarations or to use their credit-card machines. The effect of withholding on filing propensity is theoretically ambiguous. Panel C shows that the number of sales tax filers increases steadily and smoothly around the reform. This is true both in the full sample, and in the retail sector, which has the highest share of treated firms (over a third). Figure F.1 confirms this zero-effect on tax filing, using a difference-in-differences analysis on an unbalanced sample.

Panel D in Figure 2 shows that also the number of credit card reports and the share of sales tax filers with a credit-card machine displays no discontinuity at the time of the reform. Similarly, there is little change in card machine usage. As panels E and F show, among firms whose transactions are reported by at least one credit-card company, neither the share of card sales in total sales nor the average of the firm-specific share of card sales changes drastically with the reform. While both series display a small drop at the time of the reform, this drop is statistically significant only for the average share of card sales, suggesting it is driven by firms with a relatively small volume of total sales. Moreover, the size of the drop is economically very small even in this sample, accounting for one percentage point of an average share of 50 percent.³⁶

This suggests that most firms lack the market power to refuse card transactions to avoid the withholding-rate increase or reduce its impact. We can thus regard the third-

³⁵There is only a weak behavioral response to the withholding-rate notches in reported value added and the share of domestic sales, suggesting that few firms manipulate the withholding rate by misreporting the relevant line items on their sales tax declaration.

³⁶This is consistent with the regression results presented below. While the PPML and OLS estimations do not detect a significant effect on the volume of card transactions, the estimation with an inverse hyperbolic sine transformation, which put more weight on small observations, finds a small negative effect.

party reporting environment as unaffected by the reform and use the reform to isolate the effect of withholding.³⁷

4.2 Difference-in-Differences Estimation

To estimate the impact of the withholding-rate increase on total tax remittances, we start by conducting a binary difference-in-differences estimation around the time of the withholding rate increase. To obtain an estimate of the treatment effect on the treated rather than an intention-to-treat effect, we work with a sample of firms that accepted card payments prior to the withholding rate increase.³⁸ Firms with an increase in the *predicted* withholding rate are considered treated.³⁹ The treatment assignment is based on the predicted rather than the realized increase in the withholding rate, as the latter may be affected by a firm-specific request or a connection to the tax authority that allowed the firm to obtain a lower withholding rate.⁴⁰ Statutory withholding rates for semester s are determined based on firms' sales tax declarations from semester $s - 2$, so the predicted rate change depends on a firm's value added and share of domestic sales in total sales in the second semester of 2010, well before July 2011 when the reform decree was drafted. Consequently, firms could not have gamed the system to avoid an increase in the predicted withholding rate. Table 2 shows that treated and control firms are very similar in terms of their size (turnover) and profit rate in our main samples of analysis.

We estimate the effect of the rate increase using the specification

$$y_{it} = \alpha_i + \gamma_t + \beta \cdot Treat_i \cdot Post_t + \delta X_{it} + \epsilon_{it}, \quad (10)$$

where y_{it} is the outcome reported by firm i in month t ; α_i and γ_t are firm and month fixed effects; $Treat_i$ and $Post_t$ are dummies indicating the treatment group and the

³⁷Any reduction in credit-card usage would cause a downward bias in the difference-in-differences estimates presented below. If the small number of firms that reduced their card usage after the withholding-rate reform were the firms with the largest potential evasion rents, our estimates would constitute a lower bound on the true compliance impact of withholding.

³⁸We show below that the results are similar when including firms that did not accept card payments in the control group.

³⁹We exclude firms that experienced a reduction in their withholding rate, as the small size of this sample does not allow us to separately estimate the impact of a rate reduction, which is not necessarily symmetric to the impact of a rate increase. We instead estimate the effect of a rate reduction in an event study, shown in Figure H.1.

⁴⁰Collusion between the withholding agent and the firm is unlikely, given the small number of withholding agents and the intense monitoring to which they are subject.

post-reform period; X_{it} is a vector of pre-treatment firm characteristics interacted with month fixed effects; and ϵ_{it} is the error term.⁴¹ We also estimate the monthly event study version of Equation 10, to confirm that the pre-reform trend in the treatment group is not statistically distinguishable from the control group.

For the treatment status to be defined, firms need to file at least one tax declaration in the second semester of 2010. The least restrictive panel we can use is thus a semesterly-balanced panel, in which firms file at least once per semester during the period we study. In practice, most filers file regularly, so that the semesterly-balanced panel is similar to a fully balanced panel, our preferred choice.⁴²

As several outcome variables take a value of zero for a large share of observations, we use the PPML estimator as our preferred specification, a choice we explain in Appendix A. In the PPML estimation, the point estimate on the treatment dummy has the interpretation of a semi-elasticity. We use this specification to obtain the treatment effect on both the realized withholding rate and on tax remittance, which allows us to back out the elasticity of tax remittance to the withholding rate. We use this method rather than an IV strategy (instrumenting the realized withholding rate with the reform) to back out the elasticity, as the PPML does not currently allow for an IV estimation. We discuss below the robustness of our results to numerous alternative specifications.

5 The Impact of Withholding

We now present the main results on the tax-remittance response to the withholding-rate increase and examine its robustness.

5.1 Tax Remittance Response to Withholding

To visualize the identifying assumption and treatment effect on total tax remittance, Figure 3, panel A, plots total tax remittance for the treatment and control groups over time, scaled by the pre-reform mean, together with the DiD estimate from Equation 10. Total tax remittance is the sum of the tax withheld and the taxpayer’s remittance. We

⁴¹The vector X_i contains sector dummies and dummies for the decile of card machine usage (volume of transactions) at the beginning of the period of analysis.

⁴²As filing rates are not affected by the reform (cf previous section) using a semesterly-balanced panel is not a strong restriction. The results are robust to using a longer or shorter semesterly-balanced panel, or balancing the panel only pre-reform and allowing firms to exit at any time after the reform (Table 4).

observe that the treatment and control groups exhibit parallel pre-reform trends, including the same seasonal fluctuations, with peaks during the December shopping season. At the time of the reform, tax remittances in the treatment group increase sharply by 32 percent and remain at this elevated level for the next 16 months. Panel B of Figure 3 plots the event-study version of Panel A to confirm that the differences between the treatment and control group are statistically insignificant in the pre-reform period, and highly significant during the post-reform period. While tax remitted increased by 32 percent after the reform, the withholding rate increased by almost 100 percent, implying an elasticity of tax remitted to the withholding rate of 0.36. Thus, for a 10 percent increase in the withholding rate, tax payments of affected firms increase by 3.6 percent.

In addition to the revenue effect from tax filers, the withholding-rate increase mechanically increased tax remittance by non-filers. Prior to the reform, non-filers represent about 15 percent of firms for which taxes are withheld and account for 5-7 percent of the amount of withheld taxes. The amount of tax withheld from non-filers doubled at the time of the reform, while the filing propensity did not change, as discussed above.⁴³

In aggregate, the withholding-rate reform increased sales tax revenue by 8.1 percent. Panel C in Figure 3 illustrates this result by using a simple regression discontinuity in time on demeaned semester-wise revenue data. Importantly, the revenue data is from official government statistics and net of any tax refunds granted to taxpayers. We also show in panel D that revenue from the simplified tax regime, which is paid quarterly and not subject to withholding, evolves completely smoothly at the time of the withholding-rate reform, allaying concerns that the increase in sales tax revenue may be driven by fluctuations in the business cycle.⁴⁴

5.2 Robustness

Table 3 reports the treatment effect on total tax remittance and other tax return line items for various specifications. We report the treatment effect (semi-elasticity) for the fully

⁴³The reform also advanced part of the tax remittance among delayed remitters, but this has little impact on the total treatment effect, even under the assumption of large discount rates. Delayed remitters comprise 5 percent of taxpayers, they have small liabilities on average, and most remit within a few months of the deadline.

⁴⁴To investigate potential real effects of withholding, we use data on the wage bill and number of employees, and a similar difference-in-differences estimation as in our main analysis of sales tax withholding. We do not find a significant effect of withholding on these proxies of real firm size (results available upon request).

balanced and the semesterly-balanced panel. For each panel, we report three different specifications, trimming the data at the 99.9th, 99th, and 95th percentile, respectively, of the distribution of total sales. We trim rather than winsorize the data to preserve internal consistency of a firm’s tax return, for the decomposition of the treatment effect. Our preferred specification, used in the previous section and in Figure 3, is to trim at the 99th percentile, as it achieves the highest internal consistency between variables.

The treatment effect on total sales tax remittance is highly significant and large in all specifications. The point estimate is larger in the more trimmed samples, showing that withholding has a larger effect on smaller firms. The effect is also slightly larger in the semesterly balanced sample, suggesting that irregular filers (though few in number) are relatively more responsive than regular filers. Table F.1 summarizes the elasticity estimates for the different levels of trimming the data in the balanced panel. We find that the proportional effect on the tax withheld (row 3) is slightly smaller than the effect on the withholding rate, and the corresponding elasticity hence slightly smaller. This is consistent with a small behavioral response by firms reducing the base to which withholding is applied, as discussed above.

Our estimates are robust to different ways of controlling for time trends, different balancing restrictions and different treatment definitions. In Table 4, we show that our main results hardly change when we use only firm and time fixed effects or when we augment our preferred specification with treatment-group-specific Christmas fixed effects to account for the larger share of retailers among the treated firms; when we use a shorter or longer panel, or a panel which is balanced only before the reform; when clustering standard errors at the sector level; and when adding firms without a card machine to the control group.

Appendix Tables F.2 to F.4 show that the estimates from our preferred PPML specification are quantitatively very similar to OLS estimates, and also similar to estimates from data transformed with the inverse hyperbolic sine transformation or from collapsed data (Bertrand et al. 2004), though the latter two specifications suggest much larger point estimates (due to how these specifications process the presence of zeros).

The effect on total tax remittance is driven by the combination of an 14 percent increase in the share of firms that remitted any sales tax (either by direct remittance or via withholding), and a 0.8 log-point increase in the remittance amount among firms

that already remitted regularly before the reform. A similar combination of intensive and extensive margin reporting changes holds for other tax return items. This is evidenced in an OLS estimation with a binary dependent variable (Tables F.5 and F.6) and an IHS estimation on the sample of firms with mostly non-zero outcomes pre-reform (Tables F.7 and F.8).

Table F.9 shows that the treatment effect is not overturned by refund requests, increases in compensation requests on the income tax declaration (possibly due to net credits from sales tax withholding), or a reduction in income tax remittance. The main treatment effect is statistically indistinguishable when the outcome is defined as total sales tax remittances net of any refund requests and income tax compensation.⁴⁵ When the outcome is the sum of total income and sales tax remittances minus refunds, the treatment effect is slightly smaller than when considering sales tax remittance only as the outcome (Table F.9, column 2). Given that annual sales tax remittances among these firms are on average twice as high as income tax remittances, this is consistent with the demonstrated increase in sales tax remittances and even with a slight increase in income tax remittances. Indeed, to the extent that taxpayers are internally consistent (reporting the same tax base on their income and sales tax declarations), an increase in reported sales tax liability should spill over to the income tax.

6 Mechanisms

The detailed tax-return data allow us to precisely decompose the treatment effect into changes in the underlying components of final tax liability, as shown in Table 3. The order of variables in this table follows the logical order on the tax return. The decomposition suggests that the treatment effect occurs through two main mechanisms, each of which explains about half of the total effect. The first is the incomplete reclaiming of withheld taxes, which we call the default remittance mechanism. The second is the increase in reported liabilities, which we argue is driven by a change in firms' perceptions of enforcement. We discuss each in turn.

⁴⁵The number of the refund requests increased slightly at the time of the reform, but we observe less than 150 refund requests by sales tax filers per month, for 6000 treated firms in our balanced panel. This is because the amount of tax withheld is smaller than the gross tax liability for most firms, so a refund is rarely necessary.

6.1 Default Remittance Mechanism

The withholding rate increase led to a substantial increase in the amount of tax withheld, but only part of this tax withheld was reclaimed by taxpayers and credited against their liability. The amount of tax withheld reclaimed increased by less, and from a lower base, than the total amount of tax withheld (Table 3).

Our conceptual framework predicts that withholding increases tax remittances if some taxpayers do not reclaim the withheld tax, and it shows how a fixed cost of reclaiming would shape reclaiming behavior. Panels A1 and A2 of Figure 4 show that reclaiming behavior is indeed consistent with this framework. First, panel A1 shows that reclaiming is incomplete: fewer than 50 percent of all firms with withheld taxes and fewer than 60 percent of those with a non-zero gross liability reclaim any amount of withheld tax in a given month prior to the reform. Second, panel A1 also shows that the withholding-rate increase led to an increase in taxpayers' likelihood of making any reclaim. The share of reclaimers eventually surpasses the pre-reform level by approximately 10 percentage points (albeit never approaching full reclaim).⁴⁶ Third, the comparison of panels A1 and A2 shows that firms with larger amounts of withheld tax are more likely to reclaim. Indeed, the share of withheld tax reclaimed is much higher than the share of reclaimers, consistent with the fact that reclaims are more likely among firms with larger amounts of tax withheld. This is the case both before and after the reform.⁴⁷ These three empirical facts support our argument that a fixed cost prevents some firms from reclaiming their withheld taxes, thereby establishing a compliance default.

6.2 Enforcement Perceptions Mechanism

Second, the withholding rate change was followed by a 21 percent increase in the reported gross tax liability. Figure 4, panel C, shows that this increase, just as the tax remittance response, occurs sharply at reform time after otherwise parallel trends in the treatment

⁴⁶Graphs with a longer post-reform window show that the reclaiming rate eventually approaches a steady level at below 60 percent. At the time of the reform, the reclaiming rate temporarily fell because the reform increased the number of taxpayers subject to withholding, many of whom were initially unfamiliar with the reclaiming procedure. As these firms gradually begin reclaiming withheld taxes, the share of reclaiming firms rose.

⁴⁷Panel A2 also suggests that while the reform pushes more small firms to reclaim the tax withheld, it also pushes some firms to the point where their amount of withheld tax exceeds their declared gross liability, constraining their ability to reclaim. As a result, the overall share of withheld taxes reclaimed decreases.

and control groups. The tax liability increase is fully driven by a reduction in input tax credits. The increases in the reported tax liability and in the reclaiming of withheld taxes roughly offset each other, so that the final tax to be remitted by the taxpayer and the taxpayer remittance hardly changes (it decreases slightly only among the largest firms).⁴⁸

Table 5, columns 1-6, studies the heterogeneity of the increase in reported gross tax liability to substantiate our claim that it is driven by a change in enforcement perceptions. As discussed in section 2, firms which had previously misreported their tax liability, firms which are subject to withholding for the first time, and those that reclaim their reported tax liability are more likely to update their perceived enforcement probability with the withholding rate reform. These firms should thus exhibit larger increases in their reported tax liability. This is indeed the pattern we observe. The interactions between the treatment indicator and the stated characteristics are all highly statistically significant, and remain so when we use them all at once and additionally control for an interaction with firm size. Firms which are neither misreporters, nor first-time withholders nor reclaimers do not exhibit any increase in their reported tax liability.⁴⁹ This heterogeneity in the treatment effect is consistent with an increase in the perceived probability of enforcement.

6.3 Alternative Mechanisms

We now refute potential alternative mechanisms. First, the withholding reform does not seem to coincide with or lead to an increase in enforcement probabilities. Panel C1 in Figure 4 shows that audit rates are constant over time.⁵⁰

Second, the reader may be concerned that taxpayers match their reported tax liabilities to the amount of tax withheld (bunching), in which case an increase in withholding would mechanically generate an increase in reported tax liabilities. Tourek (2022) shows

⁴⁸For the largest firms (column 1 in Table 3), the gross tax liability changes less and the increase in the reclaim of tax withheld is substantial, so the final tax to remit by the taxpayer decreases slightly. For smaller firms (column 3), the liability response is much larger. This means that, despite the increase in reclaims for tax withheld, the tax to remit by the taxpayer increases.

⁴⁹Table G.2 shows the response is larger for larger withholding rate changes (4-5 percentage points, as opposed to 1-3 percentage points), particularly among previous withholders. Among first-time withholders, even small changes in the withholding rate seem salient enough to generate a large change in reported liabilities.

⁵⁰There is no evidence that the withholding reform was accompanied by a public statement on enforcement activities, or that enforcement activities other than audits changed discontinuously with the reform (such a change would also have to be targeted only at firms subject to withholding to generate our results).

evidence for a similar behavior small firms in Rwanda, that match their tax liabilities to previous year’s liabilities. As discussed in section 2, bunching behavior in the context of withholding could arise if taxpayers are liquidity constrained and declare a liability equal to the amount of tax withheld to avoid having to remit any tax, or if taxpayers consider the tax withheld as a signal for an “appropriate” tax liability to declare. Panel C2 in Figure 4 plots the distribution of the difference between the reported tax liability and the amount of tax withheld. It shows that only a small fraction of firms exhibit bunching of reported liabilities, and the vast majority of firms report liabilities much larger than the amount of tax withheld.⁵¹ Importantly, although the withholding reform shifts the distribution left-wards, the degree of bunching does not increase disproportionately.

Columns 6, 7 and 9 of Table 5 show that firms with below-median profitability, which are more likely to be liquidity constrained, or bunchers do not exhibit a stronger response to the withholding rate increase than other firms.⁵² This evidence runs counter the idea that liquidity constraints mediate the effect of withholding, or that withholding increases tax compliance mechanically. Instead, the evidence is consistent with our interpretation of the reported tax liability change as a conscious behavioral response by firms.

We conclude that two mechanisms drive the impact of withholding on compliance: a default mechanism, whereby some firms fail to reclaim withheld taxes, which mechanically translates into higher tax remittances; and a reporting mechanism, whereby the withholding-rate increase alters firms’ perceptions of the enforcement environment, increasing the reported tax liability.

7 Optimal Withholding

We now return to our model which shows that the optimal tax withholding rate is determined by equation 9:

$$\varepsilon_{\hat{\pi},\mu} = \frac{\gamma_{\mu}(e^*, \mu)\mu}{\tau \hat{\pi} v'(\tau \hat{\pi})},$$

where $\varepsilon_{\hat{\pi},\mu}$ is the elasticity of the reported tax liability $\hat{\pi}$ with respect to the with-

⁵¹The fact that tax filing and remittance is monthly for the sales tax, and at a minimum quarterly (for the income tax) also limits the potential impact of shocks and myopia among liquidity-constrained firms. It also means that the damage which withholding can do to firms’ liquidity is limited, as withholding advances the timing of tax remittance only marginally.

⁵²We do not use seasonality or variability of income as a marker of liquidity constraints, as the frequency at which we observe outcomes (monthly) is the same at which firms have to remit tax.

holding rate μ and γ_μ is the partial derivative of the evasion cost function with respect to μ .

We can use this condition to examine whether the current tax withholding rate in Costa Rica is below the welfare-maximizing rate. Using our estimate of $\varepsilon_{\hat{\pi},\mu} = 0.24$ ($= 0.21/0.87$), the fact that $\tau = 0.13$, and assuming $v'(\tau\hat{\pi}) = 1.2$ as in [Keen and Slemrod \(2017\)](#), we obtain

$$0.03744 = \mu \frac{\gamma_\mu}{\hat{\pi}} \quad (11)$$

Hence, unless the marginal cost of evasion as a share of the reported tax base is greater than 62 percent ($0.0374/0.06$), the current maximum withholding rate of 6 percent is below the welfare maximizing rate. The marginal cost of evasion is likely much smaller, suggesting that the withholding rate should be increased. A more optimistic assumption on the marginal value of public goods would imply further increases in the optimal withholding rate.

8 External Validity

As with any policy evaluation that relies on a specific source of variation in a specific context, concerns about the external validity of our study may arise. This section provides causally identified evidence on the impact of withholding from multiple reforms. We find that other quasi-experimental withholding rate increases have a similar impact on compliance as our main reform. This alleviates concerns that the impact of the August 2011 reform was exceptional due to fortunate timing or a particular targeting.

8.1 Event Study of Semesterly Withholding-Rate Updates

As discussed in Section 3.2, withholding rates in Costa Rica are firm specific and updated in January and July each year, with the rates calculated based on firms' reported value-added and share of domestic sales two semesters prior. This means that each January and July, firms within a specific range of value-added (or share of domestic sales) growth rate in year $t-1$ experience an increase in their withholding rate from zero to a non-zero rate, i.e. become subject to withholding for the first time. The fact that firms become subject to withholding at this particular time is driven by changes in their value-added rate or

share of domestic sales a year earlier, combined with the rigid semesterly schedule at which withholding rates are updated. There is thus no reason to believe that the withholding rate change would be correlated with changes in the firm production or performance in the specific month at which the withholding rate change enters into effect.

We conduct an event study of firm behavior around the July updating of withholding rates. We discard changes in January, when a seasonal increase in sales could confound the treatment effect, focus on the self-employed, and drop the year 2011, due to the large withholding rate reform. The treatment group contains firms that used a card machine prior to July in the relevant year and experience an increase in the withholding rate from zero to a positive rate in July. These firms were subject to third-party reporting by card companies both before and after the withholding rate change. The control group contains firms that experienced no change in the withholding rate nor in the third-party reporting regime between June and July.⁵³

We estimate

$$y_{iy,m} = \gamma_m + \alpha_{i_y} + \beta \cdot I\{m \geq 6, i \in E\} + u_{iy,m}. \quad (12)$$

The unit of observation in this estimation is a firm i in event year y in month of year m . We estimate the firm's reported taxable income as a function of event-time dummies γ_m , firm-year fixed effects α_{i_y} ,⁵⁴ and the post-event and treatment group dummy $I\{m \geq 6, i \in E\}$. Panel A1 in Figure 5 shows the normalized treatment and control group trends before and after the event. Consistent with our identifying assumption that the withholding rate change is not associated with underlying changes in firm fundamentals shortly before the event, the reported tax liability in the event and control groups evolves in parallel between March and June. Upon treatment in July, the event group diverges and increases its reported tax liability by 12 percent.^{55 56}

⁵³This includes both firms that did not use a card machine before July of the relevant year, and firms that used a card machine before July but experienced no change in their withholding rate. We exclude firms that used a card machine for the first time in July.

⁵⁴This is because control group firms can appear for multiple years.

⁵⁵These results are robust to winsorizing the outcome at the 99th or 95th percentile, considering only events before or only after the withholding rate reform in 2011, and reducing or increasing the considered pre and post-event period, which conditions the size of the sample as we focus on a sample that is balanced around the event time.

⁵⁶Figure H.1 displays event studies for a reduction in the withholding rate, showing that a (larger) reduction in the rate leads to a (larger) reduction in reported tax liability.

8.2 Introduction of Withholding for the Corporate Income Tax

Another source of quasi-experimental variation in withholding in Costa Rica comes from the introduction of withholding for the corporate income tax in 2015. Starting with the first month of fiscal year 2015, card companies were required to withhold 2 percent of card sales as an advance tax remittance for the income tax.⁵⁷ Similar to the 2011 reform to sales tax withholding, the introduction of withholding for the income tax did not affect the government’s information set as all card transactions were already reported nor did it affect the statutory tax rates. Firms using a card machine prior to 2015 were affected by the reform, whereas firms that did not use a card machine prior to the reform are unaffected and hence serve as a control group. We conduct a difference-in-differences estimation of firm behavior around the time of the reform in a balanced panel of firms that we can observe between 2011 and 2016. We divide the treatment group into firms that had misreported in one of the previous years (i.e. had reported sales lower than third-party reported sales at least once), and firms that had not misreported (labeled “compliers”). The estimation follows equation 10 (with the t referring to years). The outcome of interest in this estimation is the reported tax liability for the income tax.

Panel A2 of Figure 5 shows that treatment and control firms are on parallel trends between 2011 and 2014, and that the treatment group diverges after the introduction of income tax withholding. This divergence is statically significant among both compliers and misreporters, but quantitatively larger among misreporters, who exhibit a 25 percent increase in their reported tax liability after the reform. The larger response among misreporters is consistent with the idea that a change in enforcement perceptions drives the change in compliance behavior.

8.3 Enforcement Environment

In addition to concerns about the particular reform we study, one may be concerned that the Costa Rican context exhibits features which would lend withholding an outsized impact. For instance, in a context where audit rates are low, third-party information reporting may have little bite, as taxpayers would assume that audits based on cross-checks between third-party reports and self-reports are unlikely. A similar result may hold true if audits are not based on risk assessment or cross-checks, regardless of the

⁵⁷This is in addition to pre-existing withholding on card sales for the purpose of sales tax compliance.

audit rate. However, as Figure 5, panel B shows, audit rates in Costa Rica are in line with the average for countries at a similar level of per capita income. Section II.C. in Brockmeyer et al. (2019) shows that the Costa Rican tax authority conducts a variety of enforcement interventions, from phone calls to taxpayers with discrepancies between self-reports and third-party reports to comprehensive audits, most of which are targeted using cross-checks and risk criteria.

These results support the external validity of our study, not only in terms of its main finding – that withholding increases tax compliance – but also in terms of a key mechanism to which we ascribe the positive impact of tax withholding – the fact that withholding leads to an increase in reported tax liabilities.

9 Conclusion

This paper has studied the compliance impact of tax withholding, exploiting quasi-exogenous variation in withholding on firms' sales in Costa Rica. We show that doubling the withholding rate applied by credit-card companies increases sales tax remittances by 32 percent among treated firms and by 8 percent overall, although the government's information set and the statutory tax rates remain constant. The treatment effect is driven by the incomplete reclaiming of withheld taxes and by an increase in the reported tax liability. We interpret our results on the impact channels of withholding as evidence that withholding is a distinct compliance mechanism, which, unlike traditional enforcement and third-party reporting mechanisms, does not attempt to elicit taxpayers' true income, but instead establishes a default tax remittance at source. The revenue-raising property of withholding explains why withholding schemes for firms are a key feature of tax systems in lower-income countries and in low-compliance sectors.

Under most reasonable assumptions on the cost of evasion, our empirical estimates imply that the maximum withholding rate in Costa Rica is currently below the welfare-maximizing one. In our model, the elasticity of the tax liability to the withholding rate is key in determining the optimal withholding rate, as this elasticity captures the combination of the positive effect of withholding on compliance and the potential negative effect of withholding on firm production and output. However, our model is agnostic about the specific mechanism through which withholding distort firms' decisions.

Fruitful avenues for future research include modeling and empirically examining the channels through which withholding can distort production, e.g. by shifting administrative costs from the tax authority to the withholding agent and the taxpayer, by transferring liquidity from the taxpayer to the government, and by increasing effective tax rates, particularly for small and liquidity-constrained firms. Analyzing the spillover effects of withholding on firms along the supply chain and on competitor firms in the same sector or location is also worthwhile. This would allow decomposing the aggregate revenue impact of withholding into the direct effect on treated firms and the potential indirect effects.

Finally, investigating the choice of withholding agents would be relevant. In addition to state institutions and credit-card companies, governments may consider using other financial institutions and large firms as withholding agents. In doing so, they face a trade-off between improving compliance and increasing administrative costs for both the government and the withholding agents. These costs are likely to be smallest for firms that are already subject to increased government monitoring and have sophisticated accounting departments. It would also be interesting to study under which conditions governments should provide monetary or non-monetary incentives to withholding agents.

Tables

TABLE 1: REFORM OF THE WITHHOLDING RATE SCHEDULE

	Withholding Rate						
	0	1	2	3	4	5	6
Before 08/2011: Value-Added Rate \leq	5	20	30	40	55	75	∞
Since 08/2011: Share of Domestic Sales \leq	0	-	-	50	-	-	100

Notes: This table shows the withholding rate which credit-card companies apply to the card sales of firms using a credit/debt card machine. The tax withheld is considered a quasi advance payment of the sales tax. Prior to August 2011, the average withholding rate was determined by a notched schedule on the withholder's value-added rate, with notches at value-added rates of 5, 20, 30, 40, 55 and 75 percent, and resulting withholding rates of 0, 1, 2, 3, 4, 5 and 6 percent. Since August 2011, the schedule has been consolidated to three withholding rates of 0, 3 and 6 percent. The rates are determined by a notched schedule on the share of domestic (i.e. non-export) sales, with a notch at 50 percent. A firm's value-added rate and share of domestic sales are calculated based on its sales tax declarations in semester $t - 2$, as an average across months in the semester. This table is discussed in Section 3.2.

TABLE 2: SUMMARY STATISTICS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	All Firms (2010)					Treatment Group (2010)				
	Turnover	Profit Rate	% Corpo- ration	% w/ Card Machine	% s.t. Withhold- ing	Turnover	Profit Rate	% Corpo- ration	% w/ Card Machine	% s.t. Withhold- ing
Panel 1: All Sales Tax Filers										
Mean	261.6	10.4	55.8	26.7	20.8	.	.	.	.	.
SD	1231.4	91.8	49.7	44.3	40.6	.	.	.	.	.
P50	19.4	3.2	.	.	.	.	.	.	.	.
N	67734	56646	59566	67734	67734	.	.	.	.	.
Panel 2: Main Analysis Sample: Sales Tax Filers Using Card Machine, Regular Filers										
Mean	689.7	4.6	68.3	100	82.1	651.9	4.5	63.7	100	77.6
SD	1930.8	18.2	46.5	0	38.3	1805.6	15.5	48.1	0	41.7
P50	144.6	2.2	.	.	.	144.3	2.2	.	.	.
N	7131	7088	7129	7131	7131	5315	5283	5313	5315	5315
Panel 3: Extended Analysis Sample A: Including Irregular Filers										
Mean	597.6	4.6	67.5	100	81.9	575.2	4.5	63	100	77.3
SD	1762.3	17.2	46.9	0	38.5	1666.4	15	48.3	0	41.9
P50	129.3	2.2	.	.	.	130.8	2.1	.	.	.
N	9163	9095	9152	9163	9163	6852	6798	6842	6852	6852
Panel 4: Extended Analysis Sample B: Including Firms Without Card Machine										
Mean	436.5	8.8	59	33.7	27	604.3	4.8	61.9	94.7	72.1
SD	1631.5	63.4	49.2	47.3	44.4	1729.6	16.3	48.6	22.3	44.8
P50	46	3.1	.	.	.	128.9	2.2	.	.	.
N	27452	25194	27411	27452	27452	6239	6185	6236	6239	6239
Panel 5: All Income Tax Filers (2011)										
Mean	77.5	32.9	40.5	7.2	0	.	.	.	.	.
SD	607.9	33.5	49.1	25.9	0	.	.	.	.	.
P50	4	20	.	.	.	.	.	.	.	.
N	380789	266674	348959	390543	390543	.	.	.	.	.
Panel 6: Secondary Analysis Sample: Regular Income Tax Filers Around Withholding Introduction (2011)										
Mean	73.4	30.2	36.7	5.6	5.6	76.3	23.7	33.9	100	100
SD	427	31.2	48.2	22.9	22.9	314.9	24.3	47.4	0	0
P50	8	18.2	.	.	.	15.9	16.8	.	.	.
N	104592	84316	104104	104592	104592	5814	5423	5809	5814	5814

Notes: The variables are from the 2010 income tax declaration (2011 for panels 5 and 6). We use the income tax declarations rather than the sales tax declarations as the former measures the profit rate and almost all sales tax filers also file income tax but not vice-versa. Turnover is in 2015 constant CRC millions, profit rate in percent. Turnover and the profit rate were winsorized at the 99.99th percentile. The samples are defined as follows: (1) all sales tax filers; (2) sales tax filers in the main analysis sample, i.e. firms that had a card machine at the beginning of 2010 and file regularly during 2010-2013; (3) firms that had a card machine at the beginning of 2010 and file at least once per semester during 2010-2013; (4) firms that file at least once per semester during 2010-2013; (5) all income tax filers in 2011; (6) analysis sample for the study of income tax withholding: firms that filed every year during 2011-2016. This table is discussed in Section 3.3.

TABLE 3: THE IMPACT OF WITHHOLDING

	Fully-Balanced Panel			Semesterly-Balanced Panel		
	(1)	(2)	(3)	(4)	(5)	(6)
	Trimmed 99.9th pctile	Trimmed 99th pctile	Trimmed 95th pctile	Trimmed 99.9th pctile	Trimmed 99th pctile	Trimmed 95th pctile
Total Sales Reported	0.0420* (0.0247)	-0.0236 (0.0172)	-0.00670 (0.0159)	0.0184 (0.0233)	-0.00254 (0.0153)	0.00645 (0.0135)
Sales Tax Collected	0.0402 (0.0278)	-0.00451 (0.0178)	-0.00438 (0.0162)	0.0202 (0.0268)	0.0156 (0.0152)	-0.000917 (0.0152)
Input Tax Credits	-0.0197 (0.0374)	-0.112*** (0.0255)	-0.107*** (0.0187)	-0.0443 (0.0378)	-0.0883*** (0.0215)	-0.101*** (0.0178)
- Import Credits	-0.0282 (0.0618)	-0.0480 (0.0463)	-0.0859** (0.0414)	-0.0658 (0.0656)	-0.0379 (0.0428)	-0.0916** (0.0446)
- Local Purchase Credits	0.00164 (0.0387)	-0.133*** (0.0342)	-0.0884*** (0.0235)	-0.0102 (0.0386)	-0.110*** (0.0318)	-0.0847*** (0.0199)
Gross Tax Liability	0.153*** (0.0337)	0.211*** (0.0294)	0.291*** (0.0275)	0.147*** (0.0319)	0.251*** (0.0247)	0.294*** (0.0257)
Withholding Base	0.0305 (0.0281)	-0.0213 (0.0274)	0.00274 (0.0184)	0.0269 (0.0263)	0.0153 (0.0160)	0.00924 (0.0164)
Withheld Tax	0.721*** (0.0760)	0.723*** (0.0672)	0.828*** (0.0379)	0.762*** (0.0673)	0.807*** (0.0353)	0.786*** (0.0318)
Withheld Tax Reclaims	0.637*** (0.0738)	0.664*** (0.0628)	0.786*** (0.0408)	0.664*** (0.0708)	0.735*** (0.0368)	0.758*** (0.0349)
Compensation Requests	0.622*** (0.221)	0.582*** (0.221)	0.208 (0.175)	0.528*** (0.195)	0.536*** (0.195)	0.305** (0.136)
Final Tax To Remit	-0.0912** (0.0440)	-0.00791 (0.0411)	0.113*** (0.0347)	-0.0855* (0.0442)	0.0257 (0.0361)	0.0878*** (0.0309)
Taxpayer Sales Tax Remittance	-0.0719* (0.0421)	0.0203 (0.0358)	0.119*** (0.0312)	-0.0698* (0.0419)	0.0537* (0.0314)	0.0903*** (0.0277)
Total Sales Tax Remittance	0.270*** (0.0315)	0.316*** (0.0321)	0.428*** (0.0247)	0.272*** (0.0317)	0.369*** (0.0237)	0.418*** (0.0220)
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
CharacteristicsXmonth FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	257,796	252,648	235,944	332,100	325,764	303,300

Notes: This table displays DiD estimates of the impact of the (predicted) withholding-rate increase, as per equation 10. Each cell represents the point estimate (semi-elasticity) on the treatment dummy, indicating firms with a predicted rate increase at reform time. The rows reflect different outcome variables corresponding to the main line items on the sales tax return. Taxpayer remittance is the remittance made by the taxpayer at the end of each month. Total remittance is the sum of taxpayer remittance and any tax withheld. The estimates are based on the Poisson Pseudo Maximum Likelihood Estimator (PPML, see Appendix A). All estimations allow for firm fixed effects and for month fixed effects interacted with firm characteristics (sector, deciles of card usage at the beginning of the period), and standard errors are clustered at the firm level. Columns 1-3 and 4-6 correspond to estimations on a fully balanced panel (firms filing every month during 2010-2012), and on a semesterly balanced panel (firms filing at least once per semester during 2010-2012), respectively. To reduce the effect of outliers while maintaining the internal consistency of the tax declaration, we trim rather than topcode outliers, at the 99.9th, 99th or 95th percentile in the distribution of reported sales (as indicated in the column headings). This table is discussed in Sections 5.2 and 6.

TABLE 4: ROBUSTNESS OF WITHHOLDING IMPACT

	(1)	(2)	(3)	(4)	(5)
	Baseline: Three-year Panel Fully Balanced	One-Year Panel Fully Balanced	Five-Year Panel Semesterly Balanced	Three-Year Panel Fully Balanced Pre-Reform	Baseline With Larger Control Group
Baseline: Firm FE + Month FE					
+ CharacteristicsXMonth FE	0.316 (0.0321) ^{***} [0.0495] ^{***}	0.318 (0.0346) ^{***} [0.0626] ^{***}	0.340 (0.0311) ^{***} [0.0502] ^{***}	0.322 (0.0306) ^{***} [0.0449] ^{***}	0.376 (0.0246) ^{***} [0.0593] ^{***}
Firm FE + Month FE					
Only	0.324 (0.0264) ^{***} [0.0481] ^{***}	0.399 (0.0284) ^{***} [0.0753] ^{***}	0.332 (0.0245) ^{***} [0.0356] ^{***}	0.320 (0.0249) ^{***} [0.0383] ^{***}	0.304 (0.0213) ^{***} [0.0414] ^{***}
Firm FE + Month FE					
+ Treatment-Group-Specific					
Christmas Fixed Effects	0.311 (0.0259) ^{***} [0.0481] ^{***}	0.387 (0.0283) ^{***} [0.0753] ^{***}	0.321 (0.0243) ^{***} [0.0356] ^{***}	0.308 (0.0245) ^{***} [0.0383] ^{***}	0.286 (0.0209) ^{***} [0.0414] ^{***}
Baseline					
Dropping Months					
Dec and Jan	0.301 (0.0318) ^{***} [0.0495] ^{***}	0.330 (0.0325) ^{***} [0.0626] ^{***}	0.325 (0.0323) ^{***} [0.0502] ^{***}	0.311 (0.0302) ^{***} [0.0449] ^{***}	0.366 (0.0258) ^{***} [0.0593] ^{***}
Month FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	210,540	103,690	313,752	246,647	786,960

Notes: This table presents PPML DiD estimates of the effect of the withholding-rate change on total tax remittance. The benchmark estimates displayed in column 1 row 1 use our preferred specification from the main DiD results Table 3. The columns vary the length and balancing of the panel used for estimation, and the size of the control group. Column 5 uses both firms that experienced no rate change and firms that did not use a credit card machine at the time of the reform as control group. The rows vary in terms of how time effects are controlled for. In all estimations in this table, the data is trimmed at the 99th percentile of total sales.

TABLE 5: HETEROGENEITY OF WITHHOLDING IMPACT

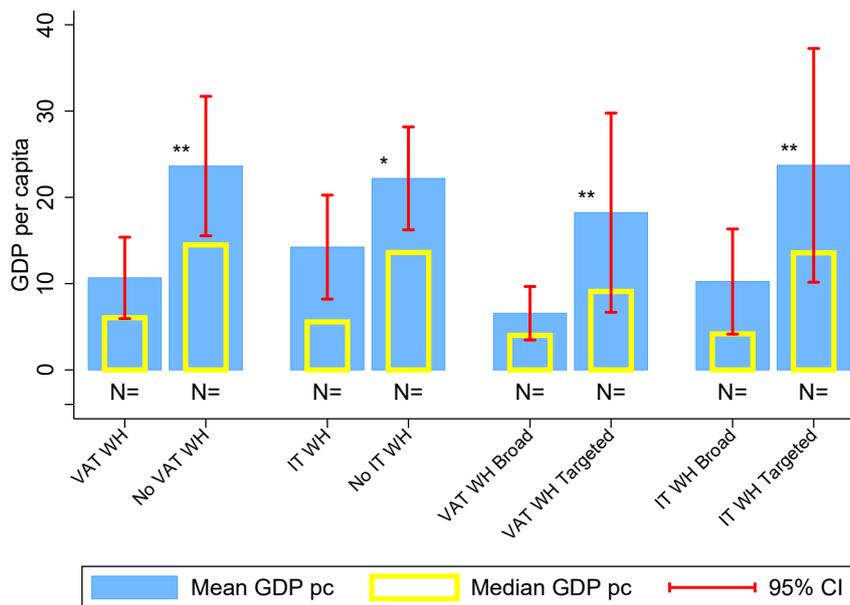
	Outcome: Reported Gross Tax Liability								
	Evidence for Enforcement Perception Mechanism					No Evidence for Liquidity Mechanism			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated (Withholding Rate Increase)	0.211*** (0.0294)	0.185*** (0.0306)	0.158*** (0.0314)	0.176*** (0.0287)	0.123 (0.0763)	-0.0319 (0.0769)	0.196*** (0.0345)	0.205*** (0.0312)	-0.0328 (0.0882)
Treated X Below Median Turnover		0.292*** (0.0407)				0.248*** (0.0512)			0.257*** (0.0518)
Treated X Misreporter			0.184*** (0.0531)			0.148** (0.0580)			0.161*** (0.0555)
Treated X First-Time Withholdee				0.681*** (0.211)		0.671*** (0.218)			0.644*** (0.218)
Treated X Reclaimer					0.0933 (0.0755)	0.154** (0.0701)			0.154** (0.0721)
Treated X Below Median Profitability							0.0292 (0.0381)		0.0288 (0.0354)
Treated X Buncher								0.0214 (0.0479)	-0.0619 (0.0482)
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CharacteristicsXMonth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	245,848	245,848	245,848	245,848	245,848	245,848	240,033	245,848	240,033

Notes: This table displays PPML DiD estimates of the impact of the withholding-rate increase on firms' reported gross tax liability, as per equation 10. The specification is identical to the one used in Table 3, column 2. In addition to the treatment dummy, columns 2-9 control for interactions between the treatment dummy and various firm characteristics. Misreporters are firms that declared sales less than third-party reports at least once prior to 2011. First-time withholdees are firms for whom the treatment (withholding-rate increase) was an increase from zero to a non-zero rate. We drop firms that experience the maximum withholding-rate increase of six percentage points, to ensure that the average rate increase among first-time withholdees is not larger than the average rate increase among other treated firms. Reclaimers are firms that reclaim (part of) the tax withheld on their tax return. Bunchers are firms that report a gross tax liability within a 5 percent margin of the amount of tax withheld. Table G.1 shows the same analysis when including also firms which do not use a card machine in the control group to maximize power. This table is discussed in Section 6.

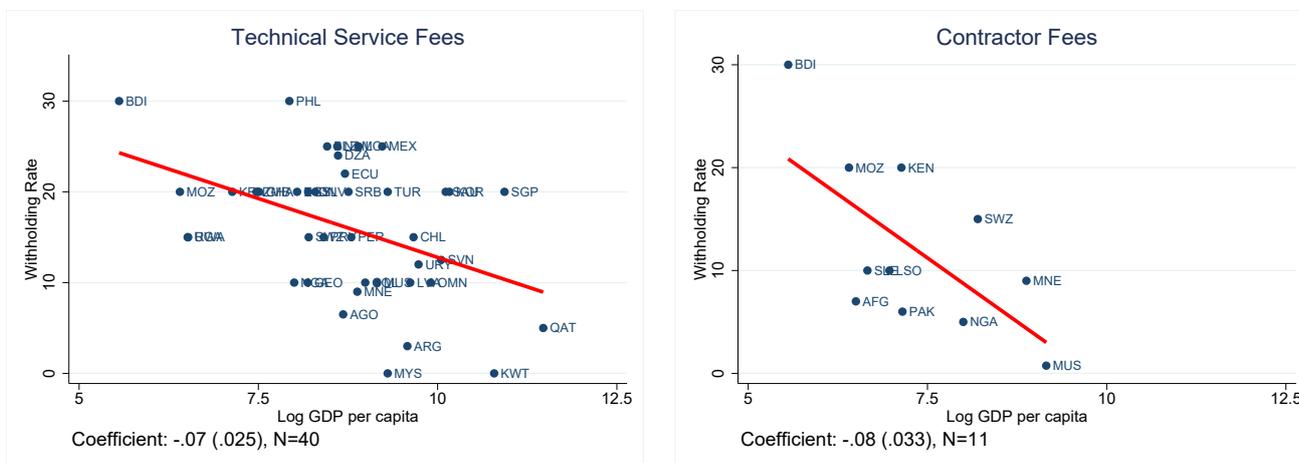
Figures

FIGURE 1: WITHHOLDING SYSTEMS AND DEVELOPMENT

A: Withholding Bases



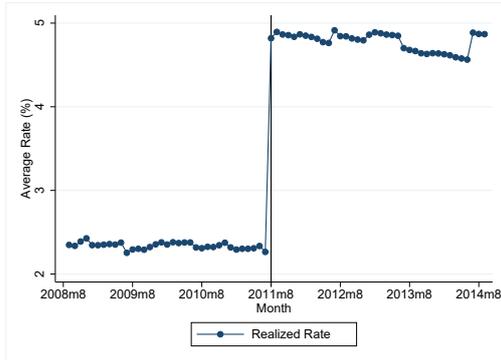
B: Withholding Rates



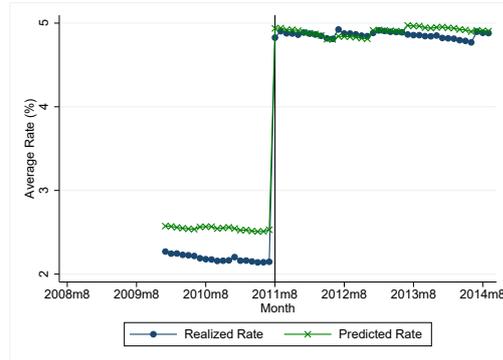
Notes: This figure shows that tax withholding on firms is widespread, and that the use of withholding, the breadth of withholding bases and the level of withholding rates are all negatively correlated with GDP per capita. Panel A displays the mean/median GDP per capita (in thousands of 2013 USD, WDI) for different subsamples of countries. The number below each bar displays the sample size. The stars reflect the significance levels of the mean difference between two adjacent bars: countries that use and do not use withholding on the VAT/sales tax; countries that use and do not use withholding on income taxes for firms; countries that use a broad withholding regime (that applies across sectors), and those that use a targeted withholding regime, applicable only to certain sectors (e.g. construction, fishing). The analysis is based on a sample of 118 countries for which data was available from the [PKF International Worldwide Tax Guide 2015](#), recent [EY International Tax Alerts](#), [PWC Tax Summaries](#), or the secondary sources referenced in the introduction. Panel B displays the correlation between log GDP per capita and the withholding rate, for withholding on technical services fees and on contractor fees, collected from the [PKF International Worldwide Tax Guide 2015](#). This figure is discussed in Section 1.

FIGURE 2: THE WITHHOLDING RATE REFORM

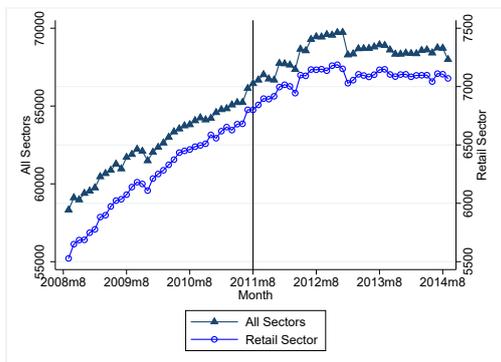
A: Withholding Rate (Full Sample)



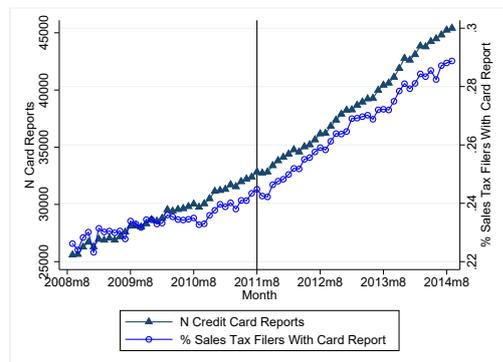
B: Withholding Rate (Prediction Sample)



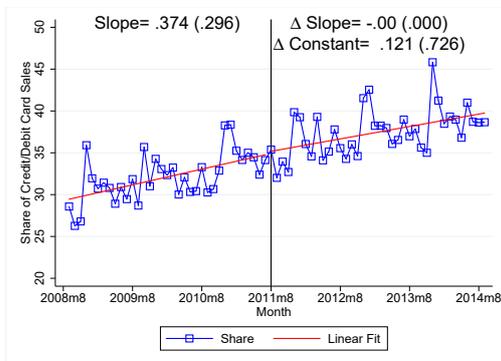
C: Number of Tax Filers



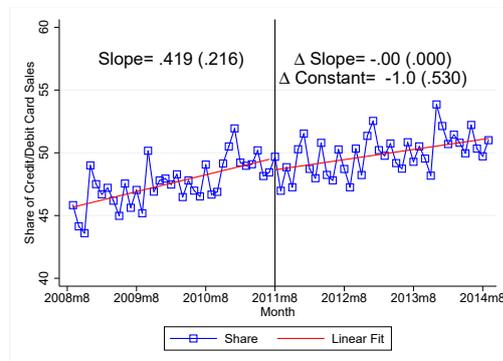
D: Number of Credit Card Reports



E: Total Share of Card Sales



F: Average Share of Card Sales



Notes: This figure displays the first stage of the withholding-rate reform and analyzes the reform's effect on sales tax filing and credit/debit card use. Panel A shows the average realized withholding rate among all firms subject to withholding. Panel B shows the average realized and predicted withholding rate among firms for whom we can predict the withholding rate based on previous semester's tax returns and the withholding-rate schedule in Table 1. Panel C shows the number of sales tax declarations for all firms, and for the retail sector which has the highest rate of card machine usage and is thus most susceptible to be treated by the reform. The number of sales tax declarations corrects for revisions and duplicates. Panel D shows the number of firms using a credit/debit card machine (as per the third-party reports received by the government), and the share of sales tax filers that use a credit/debit card machine. Panel E shows the share of card sales in total sales among firms with a credit/debit-card machine, and panel F shows the average over the firm-specific shares of card sales among firms with a credit/debit-card machine. The black solid line in all panels marks 08/2011, when the increase in the withholding rate for the sales tax entered into effect. Panel E and F show a linear fit that allows for a different trend and constant after the reform. The text displays the pre-reform slope of the linear fit, and the change in slope and constant after the reform, along with standard errors in parentheses. This figure is discussed in Section 4.1.

FIGURE 3: THE IMPACT OF WITHHOLDING

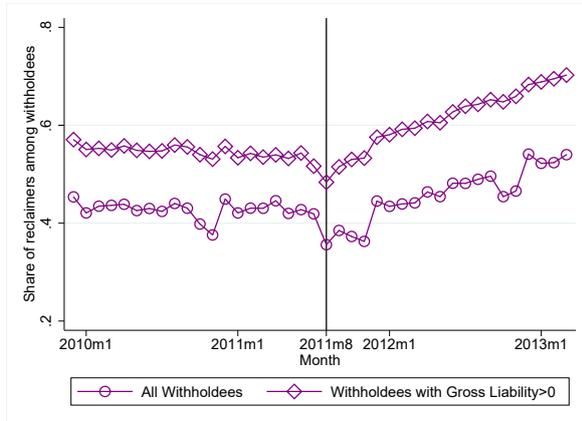


Notes: Panel A shows the evolution of total sales tax remittance in the DiD treatment and control group, as well as the DiD estimate from Equation 10. The black solid line marks 08/2011, when the increase in withholding rates entered into effect. The data is trimmed at the 99th percentile of total sales, and scaled by the pre-reform average. Panel B shows the event-study version of the Panel A, using the same controls variables and fixed effects as in Equation 10. The bottom panels show the reform's impact on aggregate sales tax revenue (panel c), and on aggregate revenue from the quarterly simplified regime tax, as a counterfactual (panel D). The sales tax data is based on official revenue statistics from the Ministry of Finance, net of the sum of refunds made by the tax authority to taxpayers who were subject to withholding in excess of their liability, and the simplified regime data is based on firm-level tax declarations. For panel B, semesters are defined to fit exactly around the time of the reform, so the first semester of each year includes February to July, and the second semester includes August to December, and January of the following year. The results are robust to running the analysis on monthly or quarterly data, using shorter or longer time series, and adding controls for the months of December and January (in the monthly data). This figure is discussed in Section 5.1.

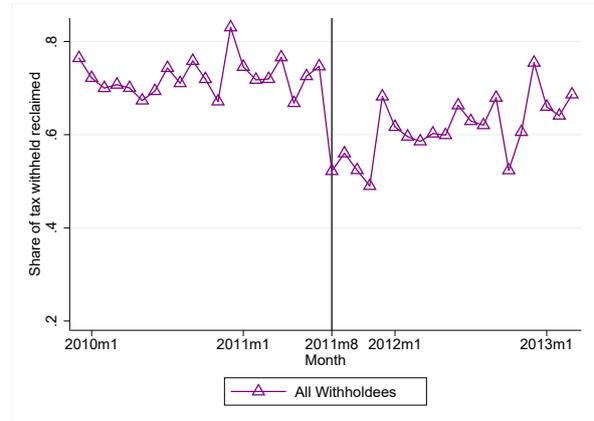
FIGURE 4: MECHANISMS OF WITHHOLDING IMPACT

A: Default Mechanism - Incomplete Reclaim of Withheld Tax

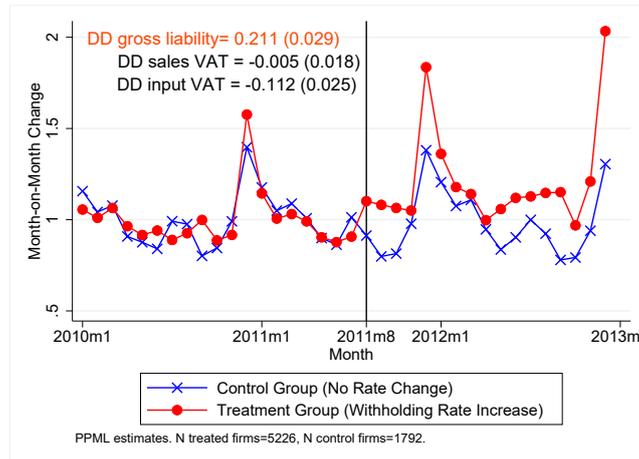
A1: Share of Reclaimers



A2: Share of Withheld Tax Reclaimed

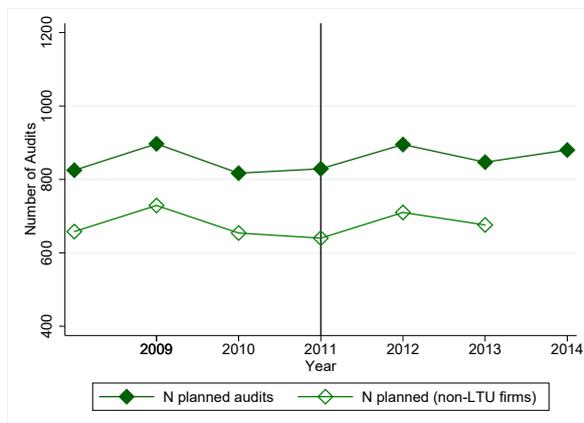


B: Enforcement-Perceptions Mechanism - Increase in Reported Tax Liability

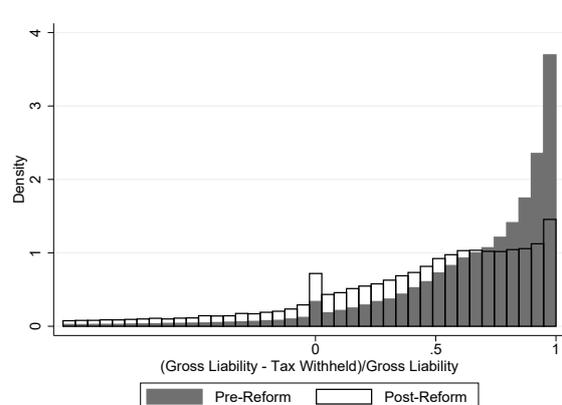


C: Ruling Out Alternative Explanations

C1: No Change in Audit Rates



C2: Little Bunching in Gross Tax Liability

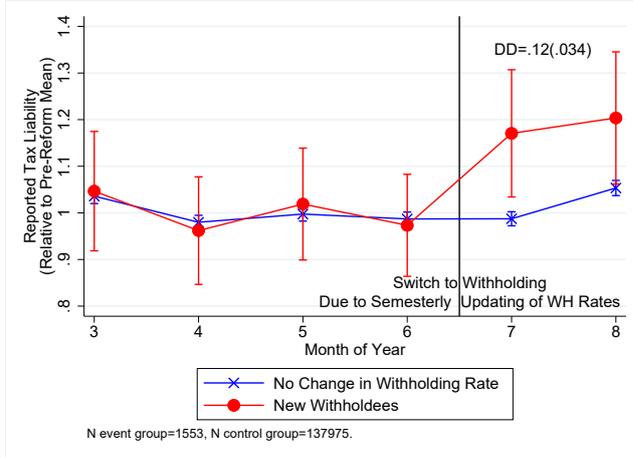


Notes: This figure illustrates the mechanisms for the withholding-rate impact. In all panels, the black solid line marks 08/2011, when the increase in withholding rates entered into effect. Panels A and B display, for all firms subject to withholding in a given month, the share of firms making a reclaim, and the average share of withheld tax reclaimed respectively. Panel B shows results of the difference-in-differences estimation of Equation 10, on gross liability. The Panel is constructed as Panel A in Figure 3. Panel C1 shows the evolution over time of the number of planned audits for all taxpayers and for taxpayers who are part of the large taxpayer unit, as per the annual work programs of the audit department. Panel C2 shows the distribution of the deviation of reported gross liability from the amount of tax withheld, before and after the reform, for the balanced panel underlying all difference-in-differences estimation. This figure is discussed in Section 6.

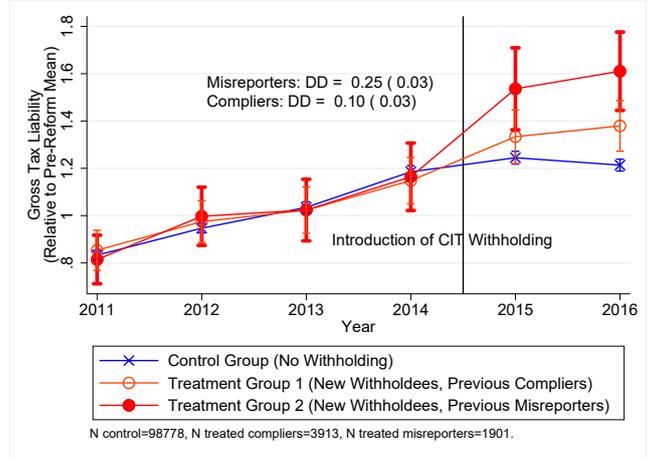
FIGURE 5: EXTERNAL VALIDITY

A: Impact of Other Withholding Schemes in Costa Rica

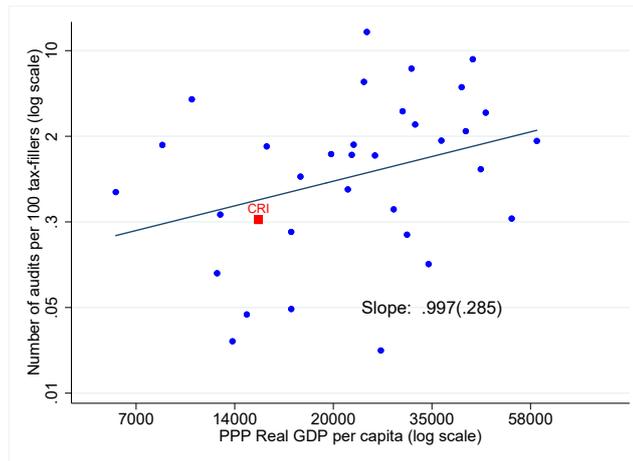
A1: Event Study of Sales Tax Withholding



A2: Introduction of Income Tax Withholding



B: Audit Rates Across Countries



Notes: Panel A1 displays an event study of the application of sales tax withholding to the self-employed, where the event group experiences an increase in the withholding rate from zero to positive in July, due to the biannual updating of withholding rates. Both groups are subject to credit card reporting prior to the reform. The outcome is the reported tax liability. Panel A2 displays a difference-in-differences study of the introduction of credit-card withholding for the income tax, where the treated group are firms which had a credit-card machine prior to 2015. Mis-reporters are firms which reported sales lower than third-party reported sales prior to 2015. The outcome variable is the reported tax liability. Panel B plots the number of comprehensive audits completed per 100 expected CIT filers, using data.rafit.org. The construction of all graphs is described in more detail in Appendix H. This figure is discussed in Section 8.

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