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How to Best Nudge Taxpayers? The Impact of a Tailored Letter Experiment in Eswatini

Fabrizio Santoro, Edward Groening, Winnie Mdluli and Mbongeni Shongwe

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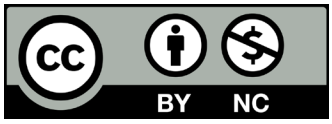

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Summary

Very little is known about why taxpayers in sub-Saharan Africa (SSA) remit their taxes. In collaboration with the Eswatini Revenue Authority (SRA), this study implements a nationwide randomised controlled trial nudging more than 20,000 income tax payers with behaviourally-informed mailings. This study attempts to shed new light on the drivers of SSA taxpayers' compliance, and how can these be leveraged by resource-constrained tax authorities. While the tax nudge literature has boomed in OECD countries and Latin America, only a handful of studies can be found on SSA – this paper contributes significantly to these. First, thanks to the wealth of administrative data available, this study is the first of its kind to target three different categories of taxpayers at the same time – non-filers, nil-filers and active; most of the existing literature focusses on positive filers. Second, we tailor the content of letters to be specific to each taxpayer category. Third, we are able to target both companies and individuals, and explore heterogeneity of results along a number of dimensions, including past filing behaviour. We find that non-filers significantly respond to the nudges, while nil- and active filers do not. The best performing nudges build on the deterrence and taxpayer-assistance paradigms. Perverse responses are found from large companies. With the causal evidence produced, we are able to formulate policy recommendations on how best to target the complex ecosystem of income tax payers.

Keywords: taxpayer compliance; tax administration; tax nudges; administrative data.

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Acronyms

CIT	Corporate income tax
HIC	High-income country
IHS	Inverse hyperbolic sine
ITT	Intention-to-treat
LATE	Local average treatment effect
LPM	Linear probability model
PIT	Personal income tax
pp	Percentage points
RCT	Randomised controlled trial
SDG	Sustainable development goal
SRA	Eswatini Revenue Authority
SSA	Sub-Saharan Africa
TIN	Taxpayer identification number

1 Introduction

As one of the Sustainable Development Goals (SDGs), domestic revenue mobilisation is a fundamental objective of revenue authorities in low- and middle-income countries.[1] While revenue authorities in sub-Saharan Africa (SSA) are progressively increasing tax collection with respect to other low-income countries (Moore et al. 2018), the tax-to-GDP ratio has risen by only 2 to 3 percentage points of GDP in the past two decades (Akitoby et al. 2019). As one of the key challenges to revenue collection, taxpayer compliance is far from being optimal. Some simple statistics clearly reflect the gravity of the problem. In Eswatini, the country under study, every year about half of income tax payers fail to file (non-filers); among those that lodge a return, about a quarter report zero income and zero tax (nil-filers). In addition, taxpayers are quite persistent over time in their filing behaviour. For example, since their registration with the authority, 18 per cent and 10 per cent of registered taxpayers in Eswatini either never filed or perpetually filed nil, respectively. These figures are economically relevant, given that income taxes represented 35 per cent of total tax revenue in 2018 (ICTD/UNU-WIDER 2020) Similarly alarming figures are found in other SSA countries, like Rwanda, Uganda, Malawi, Ethiopia and Nigeria (see section 3). Non- and nil-filing (as long as the latter entails evasion) have detrimental repercussions on domestic revenue mobilisation, and pose immediate challenges to already budget-constrained revenue administrations. At the same time, active filers can be under-declaring their liabilities. The negative consequences of these filing decisions ultimately create economic inefficiencies and horizontal inequality. More broadly, when tax evasion is involved, these decisions generate unfairness, lower the moral fibre of a society, and eventually delegitimise the government.

Revenue authorities usually implement traditional enforcement strategies, such as audits and fines, to enhance revenue collection.[2] These strategies are costly, especially for revenue authorities in SSA who are historically constrained by limited budget and enforcement capacity (Besley and Persson 2013; Pomeranz and Vila-Belda 2019). In a context in which State legitimacy is already low, as in SSA (Isbell 2017), a deterrence-based compliance strategy may be detrimental – it could reinforce distrust and taxpayer resistance (Fjeldstad and Semboja 2001), and delegitimise the revenue administration even more. For these reasons, it has been argued that the optimal mix of tax instruments can diverge from what traditional public finance theory prescribes when tax capacity and State legitimacy are limited (Best et al. 2015). More flexible and potentially highly cost-effective interventions, such as tax nudges, can represent a feasible alternative to foster voluntary compliance.[3] Tax nudges are behaviourally-informed tax compliance interventions that respect the taxpayer's freedom of choice and leave economic incentives intact, while attempting to improve taxpayers' behaviour. Tax nudges, by building on the theoretical formulations of behavioural economics, also represent a theory-grounded tool to shed light on the pecuniary and non-pecuniary factors driving compliance, and promptly suggest which of them governments can prime for revenue mobilisation. While tax nudges have been implemented in high-income countries for decades, limited evidence has been produced from low- and middle-income countries – and even less from SSA (see section 2). It is likely that the drivers of voluntary compliance are different in SSA for a number of reasons, ranging from limited taxation capacity of revenue bodies (Mascagni 2018; Moore et al. 2018), to the low level and quality of public services (D'Arcy 2011; Bodea and Lebas 2016; Blimpo et al. 2018); from distrust in State processes and tax officials (Bratton and Gyimah-Boadi 2016; Isbell 2017), to poor knowledge of the tax

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1 According to the International Monetary Fund (IMF), on average SSA will need additional resources amounting to 19% of GDP to finance the SDGs in education, health, roads, electricity and water by 2030 (IMF 2019).

2 Additional, more sophisticated enforcement strategies, which are less likely to be implemented in revenue authorities with lower than optimal administrative capacity, refer to third-party information reporting, changes in the remittance regime, shaming through public disclosure, and take-up of benefits.

3 Thaler and Sunstein (2008: 6) define nudges as 'choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives'.

system (Fjeldstad et al. 2012; Aiko and Logan 2014; Isbell 2017; Mascagni et al. 2019). However, very little is known about why African taxpayers comply with or evade their taxes.

This study attempts to fill this gap in knowledge, and to answer the first-order question of which are the key drivers of compliance. This study stems from a close research collaboration with the Eswatini Revenue Authority (SRA), which provided access to a wealth of administrative data, assisted during the challenging implementation of the experiment, and fully embraced the goals of the study. We are thus able to provide robust evidence from a lower-middle-income country in SSA, Eswatini, which has not been studied before (see section 3). We attempt to address this question by implementing a nationwide randomised controlled trial (RCT) that sent behaviourally-informed experiment letters to more than 20,000 income tax payers. Tax compliance decisions of income tax payers are particularly interesting from both a theoretical and practical point of view – since their tax evasion is particularly difficult to uncover, given that they self-report their income and have an economic incentive to underreport to reduce their tax liabilities (Allingham and Sandmo 1972; Slemrod and Yitzhaki 2002; Sandmo 2005). This challenge becomes even more delicate for revenue mobilisation purposes, since income tax (net of PAYE) usually represents the second largest contributor, after VAT, to tax revenue both in Eswatini and SSA (ATAF 2017).

The second contribution of this paper is that, departing from existing evidence (see section 2), we tailor the content of letters to be specific to taxpayers' filing behaviour, considering three filing categories: non-filing – failure to file a return, nil-filing – filing a return with zero turnover, taxable income and tax liability, and positive filing, plus the additional category of income filers reporting divergent information on their VAT returns. The reasoning behind targeting is that, for instance, a nudge teaching how to file is more likely to benefit non-filers than the other two filing categories, who presumably already know how to lodge a return – so compliance cost nudges are only sent to non-filers. In the same fashion, the threat message displays only articles of tax law that apply to the specific filing category, to make the threat more salient and realistic. It is interesting to understand whether the same type of soft nudge, such as the one on fiscal reciprocity, has a different impact on different taxpayers, such as non-filers and active; or, as with non- and nil-filers, whether a more service-oriented communication about the steps for deregistering from the system (an option which in theory is optimal for both categories) spurs the same or different reactions. To the best of our knowledge, this is the first time these three filing categories have been targeted in the same study. By targeting these categories in the same RCT, we test different theoretical motivations for each filing behaviour, and present a broader, more complex picture of tax compliance than the existing literature, which mostly focusses on positive filers.[4] Given the negative repercussions that incomplete compliance has on revenue collection in SSA, both researchers and tax administrators from the African continent need to understand what drives different behaviour.

The experiment letters represent a simplified, one-page version of standard SRA communication, and differ only in terms of the key message printed in a box at the centre of the page, and the envelope colour – this is different from ordinary SRA mailings to make the letter more salient (BIT 2012). Thanks to the support of SRA officials and the national post office, mailing of letters was processed in three rounds six weeks before the staggered filing deadlines. Following a stratified randomisation algorithm, non-filers were randomly assigned to five different treatment arms – deterrence, assistance on filing, assistance on deregistering, reciprocity and social norms. The smaller group of nil-filers were allocated to deterrence, and assistance on deregistering, arms. Due to the small sample size of nil-filers, we needed to make a choice on which treatment arms to test. Aiming to be consistent with the little experimental evidence existing on nil-filers (Mascagni et al. 2020), we opted for deterrence and deregistration as the main possible drivers of behavioural change for nil-

[4] There are a few notable exceptions, summarised in section 2.

filers. Active taxpayers were nudged with deterrence and reciprocity messages, while taxpayers with VAT discrepancies were allocated to a deterrence letter highlighting the amount of the discrepancy.[5] For each category, a randomly created control group provided counterfactual outcomes. Consistently, we consider filing outcomes that are specific to each category, and study both the extensive (filing a return) and intensive (remitting a given tax amount) margin of compliance. A third contribution is given by the fact that, in addition to studying the extensive and intensive margins, we were able to target both companies and individuals and explore their different reactions to nudges, while most similar studies focus on either incorporated agents or individual traders (see section 2). Relatedly, thanks to the nationwide nature of the RCT, we were also able to explore the heterogeneity of results along different dimensions; some of these, such as previous filing behaviour, are poorly documented in the literature and highly policy-relevant.

Using detailed administrative data on anonymised income tax filing for tax year 2019, as well as VAT, PAYE and previous years' income tax filing, with the support of survey data from 1,000 sole traders collected in a parallel study (Santoro et al. 2020), we present four sets of results. First, the best performing treatments are those targeting non-filers. Compared to a very low filing rate in the control group (6.9%), which is suggestive of the persistent nature of non-filing over time, we find that filing rates increase the most – by 2.6 percentage points (pp) or a sizeable 38 per cent – when a deterrent tone is used. Similarly, more service-oriented nudges reducing the compliance costs of filing and providing information on deregistration, as well as moral appeals, boost the probability of filing by 1.3 pp or 20 per cent over the control group. Among the latter, the social norm nudge, despite referring to a rather low descriptive norm (66% filing rate from peers) significantly increases filing. These results are remarkably in line with what was found in a meta-analysis of tax compliance experiments run by Atinyan and Asatryan (2019), who find that deterrence nudges are more effective in improving filing rates that non-deterrence ones by an average of 1.5-2.5 percentage points.

In addition, thanks to the provision of letter delivery reports from the national post office, we are able to measure the actual treatment effect on the treated. When partial (45%) letter pick-up is taken into account, estimates of impact increase accordingly and keep their statistical significance, with (i) the deterrence letter doubling filing rates, (ii) the service-oriented arms increasing filing by 60 per cent, and (iii) the moral appeals improving filing by 156 per cent over the control group. These results may seem extremely large, but, as explained above, are to be compared with a very low control group average, meaning that the majority of nudged non-filers still persist in the same behaviour. Importantly, non-filers are also significantly filing more past returns. In terms of immediate revenue considerations, nudged non-filers are not remitting more tax than controls, even if individuals are actually paying more taxes. In line with similar findings discussed below, the nudge backfires for non-filing companies – who remit less tax. Tax remitted was not the main outcome for non-filers in our pre-specified plan, but we rather gave priority to the extent to which they become visible to the authority. Non-tangible benefits from increased filing are achieved, which go beyond quantifiable extra revenue.

Unfortunately the experiment letters do not encourage nil-filers to start filing positive tax, or active taxpayers to increase their liabilities. If anything, the fiscal exchange nudge actually backfires for active companies, who reduce their tax due. This could be due to the fact that, according to survey data gathered in Santoro et al. (2020), active taxpayers have a lower average satisfaction with six different public services than non-filers. However, it is worth mentioning that letters actually increase the probability of active taxpayers filing positive tax,

[5] The deterrence letters sent to different categories varied. Only the penalties and fines associated with the particular behaviour (e.g. failure to file or false statement) of the taxpayer in one category are made salient. More details in section 4.

and much more significantly for companies – suggesting that they particularly shape the response of those taxpayers who are about to turn to nil-filing.[6] Once nudged, potential nil-filing companies eventually file positive, even if they do not remit more tax compared to the control group.

This last piece of evidence connects with a second set of results, referring to significant differences in response between companies and individuals. For instance, non-filing companies are more likely to respond (41% increase) to the threat nudge than individuals (25%), who in turn react more when taught how to file. At the same time, individual non-filers are more likely to increase tax due, once filing, than companies – who actually decrease their liabilities. This evidence could suggest that companies are more likely to enjoy the service of tax accountants, and therefore the lack of tax knowledge is not a relevant constraint for them. To support this hypothesis, we provide additional evidence on the probability of filing on time, according to which individual taxpayers, not companies, are more likely to file on time when reminded about the deadline through the compliance costs nudge. Another explanation for this negative response from companies could be companies' dissatisfaction with a taxpayer service deemed of inadequate quality – a one-page to-do list – that would have increased the annoyance of the recipients and hence their negative reaction.[7]

Third, and relatedly, allowing for heterogeneity provides a more complex picture of taxpayer responses, making the argument for a more tailored enforcement strategy. We explore different dimensions, thanks to the wealth of administrative data available: (i) non-persistent filers – those taxpayers that are more unstable in their filing behaviour and shift between the three filing categories over time – are more likely to file and even increase their tax due with respect to chronic/persistent filers; (ii) newly-registered taxpayers are less likely to respond than older ones, probably due to the fact that a one-page letter is not adequately effective in shaping their filing decisions; (iii) rural taxpayers respond more to deterrent letters than softer-toned ones, which in turn perform better in urban settings; and (iv) business size also matters – the largest active taxpayers are more likely to reduce tax amounts when nudged.

Fourth, it is worth stressing that nudges can lead to a negative response. The fiscal exchange letter can back-fire, when active taxpayers significantly report more income, and at the same time increase expenses and deductions. This compensating response implies that the final tax due does not change, or even decreases. Similar responses have been observed in the literature (Ariel 2012; Carrillo et al. 2017; Slemrod et al. 2017; Mascagni and Nell 2020), and further attention should be devoted on how to avoid it. Despite poor impact at the intensive margin, the overall cost-benefit ratio of the trial is of 1:11, and extra revenue associated with the experiment amounts to US$0.2 million. As explained in section 7, the extra revenue comes mostly from current and past returns of non-filers, as well as extra positive tax raised from those active payers who are prevented from nil-filing.

The results of this study have both practical and theoretical relevance. At a practical level, we attempt to inform the SRA's, and other similar revenue administrations', communication and enforcement strategies with robust causal evidence and policy recommendations grounded in the local reality (see section 7). Following the *economists as plumbers* framework of Duflo (2017), this study builds on collaboration with local policymakers to evaluate specific details of actual policies, and highlights margins for policy improvement that diverge from textbook models of tax compliance. In doing so, we broaden the current understanding of both researchers and tax administrators on two widely under-researched taxpayer profiles – non- and nil-filers. As summarised in section 2, these two profiles are widespread in high-income countries (Erard et al. 2018; Meiselman 2018) and Latin America (Kettle et al. 2016;

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[6] As shown in Santoro and Mdluli (2019), nil-filing is more likely to take place among companies than individuals.

[7] An opposite explanation could be that non-filing companies in the control group mistakenly remit too much tax to the authority. However, it is not clear why this is not the case for control group individuals.

Brockmeyer et al. 2019), and have only recently been documented in SSA (Mascagni and Mengistu 2016; Almunia et al. 2017; Ligomeka 2019; Mascagni et al. 2020). Further practical considerations arise from the very low letter take-up of individual non-filers, who, when exposed to the treatment, are extremely responsive to the different nudges. They might need to be reached with alternative methods to mailings, such as SMS or phone calls – rigorous research on these other delivery methods will be needed to prove their efficiency.

At a theoretical level, we test empirically the validity of predictions on the drivers of compliance in a largely under-studied African country. The conceptual framework elaborated in Prichard et al. (2019) is directly tested in the field. According to this framework, the combination of three measures – enforcement, facilitation and trust – is the way to encourage quasi-voluntary compliance in developing countries, in addition to generating political support for reform and building stronger fiscal contracts. The results presented in this paper, albeit focusing only on tax compliance, show a mixed picture of the framework's effectiveness. While the neoclassical approach of Allingham and Sandmo (1972), based on pecuniary motives and deterrence, seems to work for non-filers and partially for active taxpayers (for the latter, on the probability of positive filing only), it is ineffective in increasing tax remitted by nil-filers and actives. At the same time, a service-oriented approach, originally formulated in Alm et al. (2010) and empirically tested mostly with lab experiments,[8] has a high impact, especially for individuals who arguably face larger costs than firms in dealing with the tax system. Lastly, recurring to non-pecuniary, trust-based motives to comply (Luttmer and Singhal 2014) improves compliance of non-filers, but backfires with active taxpayers. The latter effect is probably due to higher dissatisfaction of active taxpayers in how tax revenue is spent, as documented in a parallel survey study (Santoro et al. 2020), and questions the effectiveness of the fiscal exchange theory in contexts of misuse of public funds and inadequate quality of public services. Future avenues of research should continue testing the conceptual framework of compliance in similar developing settings.

The paper is organised as follows. Section 2 provides an overview of existing evidence on tax nudges from both developed and developing countries, with a focus on SSA. Section 3 describes the institutional context; the field experiment is addressed in detail in Section 4. Section 5 presents the results. Section 6 explores the mechanisms underlying the main results, and the final section concludes.

2 Tax nudges: what works and what does not?

2.1 Summary of the evidence from Western countries and Latin America

Natural field experiments on taxpayer communication first appeared in high-income countries (HICs). Apart from early applications (Schwartz and Orleans 1967), modern tax experiments build on the seminal work of Blumenthal et al. (2001) and Slemrod et al. (2001) in Minnesota, USA. The authors nudge as many as 60,000 individual taxpayers, and show both that the threat of audit increases compliance, even if only for small taxpayers, and that public service and descriptive norm letters have no effect. Soon after these initial trials, a large number of nudge experiments blossomed in Europe[9], Australia[10] and the USA[11]. Nudge interventions have become mainstream in HICs, thanks to the increased collaboration between researchers and revenue authorities, which granted access to their administrative data and

[8] See Alm et al. (1992), Kosonen and Ropponen (2015), Vossler and McKee (2017) and McKee et al. (2018). Field experiments are much less common. See Chetty and Saez (2013) and Mascagni et al. (2019).

[9] See Torgler (2004), Hasseldine et al. (2007), Kleven et al. (2011), Fellner et al. (2013), Bott et al. (2014), Hernandez et al. (2017) and De Neve et al. (2019)

[10] See Wenzel and Taylor (2004) and Biddle et al. (2017).

[11] See Chirico et al. (2016), Perez-Truglia and Troiano (2016) and Meiselman (2018).

invested a great amount of internal resources in implementation of the nudges.[12] Overall, with the exception of Ariel (2012), these studies show that enforcement is unambiguously effective in promoting compliance across different settings; the evidence from moral appeals and civic duty is rather inconclusive.[13] Reminders per se seem to be effective. The interested reader could see Hallsworth (2014) for a more complete review of experiments in HICs.

Tax nudges have been increasingly implemented outside HICs in the last decade, especially in Latin America. These studies make an important contribution to the literature. They both manipulate the message content in a novel way, and offer a more nuanced picture of nudges' effectiveness when implemented in a less optimal institutional context than in HICs. For instance, disclosing information on the level of compliance of the subject reference group has a large positive impact on compliance with property tax in Peru (Del Carpio 2014). In the same fashion, Kettle et al. (2016) run a large (43,387) nationwide RCT in Guatemala, targeting non-filing income tax payers with four different behaviourally-informed tax letters. The authors show that the best performing nudges are a deterrent message framing non-filing as a deliberate choice, and a social norms message. The latter surprisingly tripled tax receipts by referring to the (rather low) 64.5 per cent of taxpayers that had already paid this tax, and invited non-compliers to join the majority.[14] In other instances nudges do not boost compliance, but incentivise negative, albeit fully rational, responses. In Ecuador, Carrillo et al. (2017) emailed about 10,000 corporate income tax (CIT) payers on the extent of discrepancies in their income tax return with third-party sources. While most firms failed to respond, those who increased revenue also reported higher costs on less verifiable items of the tax returns, ending up in minimally increasing tax liability.

A number of interesting lessons emerge from Latin America, which are also likely to be valid in SSA.[15] First, it shows that deterrent nudges can have limited effect in low-enforcement environments, or work only in specific contexts. Revenue authorities in most lower- and middle-income countries have limited budget resources to dedicate to audits – with the risk of nudging taxpayers with threats that cannot be backed by credible enforcement (Carrillo et al. 2017). In others, the mere fact of being contacted by the tax authority in writing, regardless of the content, has a positive impact on compliance (Ortega and Sanguineti 2013). In-person visits – putting tax collectors in direct contact with taxpayers –are more effective, despite being costly (Ortega and Scartascini 2016). Furthermore, explicitly stating the amount of fines according to the tax code reinforces impact (Castro and Scartascini 2013).[16] Deterrent signals can act as a warning and exploit inconsistencies in utility maximisation, especially with small taxpayers. In Uruguay, Bergolo et al. (2019) show that the threat of audit generates fear and induces probability neglect (Sunstein 2003).[17] Second, impact can last over time, as shown by Kettle et al. (2016) in Guatemala and Brockmeyer et al. (2019) in Costa Rica, where credible enforcement emails increase tax payments two years after the trial.[18] Third, average effects may mask differences across individuals (Castro and

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12 In the most advanced settings, specific nudge units have been launched within institutions, such as the Behavioural Insights Team (BIT) in the UK and the White House's Social and Behavioral Science Team (SBST) in the USA. According to DellaVigna and Linos (2020), there are more than 200 such units globally.

13 A noteworthy exception is the Hallsworth et al. (2017) study on norms nudges, in which a sizeable impact on tax payments can be found.

14 The descriptive norm communicated in Kettle et al. (2016) is slightly lower than the one tested in this study (see section 4.2).

15 Outside Latin America, Chetty et al. (2014) nudged more than 23,000 VAT firms in Bangladesh with 8 different versions of letters, associated with different combinations of recognition cards, information disclosure to peer groups, and descriptive information on compliance levels (the social norm nudge in this study). They show how impact differs by the ex-ante compliance levels – an increase in tax payments of 17% in high-compliance clusters, and zero effect in low-compliance clusters – for those firms exposed to the possibility that information on their compliance could have been shared with their peers.

16 Both these aspects are tested in this trial as well, as discussed in section 4.2.

17 Loewenstein et al. (2001) elaborate that individuals experiencing fear react quickly, intuitively and sub-optimally, and thus neglect the underlying probabilities of a given event.

18 It is not clear why impact is sustained over the medium term in some specific contexts, while in the majority of cases nudges are short-lived. One possible explanation can be the extent of credibility associated with the

Scartascini 2013). Heterogeneous impacts are highly common in these studies, and dimensions such as past filing behaviour, income level and peer compliance rates tend to differently influence taxpayers' responses.

2.2 Tax nudges in sub-Saharan Africa

Despite having become the norm in Europe and North America, and being increasingly tested in Latin America, evidence on tax nudges from SSA is almost non-existent. So far only a handful of studies have rigorously tested tax nudges in the region and are worth mentioning.[19]

Shimeles et al. (2017) study the impact of letters delivered to 3,120 businesses in Addis Ababa, Ethiopia, on profit tax paid, testing both a threat and a persuasive nudge. While the threat emphasises the risk of being audited and the penalty regime, the persuasive letter is patriotic in tone and lists flagship projects funded by taxes, in much the same way as the fiscal exchange nudge in this study (see section 4.2). Increases in tax paid are large – 38 per cent for the threat and 32 per cent for the persuasion letter – and highly significant. One explanation for this high impact may be that letters are hand-delivered by tax officials, increasing taxpayers' perception of being on the agency's radar. However, hand-delivering letters can be expensive, and not feasible when the nudge strategy needs to be scaled up.

In another original field experiment run in Rwanda, Mascagni and Nell (2020) test the impact on tax due of different message contents (deterrence, fiscal exchange or reminder) and delivery methods (letter, email or SMS), for a total of nine treatments. The authors target 13,000 CIT and personal income tax (PIT) payers located in the capital city, Kigali. Results show that non-traditional channels of communication, such as SMS and email, are more effective than physical letters, while softer types of nudges – reminders and fiscal exchange – outperform deterrence. At the same time, smaller taxpayers are more responsive to a deterrent tone than larger ones.[20]

In a follow-up study, Mascagni et al. (2020) explicitly target about 7,000 income tax nil-filers by exploring two main reasons behind this important but understudied behaviour, much in line with this study: (i) tax evasion, which is tested with a threatening SMS, and (ii) the need to deregister from the system, which is tested with a more service-oriented SMS. An SMS reminding about the filing deadline is also added. The authors show that nudged nil-filers are more likely (2.3%) to switch to positive filing after receiving the deterrence message, even if significance dissipates after controls are added. Likewise, informing about the deregistration procedure has a significant effect on the probability of deregistering, even if small in magnitude (just under 1%). Importantly, the reminder SMS significantly reduces nil-filing, and this could suggest that reminders can be seen as a form of friendly deterrence.

This paper contributes significantly to the limited evidence on tax nudges in SSA in at least three ways. First, thanks to the limited size of the country, all income tax payers in Eswatini, or about 40,000 units, were involved in the trial, while studies in Ethiopia and Rwanda focused on capital cities. Targeting the entire population of income tax payers, this study allows for a more in-depth study of taxpayers' response in urban and rural areas. It is reasonable to expect different levels of compliance rates due to a number of factors, including higher tax knowledge in more sophisticated and urban settings, as well as limited reach of the tax agency and lower audit probability in more remote areas. We also explore

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nudge, which is based on trust towards the revenue authority and is highly country-specific. Further research should be devoted to this aspect.

19 Similar tax experiments are being carried out in SSA, but to the best of our knowledge the results are not yet publicly available.

20 This particular dimension of heterogeneity is explored in section 6.

variation across additional dimensions, such as income distribution, demographics and compliance history (see section 6).

Second, compared to much of the literature, which focuses on a specific type of taxpayer (active/non-filer, individual/companies), the reach of nudges is improved and three different filing categories are targeted in the same trial, following the rationale delineated in section 1. This approach goes in contrast with the studies discussed above, all of which primarily focused on measuring the impact of different types of nudge on the same filing category. The policy relevance of this aspect of the study is important, since the SRA and other SSA tax authorities can learn to direct their limited resources on those taxpayers who are more likely to respond. The nationwide feature of this study enhances the generalisability of results in the eyes of the tax agency, who will benefit from a comprehensive, multifaceted picture of taxpayers in Eswatini.

Thirdly, given its relevance in Eswatini (see section 3), the persistence of a filing behaviour over time is explicitly included in the specification. The subgroup of *perpetuals* is identified, as opposed to non-perpetuals – taxpayers moving across the three filing categories year after year. The study of perpetuals is important, as past behaviour is likely to be a key determinant of actual compliance (Dunning et al. 2017; Tourek 2020). Survey data from Eswatini shows that perpetual non-filers are more rooted in their negative attitudes and perceptions than non-perpetual ones (Santoro et al. 2020). To the best of our knowledge, this dimension has not yet been explored in the literature.

3 Anatomy of tax compliance in Eswatini

3.1 Institutional context

The Kingdom of Eswatini is a lower-middle-income country in Southern Africa with a per capita income of $3,243 in PPP (2017).[21] Economic growth is estimated to have slightly risen to 2.4 per cent in 2018 from 2 per cent in 2017, although growing fiscal challenges resulted in a projected growth rate of just 1.3 per cent for 2019 (World Bank 2018).[22] The country is highly dependent on South Africa, which provides around 85 per cent of its imports and a market for about 60 per cent of exports. Its tax-to-GDP ratio (14.7%) is slightly below the average in sub-Saharan Africa (15.0%), while being substantially lower than the 34.2 per cent average in OECD countries and about half of that of Southern Africa.[23]

The Eswatini Revenue Authority (SRA) is a semi-autonomous institution established by the Revenue Authority Act in 2008, officially taking over the function of revenue collection on 1 January 2011. The SRA collects both direct taxes, representing about 57 per cent of tax revenue in 2017/18, and indirect taxes, amounting to 43 per cent of revenue. The main direct income taxes are taxes on companies (16% of total revenue) and taxes on individuals (36%). The main indirect taxes are VAT (30%) and fuel taxes (12%). This experiment targets income

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21 Source: World Bank World Development Indicators.

22 The country faces major development challenges, and human development indicators are low compared to other middle-income countries. Based on the international poverty line of $1.90 a day, and the lower-middle-income poverty line of $3.20 a day, it is estimated that 38 per cent of the Swazi population live in extreme poverty, and a total of 60.4 per cent are poor overall. This is accompanied by an unemployment rate of 23 per cent in 2018. Health issues are difficult to address, with HIV/AIDS and tuberculosis widespread in the country. As of 2018, Eswatini has the twelfth lowest life expectancy in the world, at 58 years. The population growth rate is 1.2 per cent, with a total population of 1.2 million in 2018 (World Bank 2018).

23 Appendix Table A1 reports key fiscal and governance indicators for Eswatini and Southern Africa.

tax payers registered for corporate income tax (CIT)[24] and personal income tax (PIT).[25] The latter focuses on sole traders (37% of all PIT registered payers) and directors (21.5%), but excludes non-business employees taxed at source (through PAYE, 41% of the total) for the inherently different tax remitting mechanism and compliance factors. Removing PAYE, it results that income taxes represent a sizeable 35 per cent of total tax revenue in 2018 (ICTD/UNU-WIDER 2020). As explained more in detail in section 4.1, as at July 2019 about 55,000 taxpayers were registered for income tax.

In terms of filing obligations and deadlines, income tax returns must be submitted according to a staggered timeline. Non-VAT-registered small and medium enterprises are expected to furnish their returns by 31 October each year, individuals have to file by 30 November, and large companies and VAT registered entities must submit their returns by 31 December. The tax year ends on 30 June. Filing can take place either in person or through the online e-tax system. The revenue authority is encouraging taxpayers to register for the online system (registration is not compulsory and there are no specific thresholds to be eligible for it), which would reduce compliance costs and facilitate the sharing of information with the authority. However, as of July 2019, when the randomisation took place, only 2,700 of the total of 55,000 taxpayers were on the e-tax system (two-thirds of these are companies in urban areas, suggesting that registration can be associated with lower compliance costs and higher tax knowledge) (see section 4.1). One of the treatment arms for non-filers also aims to push taxpayers to register for the online system in the hope of reducing their compliance costs.

Importantly for this study, the law mandates that every registered taxpayer is required to file their return regardless of whether they are operative during the year. Strict sanctions are imposed by law for non-filing and for false assessment. Anyone who fails to furnish a return within the stipulated period may be liable on conviction to a fine of SZL10,000 ($719) and/or imprisonment for a period of up to one year. Those making false assessments with an intention to evade are liable to a fine of SZL50,000 ($3,591) or imprisonment for up to five years.[26] These amounts are discouraging, representing about a quarter of the total annual income of PIT payers and 9 per cent of the total turnover of companies. Overall, also thanks to its sparser population, the enforcement capacity of the tax administration seems to be higher than the SSA average. According to ATAF (2017), Eswatini has a ratio of labour force to tax administration staff of less than 500:1, while most countries in Africa have a ratio of about 3,600:1. This is an adequate staffing capacity to monitor compliance in the country.

3.2 Patterns of compliance

Appendix Figure A1 shows the trend of PIT and CIT collection over time, according to which CIT collection reported a 14 per cent below-target gap in 2017/2018, while individual income tax performed fairly well, being 13 per cent above target.[27] Apart from broader indicators of revenue collection, a closer look at tax returns data can help better identify the patterns of compliance in the country. Tax compliance is a multidimensional concept that can be disentangled in at least three separate filing choices: (i) actively filing a return, either with positive income and tax due or with losses, (ii) filing a return with zero income and tax due (nil-filing), and (iii) taking the short-cut of not filing a return at all despite being registered with

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[24] CIT is levied at a standard rate of 27.5%, and imposed on taxable income from corporate business activities. Taxable entities include companies, whether incorporated or not, as well as foreign-incorporated entities of a similar nature, whether resident or non-resident; permanent establishments of non-residents; trusts and partnerships. Some entities are exempted from CIT; exemptions must be authorised by SRA's Commissioner General.

[25] PIT has a progressive structure – a maximum marginal rate of 33%, and exemptions for income below SZL41,000 ($2,848).

[26] More drastic measures, such as imprisonment, are rarely, if ever, implemented.

[27] This performance was underpinned by higher PAYE collection, mainly due to an increase in employee numbers in the public administration and manufacturing sectors (SRA 2018).

the authority (non-filing).[28] As explained in section 1, all these can hide different forms of non-compliance, from legal tax avoidance to blatant tax evasion. Filing categories are directly observable from administrative data in a quite straightforward fashion, even if the algorithm used in this paper is rarely embedded in the monitoring and data mining processes of SSA tax authorities. Administrative data provides a picture of what taxpayers decide to disclose to the authority – unreported income is not observed – and it does not include the informal sector, which by its very nature is invisible to the authority.[29] The following patterns of compliance can be derived in the period 2013-2018 as at March 2019 (about 3 to 5 months after the most recent filing deadline):

- *Active taxpayers*: conditional on filing, the six-year average of active (non-nil) returns is 70.5 per cent for CIT and 74 per cent for PIT payers. Figure 1 displays the trend over time as a share of all filing taxpayers (in turn a subset of all taxpayers required to file, see *non-filers* below), which is quite stable for CIT and more oscillatory for PIT payers. Perpetually active taxpayers amount to 52 per cent and 61 per cent of the CIT and PIT *filing* population (5,214 and 14,637 taxpayers, respectively). Out of the total 68,000 income tax payers registered with the authority, less than a third persistently file non-zero returns.
- *Nil-filers*: the share of nil-returns is derived from the share of active described above. Every year in 2013-2018, about 29.5 per cent of CIT and 26 per cent of PIT returns are nil, thus remitting zero tax. This amounts to 4,707 (45%) and 9,327 (32%) CIT and PIT payers filing nil at least once over the period, respectively. When considering the persistence of this behaviour over time, 2,895 of CIT and 4,185 of PIT payers file nil every year in which they file a return. The share of perpetual nil-filers is sizeable: they represent 29 per cent of CIT and 17 per cent of PIT filing populations, and overall more than 10 per cent of all registered taxpayers. For a more detailed discussion on CIT nil-filers in Eswatini, see Santoro and Mdluli (2019), who show that nil-filing is more prominent in some sectors (construction, ICT and services) than others (public administration), and much more frequent in younger firms (46%) – firms in their first year after registration – than older ones (26%). Also, survey data collected in Santoro et al. (2020) shows that the main reason behind nil-filing seems to be that the firm is not yet operative.[30] Eswatini is not an exception in SSA, and further evidence on nil-filing has been produced in other countries. In Rwanda, 53 per cent of CIT and 19 per cent of PIT returns are nil in 2013-18 (Mascagni et al. 2020), while Mascagni et al. (2019) show that 35 per cent of VAT returns from July 2016 to June 2017 have both zero VAT on sales and zero VAT on purchases. In Ethiopia, about 23 per cent of CIT returns filed in 2006/2013 are from nil-filers (Mascagni and Mengistu 2016). Likewise, in Uganda 27 per cent of PIT returns are nil over the period 2013-2018,[31] and, according to Almunia et al. (2017), 15 per cent of VAT returns in 2012-2015 are nil.
- *Non-filers*: failure to file – despite being compulsory by law and punished with fines (section 3.1) – seems to be a much more widespread phenomenon in Eswatini, if not the rule. For CIT and PIT respectively, the six-year average of missing returns is 43 per cent and 57 per cent of all taxpayers eligible to file an income tax return (see Figure 1, right). This implies that more than a third of CIT payers (5,334) and more than half of PIT payers (24,386) supposed to file a return in a given year fail to do so. Considering the persistence of this behaviour over time, as many as 2,339 companies and 10,035 individuals are persistent non-filers, meaning that they have not filed a return since registration. About 18 per cent of all registered taxpayers have never lodged a tax return,

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28 Tax compliance also includes registering with the revenue authority and paying taxes due.

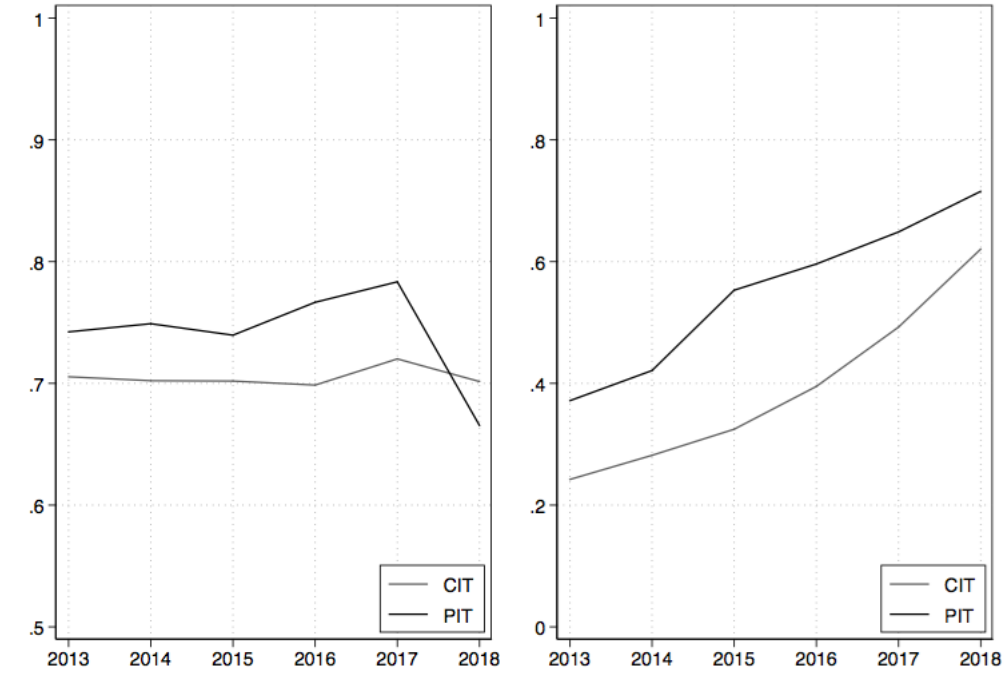
29 Although the most recent estimate of informality in Eswatini is 5 years old, and it may have reduced, the informal sector made up roughly 40% of national income on average for years 2005-2015 according to estimates of Schneider and Medina (2018) – a much higher share than the overall regional average of 32% (see Appendix Table A1).

30 88% of the sample agree with this hypothesis, while 63% think it hides evasion.

31 This finding comes from the author's calculations on data from the Uganda Revenue Authority.

and about half of all taxpayers failed to file at least once. Again, this behaviour is not peculiar to Eswatini. Non-filing has been documented in high-income countries[32] and Latin America.[33] Most relevantly, non-filing is common practice in SSA. In Rwanda, over three-quarters of individuals supposed to file for fiscal year 2018 failed to do so, and about half of companies. Figures from Uganda are even higher, with the average rate of PIT non-filing being 86 per cent over the period 2014-2018.[34] In Malawi, almost 50 per cent of income tax payers have filed no tax return and/or made no tax payment over the period 2014-2016 (Ligomeka 2019). Additional descriptive evidence from Kenya shows that only 3.5 million of over 9 million registered taxpayers filed their 2018 returns.[35] Moore (2020) notes that non-filing rates in Nigeria are exceptionally high: 98 per cent for PIT; 94 per cent for CIT; and 95 per cent for VAT.

Figure 1 Compliance trends 2013-2018: active (left) and non-filers (right)



Source: SRA CIT and PIT returns

Note: active taxpayers (left) are measured as a share of all filing taxpayers. Non-filers (right) are measured as a share of all taxpayers required to file for income tax.

In conclusion, compliance with income tax in Eswatini is far from optimal. Only about a third of the total taxpayer population regularly file positive returns and remit non-zero taxes. The remaining two-thirds are characterised by high instability in filing patterns. The majority of taxpayers either intermittently file, and then only in some cases file positive taxes, or mostly just fail to lodge a return.

A first consideration is that deregistering from the tax system does not seem to be the preferred option, with only a few hundred taxpayers exiting the system every year (see Appendix Figure A2). Either due to lack of knowledge or hoping to grow in the future, most

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32 Meiselman (2018) shows that non-filing nears 50% for local taxes in Detroit, USA, while the share of non-filers for US federal individual income tax is about 7% for the period 2000-2012 (Erard et al. 2018).

33 In Guatemala, the share of non-filers of income tax in 2013 is 39% (Kettle et al. 2016); in Costa Rica, 50% of registered firms failed to file in the period 2006-2014 (Brockmeyer et al. 2019); in Venezuela, the non-filing rate for the municipal income tax is 20% (Ortega and Scartascini 2016).

34 Figures from Rwanda and Uganda have been computed by the author in parallel studies on tax compliance, drawing on detailed tax returns data.

35 See https://www.businessdailyafrica.com/lifestyle/profiles/what-to-expect-file-nil-return/ 4258438-5232858-oiqmom/index.html, accessed on 10 June 2020.

nil- and non-filers remain formally registered despite not contributing any tax. Another anecdotal explanation for the negligible extent of deregistration is that a taxpayer has to clear all pending tax obligations when deregistering, thus involving remittance of past tax due and the extra compliance cost of lodging all missed returns.
Second, nil-filing seems to be more common for CIT payers, while non-filing is the preferred choice of PIT payers – where non-filers outnumber active taxpayers every single tax year (Santoro et al. 2020). At the same time, an additional layer of complexity is that nil-filing seems to be correlated with non-filing. As discussed in Santoro and Mdluli (2019), non-filers who eventually end up filing are more likely to declare nil – tax officials suggest they do this to put their records in order.

4 Research design

4.1 Data sources

Different data sources have been used in this study. Detailed administrative data are the most important source for running the impact analysis. Two additional sources, post office delivery reports and survey data collected in Santoro et al. (2020), proved to be extremely useful for estimating the impact of the treatment on the treated subgroups, and to provide more information on the mechanisms at play, respectively.

We have direct access to administrative data, granted by a confidentiality agreement signed with the revenue authority. We merge different types of datasets. First, we refer to the taxpayer registry, which contains background information on registered taxpayers, such as size, location and sector of activity. The registry is also used to gather contact information of the taxpayers to be nudged. By the end of July 2019, when the sample randomisation took place, the registry contained a total of 55,462 taxpayers, 30 per cent of which were companies and the rest individuals. Second, we use income tax returns of corporations (CIT) and self-employed (PIT) during the period 2013-2019, in which: (i) tax year 2018 serves as a baseline year to identify the filing categories, (ii) year 2019 is used to observe outcomes after the intervention, and (iii) years 2013-2017 are considered to measure pre-trends in behaviour. Returns data amounts to about 6,000 companies and 12,000 self-employed filing per year on average. This data includes all line items from the tax return form with particular detail, including the main financial variables, such as turnover, gross profit and tax liability. Third, VAT returns for the same period are observed, as filed by the subpopulation of about 4,000 VAT registered entities in the country. Fourth, information on deregistrations from the tax system is available. A unique taxpayer identification number (TIN) is assigned to each taxpayer; this is consistent across all datasets and used as a key identifier in merging them.

Administrative data serves two main purposes. First, it is needed to identify, locate and randomly assign the taxpayers to the treatment arms. Second, the data allows measurement of pre-treatment compliance and identification of the three (mutually-exclusive) categories under study. The filing behaviour is classified by looking at the most recent tax year, 2018. This means that a taxpayer labelled as *active* positively lodged a 2018 tax return, while a nil-filer reported zero and a non-filer failed to file in that year. Furthermore, we are able to observe the filing behaviour in the previous five-year period and create the *perpetual* sub-category – taxpayers who keep filing in the same way every year. In each filing category there will be a relatively large subgroup of perpetual non-/nil-/active filers who have been consistently filing in the same way since registration. To the best of our knowledge, this is the first time that (any type of) tax data in Eswatini has been used for research purposes.

Additional relevant data comes from the post office's delivery reports (more on the delivery process below). The post office linked each letter to a recipient's TIN. It also tracked which

letters were not collected within two weeks of delivery. With this data, we know whether letters have been effectively collected, and identify the taxpayers actually treated by the nudge. This piece of information is essential to estimate the local average treatment effect (LATE), or treatment on the treated, as explained more in depth in section 4.3. Unfortunately the post office has still not released data on the actual date of collection, but only whether the letter was returned uncollected or not. It is also not clear whether a letter is returned to the post office because the postman failed to deliver it to the designated box, or because the recipient did not collect from their mailbox.[36]

As a final source of data, we recur to the taxpayer perception survey fielded in November 2019 of 1,009 PIT payers, evenly split by active and non-filers. The survey was meant to be representative of PIT payers. It is directly linked with tax returns data through TINs. The data gathered in this is used to study the determinants of compliance in a parallel study (Santoro et al. 2020), and is used to explore the mechanisms of impact more in depth (section 6).

4.2 Study design: letter message experiment

Experiment letters and testable hypotheses. Using the terminology of Harrison and List (2004), the RCT under study can be labelled a natural field experiment, since the taxpayers under study do not know that an experiment is occurring. The letter experiment consists of a one-page letter mailed to the taxpayer. We experimentally manipulate the content of the letter by highlighting alternative key messages in a box at the centre of the page to make it more salient to the recipient (BIT 2012). For the same purpose, a clear subject line is added to the letter, such as *Comply to avoid penalties and fines for failure to file*. Everything apart from the box and subject line, such as headings and footers, the introductory two-line paragraph and final text with information on how to communicate to SRA (phone number, fax number and email address), remain constant across all treatment arms. The format of the letter mirrors that used in standard SRA correspondence with taxpayers. To enhance credibility, experiment letters have been signed by the SRA Director of Compliance. Finally, in line with practitioners' recommendations (BIT 2012), the letter is kept simple and easy to understand. Convoluted and wordy sentences are removed. Letters are personalised, with the name of the taxpayer at the top of the page, and use active language, addressing the reader as *you*. While the text may seem long, we needed to strike a balance between being concise/effective and conveying complete, exhaustive information. This is similar to what usually happens in the literature. The length of this experimental letter is shorter than in Carrillo et al. (2017), Ortega and Scartascini (2016), Bergolo et al. (2019), and more in line with Del Carpio (2014), Pomeranz (2015) and Mascagni and Nell (2020). An example of the experiment letter is provided in Appendix Figure A3.

The SRA standard letter was extended along five dimensions: threat/deterrence (T1), taxpayer assistance on how to comply (T2) and how to deregister from the system (T3), a reciprocity appeal stressing the fiscal exchange aspect of taxation (T4), and social information (T5). The control group is assigned to an untreated mailing condition (T0) and does not receive any letter.

The deterrence nudge T1 emphasises the size of penalties associated with a given wrongdoing and the pecuniary costs of evading. It could be that taxpayers are overestimating these costs and then the intervention would imply a downward revision of this component, thus making evasion even more likely. However, survey evidence from a parallel study on 1,000 PIT payers (Santoro et al. 2020) shows that about 98 per cent of the sample did not know the amount of these penalties. An element of targeting is introduced, as the content of T1 changes by filing category. The penalties on failing to declare are highlighted for non-

[36] For more information on the process of delivery, see the paragraph on logistics below.

filers, while those on false declarations are included for nil- and active filers. The nudge message for non-filers includes the following paragraph:

- *SECTION 66 of the INCOME TAX ORDER (1975): a taxpayer who fails to submit a return within the stipulated period commits an offence and may be liable on conviction to a fine of E10,000, or imprisonment for a period of up to one year, or both.*
- *SECTION 40 of the INCOME TAX ORDER (1975): a taxpayer who defaults in submitting a return for any year of assessment is liable to pay additional tax of an amount equal to twice the tax chargeable in respect to his taxable income for such year of assessment.*

Please, comply with your tax obligations and to ensure your declarations are correct to avoid fines and penalties.

Nil- and active filers received the same message, with the only difference of the fines imposed on false statements (SZL50,000 or imprisonment up to five years), and a final sentence saying that *if all information you reported is complete and correct, you do not need to make any changes*. Taxpayers with VAT discrepancies are showed the turnover reported in both the income tax and VAT returns, as well as the amount of the discrepancy arising between the two. The following hypothesis on T1 is derived:

H1: *receiving a deterrence letter T1 increases both the probability to file for non-filers and the tax declared for nil-filers and active. The impact should extend to previous years' returns and spill over other taxes, such as VAT. It should also be larger for smaller taxpayers, given that the cost of evading is now made more salient and is proportionally higher for them.*

The compliance costs nudge T2, delivered to non-filers only, communicates all the steps necessary to file a return, including a reminder of the upcoming filing deadline and indications on how to register for the e-tax system (section 3). The overall goal is to reduce the compliance costs that make it extremely difficult for taxpayers to comply with tax rules. Compliance costs can be seen as a burden taxpayers have to bear to be compliant, which includes the time and cost associated with preparing tax returns, filing, paying, acquiring the relevant tax knowledge and interacting with tax authorities. These costs are likely to be large in Eswatini. Survey evidence in Santoro et al. (2020) shows that 83.5 per cent of non-filers in the sample do not know when the next deadline is, compared to 31 per cent of surveyed active taxpayers. More broadly, active filers perform 35 per cent better than non-filers in a six-item tax quiz embedded in the survey.[37] This evidence demonstrates how compliance costs could be more relevant for non-filers, hence the targeting of this category. The tone is friendly and instructive, with no reference to penalties for non-compliance. A blank tax form, as well as a blank form for e-tax registration, are enclosed with the letter. Both for its content and attachments, T2 can be seen as a more complete educational nudge than the reminder-only type of messages usually tested in the literature (see section 2). The following text is introduced:

You just have to follow these simple instructions:

1. *Obtain the CIT/PIT Income Tax Return form from a SRA Service Center countrywide or download it from the SRA website. For your convenience, also find the tax return form attached to this letter.*
2. *Fill in the attached form correctly so that your taxes can be calculated*
3. *Follow instructions on the tax rate applicable to get the correct tax payable*
4. *Sign and submit the Tax Return to any SRA Service Center before the deadline XXX*[38]

[37] The difference in knowledge is statistically significant at the 1% level.
[38] The deadline varies according to the taxpayer's type (see section 3).

Alternatively, you can also save time and travel costs of coming to SRA to physically submit your Income Tax Return by filing online. All you need to do is to register for e-tax with SRA. Fill in the e-tax registration form attached and submit tax return online before the deadline. Please, note that e-tax registration takes 5 days and only after receiving registration confirmation from SRA you will be able to file online. Please, follow the steps above and file your past and future returns. ***Learn how to file in order to be a compliant taxpayer.***

The following hypothesis is formulated:

H2: *receiving a compliance costs letter T2 increases the probability to file for non-filers. The impact should extend to previous years' returns as well. It should also be larger for smaller taxpayers, given that compliance costs are usually regressive in nature.*

The deregistration nudge T3, targeted at non- and nil-filers, again shows the more service-oriented side of the tax authority. While the current deregistration process may be considered confusing, the letter attempts to explain the steps to follow to exit the tax system in a clear and direct way. Similarly to T2, a blank deregistered form is included in the mailing. The goal is to reduce taxpayers' ignorance and perceived complexity associated with deregistering:

If your business is not operating, you can easily deregister from SRA. You just have to follow these simple instructions:

1. *Obtain a de-registration certificate for the business from the Registrar of Companies office at the Ministry of Commerce.*
2. *Visit any on the SRA service centers with the following documents:*
    - *De-registration certificate*
    - *A signed Taxpayer Declaration Form which is obtainable from SRA.*
    - *If the business is also registered for VAT, it is a mandatory requirement for you to bring the original copy of your VAT registration certificate.*
3. *Once your documents have been accepted, you will receive confirmation on your de-registration status from an SRA official within 5 working days. As you deregister you are also reminded to comply with all your past tax obligations (tax returns and any payments due).*

In case you are no longer trading and don't plan to be operative in the future, deregistering with SRA is advisable as you will no longer have periodic obligations to file returns or make payments for the deregistered TIN. If your business is dormant but you still intend to keep your business registered with SRA, you can disregard this message and continue to file your returns as required.

The following hypothesis stems:

H3: *receiving a deregistration letter T3 increases the probability to exit from the system. The impact should be larger for perpetual non- and nil-filers, since it is more likely that they ceased operations, thus it is optimal for them to just deregister.*

The fiscal exchange nudge T4 is targeted at PIT non-filers and active payers;[39] it appeals to taxpayers' morality by stressing the importance of tax revenue in order to finance national development. First, the recipient is told that their contribution directly affects all Emaswati's lives. Second, the text gives examples of flagship development projects. These projects have been directly financed by taxpayers, and help to make the reciprocity link between taxes and

[39] Originally intended for nil-filers as well, this was not possible as the final size of the nil-filing subgroup was too small. The same is true for CIT non-filers.

public services more concrete. The message ends with an open question rhetorically addressing the taxpayer:

Your tax payment contributes to the funding of publicly financed services that make the lives of Emaswati better.
For example, public infrastructures are directly funded by the taxes you pay: last year, the Lower Usutu Smallholder Irrigation Project in Lubombo Region has been successfully constructed and is now fully operational. In addition, rural electrification, rural water and many other development projects, which the Government has embarked on, are financed by the taxes you pay. Therefore, tax compliance by all stakeholders has positive effects on the lives of Emaswati. Please, declare your taxes correctly.

Are you going to support the building of a better Eswatini for all?

In relation to T4, the following hypothesis is testable:

H4: *receiving a fiscal exchange letter T4 may increase or decrease compliance, depending on the level of satisfaction with government spending.*

The social norm nudge T5, mailed to PIT non-filers only for reasons of sample size, gives information about the extent of filing in the taxpayers' region in the period 2013-2018. Following Cialdini and Goldstein (1991), the descriptive norm – what others do, rather than the injunctive norm – what others believe or approve, is communicated. The main idea is to encourage non-filers to join the compliant majority by increasing the moral costs of non-compliance (Myles and Naylor 1996; Traxler 2010; Frey and Torgler 2007), mostly through feelings of shame and guilt for being part of a small minority of evaders (Elster 1989; Wenzel and Taylor 2004). T5 is framed at the region level, rather than the national level, to make the norm more specific to the context or group to which the individual belongs (Hallsworth et al. 2017). A reference level of compliance of 66 per cent is presented. This compares to survey evidence from Santoro et al. (2020) showing that the perceived extent of compliance is about 53 per cent. In this sense, T5 may update the taxpayers' perception and ideally push them to join the majority. At the same time, T5 risks to backfire for some taxpayers if the compliance rate revealed in the message is lower than what they previously thought. T5 reads:

Do you actually know that the majority of your peers in Eswatini regularly submit their declaration for Personal Income Tax (PIT)?
According to SRA's administrative records, in the period 2013-2018 ***two thirds (66%)*** *of PIT payers living in your Region declared their income tax. You are currently part of the minority of PIT taxpayers in your Region who are yet to declare for this tax for the year 2018.*

Please, declare all your taxes and be part of the majority.

Relatedly, hypothesis H5 is formulated:

H5: *receiving a social norm letter T5 may increase or decrease compliance, depending on the perceived descriptive norm on compliance held ex-ante.*

The final hypothesis tested considers that the mere fact of receiving a letter from the authority may increase perceived enforcement and thus compliance:

H6: *receiving* any *letter from the authority signals that the taxpayer is under the authority's radar and therefore increases both the probability to file for non-filers and the tax declared for nil-filers and active. Spill-over and heterogeneous effects should work in the same direction as in* ***H1****.*

Sample. The sample is extracted from the registry data described in subsection 4.1. Inclusion criteria are applied, such as: (i) the taxpayer has registered by December 2017, so to be liable to file an income tax return for the year 2018 and therefore allow for categorisation in a filing category;[40] (ii) the registration status is labelled as active, meaning that the taxpayer did not deregister and exit the tax system by December 2017 (therefore they are still liable to file), as well as the taxpayer is not exempted;[41] (iii) they have been uniquely identified and duplicates are removed;[42] (iv) they have valid address information and are located in Eswatini. A clean population of about 40,000 income tax payers is derived from the original taxpayer registry.

The population of taxpayers is then merged with CIT/PIT returns for 2018 and categorised according to their filing behaviour. Crucially, non-filers are those taxpayers that appear as registered with the authority but for whom a CIT/PIT return is not found in 2018. Non-filers are, in principle, potential filers who have not submitted their returns yet. The share of non-filing is therefore a moving target, and depends on the specific date at which data is analysed. In this study, sample creation and randomisation took place at the end of July 2019, hence non-filers had not filed at that time, about nine months after the deadline. At the same time, active and nil-filers are observed directly from the CIT/PIT tax returns data. In line with compliance patterns in the country (see section 3), non-filers and PIT payers represent the majority of taxpayers. Given the limited size of the target population, no further sampling strategy is pursued, and the randomisation involves all 40,000 income tax payers. In this sense, this experiment can be considered already *at scale* and representative of the entire taxpayer population in the country.

The summary statistics of key characteristics of the sample, as derived from the tax authority records, are reported in Table 1 below. Some relevant differences emerge across groups. First, non-filers are less likely to be incorporated than nil- and active taxpayers, in line with what is described in section 3. Second, groups are roughly comparable in terms of business age, with nil-filers being slightly younger. Third, non-filers are less likely to be in the trading sector, and, perhaps relatedly, less likely to be registered for VAT and e-tax. More specifically, while about a fifth of active taxpayers are registered for VAT and 7 per cent overall in the sample, very few (2%) taxpayers in the sample are registered for e-tax. Fourth, as many as 60 per cent of taxpayers in the sample keep filing in the same way after registration. While it is positive to see that 76 per cent of active are persistent in their behaviour, it is also concerning that more than half of non- and nil-filers have been non- and nil-filing since they entered the tax system. Lastly, categories are quite evenly distributed across the four districts.

Randomisation into treatment is performed through a replicable algorithm in Stata and takes place within each filing category, since the nudges are tailored. The choice of the treatment arms to assign to filing categories depended on power considerations. While we were sufficiently statistically powered enough to capture small effects for non-filers and active, the smaller size of the nil-filing group implied that a maximum of two treatments could be tested on them.[43] Non-filers are allocated to treatments T1 to T5, while nil-filers receive T1 and T3 and active taxpayers are assigned to T1 and T5 only (see Table 2 below). Stratified randomisation is implemented in order to achieve better balance, increase statistical power and allow heterogeneity analysis (Glennerster and Takavarasha 2013). The variables chosen

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40 9% of observations are removed, as they registered in 2018 or 2019. An additional 20% of taxpayers are discarded since they are not registered for income tax.

41 About 2,000 taxpayers are dropped as officially suspended; only 32 entities are officially exempted.

42 Duplicates can occur when the taxpayer is registered for multiple taxes or due to technical mistakes in the registration process. About 12,000 duplicate observations are dropped.

43 Pre-specified power calculations (power = 80% and alpha = 5%) indicated that a minimum detectable effect of 5% and 4% for non-filers (reduction in non-filing) and active (increase in tax due) could be found. An MDE of 20% for nil-filers was implied as well, which is not extremely high but still more difficult to reach when compared to the other two categories.

as strata are those expected to influence the outcome. For nil- and non-filers, strata includes the district and whether the taxpayer is at their first year since registration. Size is not used in this case, since taxpayers in these categories are never large.[44] For PIT, a dummy for whether the individual is a sole trader (see section 3) or not is also used. For active taxpayers, the strata above are used, and a dummy for whether the taxpayer is large is added. For the subgroup of active taxpayers with VAT discrepancy, district, first year and compliance type (active, nil- and non-filer) are used as strata.[45] The final random allocation produced is shown in Table 2.

Table 1 Experiment sample – summary statistics

Variable	Non-filers N	Non-filers Mean/SE	Nil-filers N	Nil-filers Mean/SE	Active N	Active Mean/SE	Total N	Total Mean/SE
CIT	25,525	0.18 (0.00)	3,575	0.40 (0.01)	11,405	0.33 (0.00)	40,505	0.24 (0.00)
Reg. year	25,525	2012.63 (0.02)	3,186	2012.86 (0.06)	9,225	2011.77 (0.04)	37,936	2012.44 (0.01)
# returns	25,525	4.34 (0.01)	3,575	3.97 (0.03)	11,405	4.34 (0.01)	40,505	4.31 (0.01)
Hhohho	25,525	0.38 (0.00)	3,575	0.41 (0.01)	11,405	0.42 (0.00)	40,505	0.39 (0.00)
Lubombo	25,525	0.15 (0.00)	3,575	0.12 (0.01)	11,405	0.11 (0.00)	40,505	0.14 (0.00)
Manzini	25,525	0.39 (0.00)	3,575	0.42 (0.01)	11,405	0.39 (0.00)	40,505	0.40 (0.00)
Shiselweni	25,525	0.08 (0.00)	3,575	0.06 (0.00)	11,405	0.07 (0.00)	40,505	0.07 (0.00)
Trading	25,525	0.13 (0.00)	3,575	0.27 (0.01)	11,405	0.27 (0.00)	40,505	0.18 (0.00)
VAT reg.	25,525	0.02 (0.00)	3,575	0.08 (0.00)	11,405	0.20 (0.00)	40,505	0.07 (0.00)
Etax reg.	25,525	0.02 (0.00)	3,575	0.05 (0.00)	11,405	0.18 (0.00)	40,505	0.07 (0.00)
Perpetual	25,525	0.53 (0.00)	3,575	0.59 (0.01)	11,405	0.76 (0.00)	40,505	0.60 (0.00)

Table 2 Treatment groups

Category	*T0 Control*	*T1 Deterrence*	*T2 Costs*	*T3 Deregistration*	*T4 Exchange*	*T5 Norms*	*Total*
Non-filers	15,266	2,431	2,429	2,424	1,373	1,366	25,289
Nil-filers	1,182	1,162		1,164			3,508
Active	3,607	3,574			3,578		10,759
VAT disc.	477	472					949

[44] Unsurprisingly, large taxpayers only rarely fail to file or file zero, given that this behaviour would almost automatically trigger an audit from the authority.

[45] Business size is not included as highly correlated with being active - see previous footnote.

Sample balance on observables. As expected, the randomisation is successful in creating balanced groups. Appendix Section B provides a set of tables that compare the pre-treatment balance of characteristics between the different nudge types, and also shows p-values from F-test of the joint significance of characteristics in discriminating between groups. Balance is achieved in statistical terms: of the 145 tests presented in Section B, in only seven cases the null hypothesis of equality of means is rejected at the 10 per cent level, well below what is expected from pure chance.

Logistics and timeline. The field experiment was organised in close collaboration with the revenue authority, which provided invaluable support throughout implementation. Since the nudge represented an official communication from the authority, the content was ratified by the Legal Office.[46] Before the experiment started, the author briefed all tax officials working in the processing of the mail, as well as those involved in the call centres. The confidentiality of the research was stressed, so that taxpayers were not aware that they were part of a study. All taxpayers' queries were directed to the call centre, which followed a pre-specified protocol in addressing the calls and clarified that the letter was to be considered as an important communication from the authority, even if it did not necessarily translate into an actual audit.[47] The taxpayer TIN was used as a tracking identifier for the corresponding letter. A similar nationwide tax communication effort had not been carried out in the country previously.

Before this experiment, the tax authority did not send standard mail to broad categories of taxpayers, but rather ad hoc letters to specific recipients and for specific reasons, such as informing about taxes due, the outcome of a tax assessment, prepayment of taxes, and, more relevant to this study, to nudge VAT non-filers to submit their returns.[48] Appendix Table A8 reports all the types of notices sent by the authority. Nudging usually takes place through newspapers and billboards, while most physical letters inform about payments.

The letters were sent using registered mail, so that the delivery could be tracked for each taxpayer. Each letter was assigned an identification number uniquely linked to a taxpayer's TIN. It is almost impossible for a letter to have been delivered to a taxpayer in the control group, since control TINs have not been shared with the post office or linked to any letter. The mailing process in Eswatini involves the post office leaving the letter in a recipient's box, located in the nearest post office. The letter remains in the box for 14 days, and is returned to the central post office if uncollected in that time. It is the responsibility of the taxpayer to routinely check their postbox to see if any mail has been delivered.[49] The one-page letters were folded in SRA-labelled envelopes by a dedicated team of SRA staff and interns. A different colour of envelope was chosen to make the letter more salient to the taxpayer, and differentiate it from SRA standard mail. SRA staff, in collaboration with the national post office, processed the posting.

The letters were mailed in autumn 2019, after the end of the tax year (June 2019), to study changes in reporting behaviour while not affecting a firm's production decisions – that is, whether to produce less in order to remit less income tax. The letters were posted in three waves. Given the staggered filing deadline for income tax payers (see section 3), letters were grouped in batches and sent 40 days before the recipient's deadline. This means that for small CIT payers, whose deadline falls at the end of October, letters were sent by mid-September (round 1). Likewise, PIT non-VAT registered payers and large CIT/PIT entities

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46 The trial also obtained ethical clearance from the University of Sussex (ER/FS294/1).

47 Anecdotal evidence shows that some nudged taxpayers tried to reach SRA staff informally, and in a few cases approached the Office of the Commissioner General directly. These cases were not the norm and, despite introducing an element of uncertainty and bias in the identification strategy, can be considered as negligible.

48 However, due to resource constraints not all VAT non-filers are systematically nudged in each period.

49 Despite the peculiarity in the mailing delivery process in Eswatini, which entails extra costs in reaching the nearest post office to collect the letter, the SRA and post office were quite confident that taxpayers, especially business people, check their mailbox on a regular basis.

received the nudge by mid-October (round 2) and mid-November (round 3), respectively. The 40-day timeframe has been chosen to reach a balance between the need to make the nudge punctual, and to nudge taxpayers before they actually filed a return. The closer to the deadline the recipient receives the letter, the more likely their response will be shaped by the nudge; the further from the deadline, the more likely it is that taxpayers have not declared yet and can be influenced by the nudge. The tax returns data for the period 2013-2018 shows that while 37 per cent and 25 per cent of CIT and PIT payers file after the deadline on average every year, an additional 50 per cent and 60 per cent file in the last 40 days. That translates to about 85 per cent of total taxpayers who have not filed 40 days before the deadline, as summarised in Appendix Figure A4.

4.3 Identification strategy

Main specification. To comply with international research standards, we pre-registered our trial with the AEA RCT Registry (ID number AEARCTR-0004753). The identification strategy is quite straightforward, as it relies on the fact that the study is a randomised controlled trial. We regress our compliance outcomes on treatment dummies and taxpayer controls. The estimating equation is run for each filing category, and for non- and nil-filers writes:

$$Y_i = \alpha + \sum_{j=1}^{n} \beta_j Treat_i + X_i\Gamma + \epsilon_i \tag{1}$$

The equation takes the following form for active taxpayers:

$$Y_i = \alpha + \sum_{j=1}^{n} \beta_j Treat_i + \theta_i Y_{i0} + X_i\Gamma + \epsilon_i \tag{2}$$

Where the outcome Y is the ex-post compliance behaviour of taxpayer i, as measured at three months after the experimental interventions, unless stated otherwise. The variable $Treat_i$ indicates which treatment nudge j taxpayer i has been assigned to. Therefore, β_j stands for the intention-to-treat (ITT) estimate of impact of nudge j. The set of control variables X_i includes the strata used in the randomisation (see section 4.2) to assure valid inference (McKenzie 2012) and additional controls to increase power, such as the sector of activity and the frequency of filing in the previous five years. The error term ϵ_i is clusterised at the taxpayer level and robust to heteroscedasticity. When it comes to active taxpayers, for which non-zero filing behaviour is observed before the experiment, we also include the baseline outcome variable Y_{i0} (lagged tax) as a pre-treatment control, in an ANCOVA estimation which helps reduce the variance of the error term and thus results in gains in statistical power (McKenzie 2012).

An additional specification calculates the impact of letters on recipients who actually collected them. While the main specification above provides ITT estimates, LATE estimates are derived by using an instrumental variable model where actual collection of the treatment letter is instrumented by random assignment to it. LATE refers to the impact on compliers, which would be larger than the ITT estimates, given the partial letter take-up (Angrist and Pischke 2009). Lastly, in section 5.7 we examine the robustness of our core findings to: (i) clusterising the error terms at the district level, (ii) using different operationalising of tax liabilities (for active only), and (iii) allowing for delays in the timing of the mail delivery.

Outcomes. The outcomes of interest differ by taxpayer category. For non-filers, the main outcomes are the probability of filing a tax return and the probability of deregistering from the system. For nil-filers, we consider the probability of switching to non-zero filing, as well as the probability of deregistering. Lastly, for active taxpayers and those in the VAT discrepancy group, we focus on the tax declared. The latter is framed both as the probability of declaring

more than the previous year, to show an increase in reported liability, as well as in the level of tax declared, adequately transformed in logs and in hyperbolic sines and converted into US dollars. Additionally, we consider secondary outcomes, such as: (i) the probability of filing or amending previous returns; (ii) spill-over effects on VAT/PAYE declaration for the subset that is VAT/PAYE registered (mostly active); (iii) for active only, both turnover and costs/deductions declared, as well as the probability of positive filing, given the high instability in filing patterns (section 3); (iv) for non-filers only, the probability of filing on time, as well as the probability of registering for the e-tax system.

Choice of model. The choice of the model depends on the outcome of interest. For dichotomous outcomes, such as the probability of filing a return, we implement a linear probability model which provides easier interpretations for the marginal effects than logistic regression models.[50] As discussed in the robustness section, results do not change if we use a logit model. On the other hand, if the outcome is tax liability, we adopt a tobit model which best addresses censored distributions, as widely used in the tax literature (Alm et al. (2010); Slemrod and Weber (2012); Alm and McClellan (2012); Mascagni et al. (2018)).

Heterogeneity. Despite being already quite targeted to each filing category, the nudges under study can nevertheless show heterogeneous effects across subgroups. For this reason, we perform the analysis of taxpayers' responses across four subgroups for which we are sufficiently statistically powered: (i) perpetual taxpayers, (ii) top income decile at the baseline (available for active taxpayers only – 1,100 of which are in the top decile), (iii) being a new registered taxpayer (i.e. being in the first year after registration), and (iv) being located in urban areas.[51] Variables (ii) and (iii) are used as strata and are balanced by design. However, also variables in (i) and (iv) result to be balanced, as shown in Appendix Section B.

5 Results

5.1 Do non-filers switch to filing their returns?

In this subsection we measure the response of non-filers. As explained in section 3, these taxpayers failed to file a return for tax year 2018, in contrast with what the tax code prescribes. Figure 2 shows the rate of income tax filing and payment over time by treatment status, for mailing round 1 (SMEs) and 2 (individuals) taxpayers. The start of the experiment and the corresponding deadlines are indicated by vertical lines. While pre-intervention trends in the treatment and control groups are almost identical for both groups, a small positive treatment effect on filing and payment start to emerge after the official start of the experiment. The rise in filing is not immediate. In some cases, as with the deterrence nudge in round 1, nudged taxpayers start filing much before the deadline and continue doing so after it, probably due to the threat of a penalty. A similar pattern emerges from individuals (round 2) nudged with the compliance costs letter, even if the jump is much closer to the deadline and supportive of the reminder mechanism explored in section 6. In all other cases, the increase in filing is sizeable but appears much after the start of the experiment, mostly even after the deadline. This could suggest that significant delays in delivery took place in the field, for which we run a robustness check in section 5.7. In any case, the increase in filing takes a stable trend around the deadline, about 7 weeks after the experiment start date, and remains approximately constant during the next 15-20 weeks.

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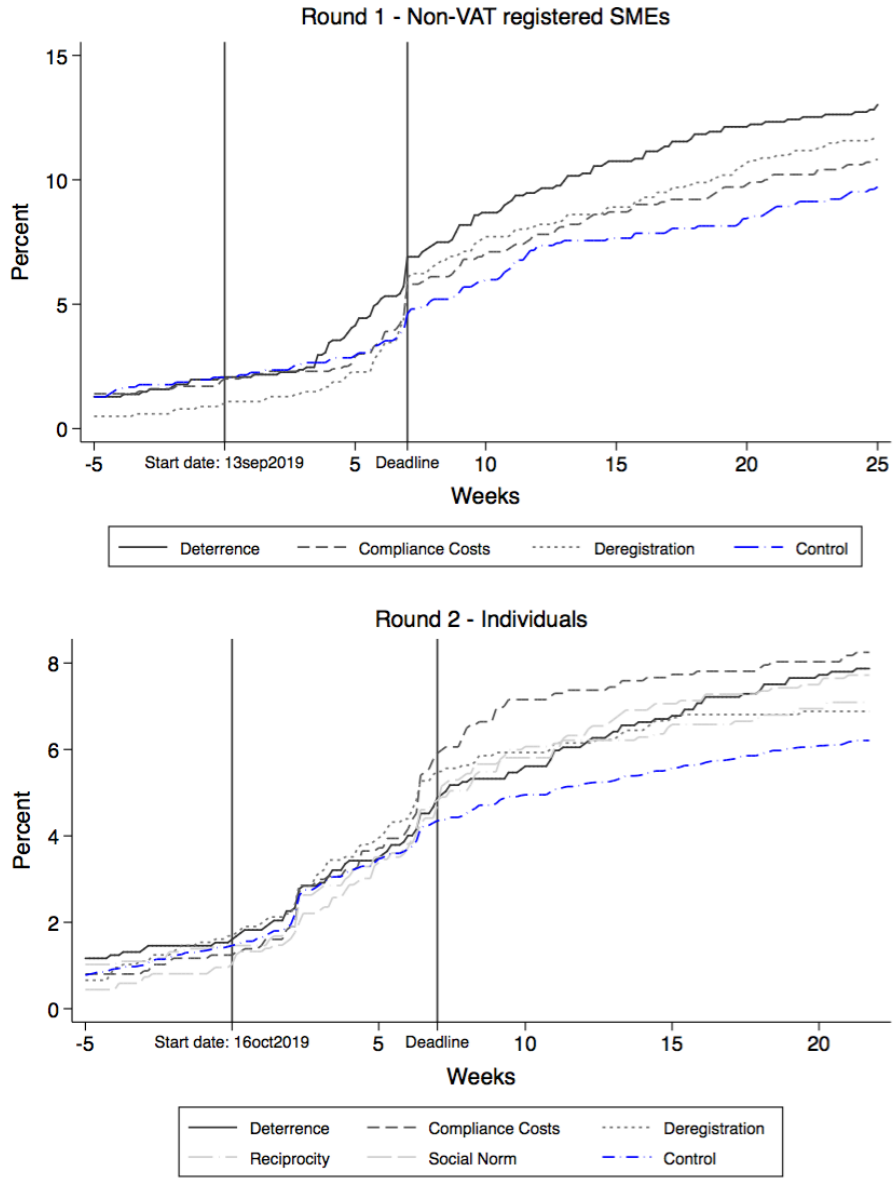
[50] While the assumption of homoscedasticity does not hold in a Linear Probability Model (LPM), calculating *robust* standard errors controls for that (Angrist and Pischke 2009). Moreover, LPM does not restrict predicted values within the 0-1 interval, but the share of such values is not high, ranging from a minimum of 0% to a maximum of 5% of the sample.

[51] For individual taxpayers only, we also look at age and whether the taxpayer is married.

Figure 2 Declaration rates over time by treatment group: round 1 and round 2



Turning to the OLS estimates, Table 3 reports the coefficients of impact of the treatment letters on the probability of filing a return. Standard errors are presented in parentheses. Column 1 and 2 pool CIT and PIT together, without and with controls, respectively. T4 and T5 arms, which are tested on PIT only, are dropped from the pooled sample. Columns 3 and 4 consider CIT payers, while columns 5 and 6 look at PIT payers considering only treatments T1-T3, which are common to both categories, to enhance comparability across the two. Lastly, columns 7 and 8 report all treatments for PIT payers. Coefficients from regressions with controls are also displayed in Figure 3. All coefficients must be interpreted as incremental changes with respect to the control group. The control group mean – the filing average at the endline for not nudged non-filers – is reported at the bottom. By construction, the filing average of the control group at baseline is 0 per cent and therefore not reported in the table. As expected, very few (7%) taxpayers who failed to file in 2018 filed for 2019, thus suggesting again how non-filing can be a well-rooted behaviour persisting over time.

Table 3 Non-filers - impact on filing probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.036***	0.026***	0.038***	0.039***	0.017**	0.017**	0.017**	0.017**
	(0.007)	(0.007)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.008)
Compliance costs	0.024***	0.013**	0.007	0.006	0.018**	0.018**	0.018**	0.018**
	(0.006)	(0.006)	(0.013)	(0.013)	(0.008)	(0.008)	(0.008)	(0.008)
Deregistration	0.024***	0.014**	0.021	0.021	0.009	0.009	0.009	0.009
	(0.006)	(0.006)	(0.013)	(0.014)	(0.007)	(0.007)	(0.007)	(0.007)
Fiscal exchange							0.012	0.013*
							(0.008)	(0.008)
Social norm							0.013*	0.014*
							(0.008)	(0.008)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.095	0.095	0.067	0.067	0.067	0.067
R-sq.	0.003	0.016	0.002	0.009	0.001	0.015	0.001	0.015
F joint test	0.000	0.000	0.036	0.027	0.015	0.015	0.017	0.014
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Results from the table show that all letters increase the probability to file in the pooled sample (col. 1), and significantly so. When controls are added (col. 2), deterrence increases filing probability by 2.6 percentage points (pp) or a 38 per cent increase over the control group. The compliance cost nudge also positively pushes non-filers to lodge a return, even if by a smaller increment (1.3 pp or 19%). Interestingly, the deregistration nudge, which was aimed at increasing *exit* from the tax system, has the unintended effect of pushing non-filers to become visible and still be part of that system. The size of the impact of the deregistration nudge is similar to that of the compliance costs. So far, the trial's results highlight that both the stick of the threat and the carrot of a more service-oriented approach improve compliance, even if the former performs twice as well.

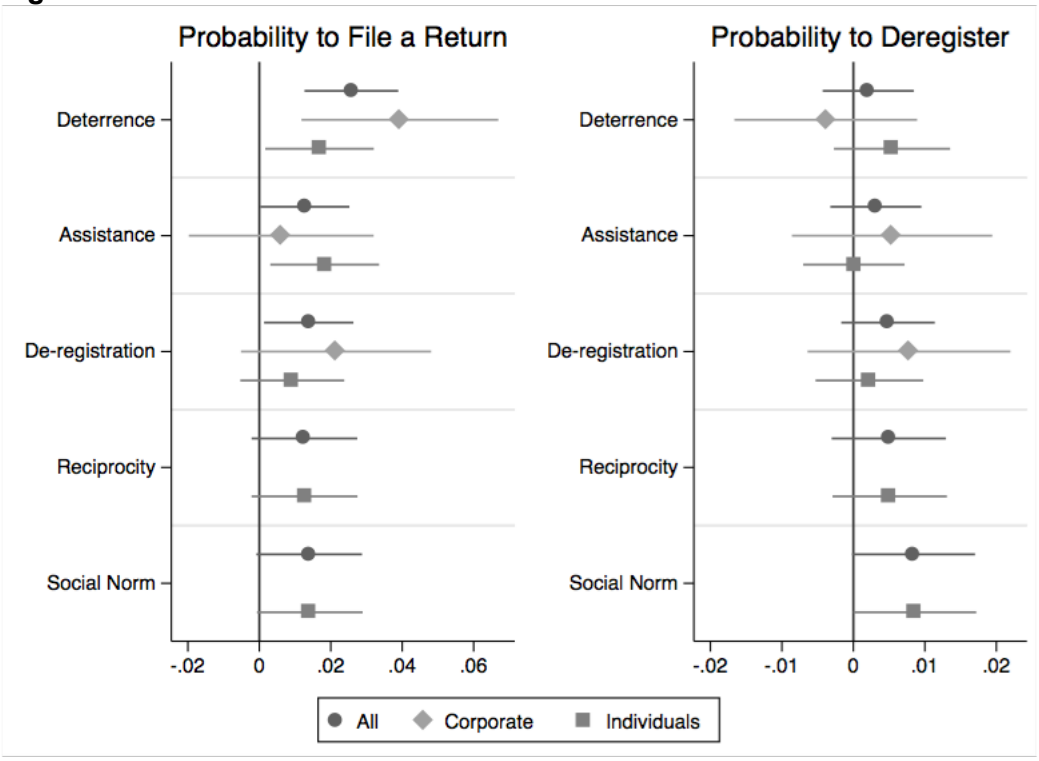
Considering columns 4 and 6/8, a number of considerations can be made. First, companies seem to be affected by the deterrence letter only, with the softer nudges losing significance. The impact of T1 is sizeable (col. 4) – 3.9 pp or 41 per cent of the control group mean. The deterrence nudge significantly improves individuals' compliance as well, by a smaller increase (1.7 pp or 25%).[52] Second, compliance costs seem to matter more for individuals than companies. PIT payers receiving T2 experience an increase of 1.8 pp (25%), while companies are not affected. This could be due to companies being more likely to have tax accountants, and therefore lack of tax knowledge is not a relevant constraint for them. This first evidence links back to the survey data on PIT payers in Santoro et al. (2020). From it, it results that for 89 per cent of surveyed non-filers lack of knowledge is an important obstacle to filing. The same figure for active payers is 72 per cent. Likewise, tax knowledge, as

[52] The evidence on PIT payers is linked with survey data collected in Santoro et al. (2020) and it is likely to be explained by an increase in audit probability, rather than improved knowledge of the penalty structure. The survey data shows that audit likelihood is a key determinant of the decision to file, while awareness of the size of penalties is not. More on this in section 6.1.

measured in a tax quiz embedded in the survey, starts to be strongly significantly correlated with filing. While CIT payers are not covered, the survey evidence is consistent with the large impact of the compliance costs nudge found in this trial. Third, the deregistration nudge remains significant for companies only, probably due to the fact that exit from the system is more costly for them than for individuals. Fourth, the additional tax morale nudges T4 and T5 both have a weak positive effect on individuals of about the same size (20%), as reported in column 8. This means that while deterrence matters, moral appeals and facilitation are also effective, in line with the recently formulated framework of tax compliance presented in Prichard et al. (2019). These three components under study work in a complementary fashion and none of them backfires.

A second main outcome of the non-filer trial is the probability of deregistering from the tax system. As explained in section 4.2, a specific nudge, T3, teaches how to navigate the deregistration process. Nudge impacts on this outcome are presented in Appendix Table A9. Overall, less than 2 per cent of the control group deregistered, in line with previous years. On top of that, the deregistration nudge increases exit from the system by 0.7 pp (col. 1), or about a 30 per cent increase. However, this estimate turns insignificant when controls are added (col. 2). Surprisingly, the social norm message for PIT payers increases exits by 0.9 pp, or more than 50 per cent of the control group mean. Figure 3 also plots impact estimates on deregistration rates. As explained in section 3, while lack of knowledge of the process is addressed with the corresponding nudge, its low impact may be explained either by an over-optimistic belief of still being operative in the future, or, more likely, by the extra monetary and time costs of clearing all past filing and payment obligations. The fact that the social norm is pushing some individuals to deregister may suggest that the descriptive norm of non-filing is excessively high. For this reason, T5 may have convinced some non-filers to leave the system. This goes in contrast with the positive impact of the social norm letter on filing, meaning that for another group of taxpayers that norm is low, and they are induced to join the filing majority.

Figure 3 Treatment effects – non-filers



Given the large magnitude of these estimates, one may wonder to what extent they reflect real additional tax revenue. To address this question, it is sensible to enquire how much tax non-filers are induced to remit when nudged. Appendix Table A10 reports impact estimates on the log tax declared. The dependent variable is set to zero for those taxpayers who do not file at all. While the pooled results show no significant impact (col. 1-2), allowing for heterogeneity between corporate and individual taxpayers shows how companies are remitting less taxes than the control group, and sizeably and significantly so when allocated to the compliance costs letter, while individuals react positively. Unincorporated taxpayers remit 0.06 more log tax when taught how to file a return, significant at the 10 per cent level. This amounts to about 50 per cent more than what control group individuals remit. In contrast, non-filing companies are reducing taxes in much the same vein as active companies, described below. This negative reaction could be either due to lack of clarity in the nudge, which irritated recipient taxpayers who respond negatively out of annoyance, or, less plausibly, to the fact that control group companies are actually remitting more tax to the authority out of confusion and hassle costs (Benzarti 2015). However, it is not clear a priori why we do not see the same pattern in control group individuals.

5.2 Do nil-filers start to file positively?

For nil-filers – taxpayers who filed nil returns at baseline – the evidence on the nudges is inconclusive. Table 4 reports the impact of the deterrence and deregistration nudges on nil-filers' probability to switch to positive filing. First, it can be noticed that 17 per cent of the control group positively filed in 2019, with individuals being three times more likely to switch to positive filing than companies. Relatedly, only 56 per cent (or 1,969) of the nil-filers subsample actually filed a return. The remaining 44 per cent are included in the model, with the dependent variable taking value 0 for them. These two pieces of evidence underline once more the high instability in filing behaviour over time, which is exacerbated for nil-filers in particular. The fact that a sizeable proportion fall back to non-filing, while an additional 17 per cent positively file, make it difficult to find precisely estimated impact coefficients, both due to lower sample size available and a relatively high control group mean. In terms of impact, the threat letter seems to backfire, producing more nil-filing, even if the coefficient is not precisely estimated. Third, the deregistration nudge has a positive impact (in line with evidence from Mascagni et al. (2020) in Rwanda), but again not significant. More detailed consideration of the reasons why nudging nil-filers has been unsuccessful are provided in section 6.

Table 4 Nil-filers - Impact on positive filing probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	CIT	CIT	PIT	PIT
Deterrence	-0.002	-0.002	-0.010	-0.012	0.003	-0.002
	(0.015)	(0.015)	(0.017)	(0.017)	(0.022)	(0.022)
Deregistration	0.004	0.003	-0.006	-0.005	0.012	0.007
	(0.016)	(0.015)	(0.017)	(0.017)	(0.022)	(0.022)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.168	0.168	0.075	0.075	0.225	0.225
R-sq.	0.000	0.011	0.000	0.030	0.000	0.017
F joint test	0.912	0.958	0.830	0.773	0.856	0.924
Observations	3508	3508	1352	1352	2156	2156

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed a non-zero income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

If anything, a weak impact can be found when considering exit from the system. The deregistration nudge significantly affects PIT payers only, more than doubling exit rates.

However, this estimate turns insignificant when controls are added. Results are reported in Appendix Table A11.

5.3 Do active taxpayers increase tax liability?

Table 5 considers the impact of the deterrence and fiscal exchange nudge on active taxpayers' probability to increase their tax liabilities, conditional on filing.[53] These taxpayers reported a positive taxable income and tax liability at baseline. Overall, 30 per cent of the control group show an increase in reporting one year later. However, the two nudges do not increase taxes (col. 2). The deterrence nudge is not effective in raising tax declared, probably due to the fact that recipients do not consider the threat as credible. While perceived enforcement may be effective in increasing tax compliance at the extensive margin (more filing), as shown in Santoro et al. (2020), it seems not to be enough to improve the intensive margin of compliance – tax declared. As a second possible mechanism, additional survey evidence from Santoro et al. (2020) suggest that knowledge of the penalty structure is not a key driver of filing. This is confirmed by the failure of the deterrent letter, which aimed to increase the salience of penalties, to have an impact.

Table 5 Active - impact on the probability of increasing tax paid

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	0.008	0.008	0.015	0.015	0.005	0.006
	(0.012)	(0.012)	(0.023)	(0.023)	(0.014)	(0.014)
Fiscal exchange	-0.011	-0.012	-0.056**	-0.055**	0.006	0.007
	(0.012)	(0.012)	(0.023)	(0.023)	(0.014)	(0.014)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.348	0.348	0.280	0.280
R-sq.	0.000	0.014	0.004	0.013	0.000	0.017
F joint test	0.000	0.000	0.000	0.000	0.000	0.000
Observations	8678	8678	2497	2497	6181	6181

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

The reciprocity letter is also ineffective. CIT payers actually decrease their tax declared once nudged with this letter, while PIT payers are unaffected. This trial shows how nudges can backfire, at least for certain categories of taxpayers. The fact that the same effect does not hold for individuals may suggest that companies are less satisfied with how tax revenue is used to fund public services, probably because they are more likely to bear the cost of poor infrastructure and other public services in the country. Consistently, survey data gathered in Santoro et al. (2020) shows that active taxpayers have a lower average satisfaction with six different public services than non-filers. While survey data is available for PIT payers only, the backfire effect for CIT suggests that dissatisfaction is common across companies as well. Likely because non-filers are free-riding on tax-funded public services, they are more satisfied with the provision. At the same time, the reciprocity nudge generates a reaction from them, probably due to a sense of guilt (Andreoni et al. 1998). At the same time, active filers who have contributed to the public purse may feel dissatisfied with how taxes are spent,

[53] A sizeable 20% of active taxpayers failed to file, equally balanced across CIT and PIT categories. This finding shows once more how the three categories are exchanging taxpayers with each other over time.

and they feel it is right to retaliate against the tax collector. In section 6, we will try to disentangle the null effects to explore any underlying mechanisms at play.

Similarly, the subgroup of taxpayers with VAT discrepancies do not react to the deterrence nudge, with results reported in Appendix Table A12. The null findings of this trial may suggest that the discrepancies found in the cross-checking exercise are legitimate, or that nudged taxpayers do not believe that the authority will credibly enforce the threat communicated in the letter.

5.4 Treatment on the treated

In this subsection, we exploit the availability of letter delivery reports to calculate LATE estimates (see section 4.3). While ITTs are more relevant from a policy perspective, since they are informative on the effect size of implementing an intervention that cannot be mandated (Bloom 2008), LATEs tell the actual impact of being exposed to the nudge. As explained in section 4.1, delivery reports indicate whether a given letter was returned uncollected or not, while it is not clear whether this is due to failure to deliver or failure to collect from the recipient conditional on delivery. Not surprisingly, and consistent with similar studies, letter take-up was far from optimal – 45 per cent. However, quite unexpectedly, delivery rates varied widely for companies and individuals. Treatment exposure was almost total for companies, about 93 per cent, and comparable across categories: 93.1 per cent of non-filing, 94.8 per cent of nil-filing and 93.2 per cent of active companies actually collected the letter. In contrast, take-up rates for individuals were stunningly low – 21 per cent. Letters were collected by only 12.1 per cent of non-filing, 33.4 per cent of nil-filing and 30.1 per cent of active individuals. One possible explanation for the low take-up from individuals may be that a much larger number of letters, about 13,000, was processed for individuals in round 2 (see section 4.2). However, nil-filers and actives are equally targeted in round 2, and they show much higher pick-up rates than non-filers. A more reasonable explanation may be that individual non-filers are a quite peculiar category of taxpayers in the tax system, quite distinct even from non-filing companies. Contact information for this group may be incomplete or outdated. Likewise, they may feel distant from or not interested in what the authority has to communicate to them. Despite the incomplete implementation of the experiment, delivery rates were not unbalanced across treatment groups, so they are not inducing any bias in the estimation strategy.[54]

Table 6 reports the LATE coefficients for non-filers, while Appendix section 4 displays the results for nil- and positive filers. Unsurprisingly, the already insignificant impact on nil- and positive filers remains so in Appendix Tables A13 and A14, with the exception of the backfiring effect of positive filers when nudged with the fiscal exchange nudge. The LATE estimate for T2 does not change much from the ITT one in Table 5, due to the almost complete take-up of companies.

It is worth noticing that LATE estimates for non-filers in Table 6 remain highly significant and larger in magnitude, especially for individuals, commensurate with the lower relative probability of treatment. The pooled LATE estimates in col. 2 imply that the deterrence nudge more than doubles declaration rates compared to the control group, while the two service-oriented nudges provoke a 60 per cent increase. LATE impacts for CIT slightly increase with respect to Table 3. In contrast, the estimates for the individual subgroup, for which exposure to the treatment was particularly low, are about eight times larger than the ITT ones and still significant. For example, both the deterrence and compliance costs letter increase filing rates

[54] Non-filers CIT: T1 92.7%, T2 93.4%, T3 93.3% (p-value 0.807). Non-filers PIT: T1 11%, T2 11.2%, T3 12.1%, T4 12.2% and T5 13.4% (p-value 0.496). Nil-filers CIT: T1 93.3%, T2 96.2% (p-value 0.058). Nil-filers PIT: T1 34.6%, T2 32.1% (p-value 0.321). Active CIT: T1 92.6%, T2 93.8% (p-value 0.291). Active PIT: T1 30.1%, T2 30.2% (p-value 0.949).

by 15-16 pp, which translates into three times larger filing rates than the control group. Moral appeals also increase filing by about 150 per cent.

Table 6 Non-filers - impact on filing probability - LATE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.084***	0.071***	0.042***	0.044***	0.148**	0.146**	0.148**	0.146**
	(0.012)	(0.014)	(0.015)	(0.015)	(0.062)	(0.062)	(0.062)	(0.062)
Compliance costs	0.056***	0.041***	0.008	0.007	0.162**	0.162**	0.162**	0.162**
	(0.012)	(0.014)	(0.015)	(0.015)	(0.064)	(0.064)	(0.065)	(0.064)
Deregistration	0.057***	0.043***	0.022	0.023	0.074	0.076	0.074	0.076
	(0.012)	(0.014)	(0.015)	(0.015)	(0.060)	(0.060)	(0.060)	(0.060)
Fiscal exchange							0.102*	0.105*
							(0.060)	(0.060)
Social norm							0.101*	0.105*
							(0.054)	(0.054)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.095	0.095	0.067	0.067	0.067	0.067
R-sq.	0.005	0.017	0.002	0.009	0.001	0.012	0.003	0.014
F-stat	5333.19	3979.39	4791.95	4607.51	621.37	663.46	386.31	423.43
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are LATE estimates where actual exposure to the treatment is instrumented by the random assignment to it. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

These results are promising, in the sense that they indicate that individual non-filers are particularly responsive to nudges from the authority.[55] If collection of the letters had been optimal, the intervention would have induced at least three times higher filing rates with respect to the status quo. The revenue authority must take this aspect into account when designing future communication strategies for individual taxpayers. Individual non-filers are responsive, but need to be reached more effectively.

5.5 Fiscal externalities

While this trial was specifically targeted at influencing filing behaviour with CIT and PIT in 2019, nudges could also have impacts that spill over other types of taxes or previous declaration periods. Taxpayers might perceive the nudge as a broader increase in enforcement, and thus comply more with other tax obligations as well. On the other hand, they might perceive the intervention as pertaining to income tax only, and increase compliance with this type of tax only, while reducing compliance with other tax to compensate for the income loss. In considering possible fiscal externalities, we recur to a rich set of administrative data on (i) filing for other types of taxes, such as VAT and PAYE, as well as (ii) amendments of previous tax returns.

[55] LATE estimates for those additional non-filer outcomes whose ITT estimates are discussed in the next sections are omitted for brevity. The pattern is consistent with what is shown in this section, i.e. that coefficients of impact for individuals are 7-8 times larger when accounting for low take-up.

Results on other types of taxes are not supportive of any spill-over effect. If we consider VAT and the active category, Appendix Table A15 shows that both hard- and soft-toned messages increase the probability of filing and the amount of VAT due, but not significantly so. This is mostly due to the reduction in power we get when restricting the analysis on VAT-registered active taxpayers, who are only 15 per cent of the total. For the same reason, this exercise is not feasible for non- and nil-filers.[56] PAYE is remitted by 27 per cent of active taxpayers. At the same time, no significant spill-over effects are found in this case.

Fiscal externalities can also refer to tax returns corresponding to previous years. Given the data available (see section 4.1), we are able to see whether nudged taxpayers amend previous returns in the period 2013-2018. Interestingly, we see a significant impact for non-filers. This category, when nudged, is significantly more likely to file for previous years' returns, in addition to the direct effect on ex-post filing (Table 3). Table 7 shows the nudge effects on the probability to file at least one previous return in the period 2013-2018. The deterrence mailing presents the largest results (1.6 pp), amounting to more than half of the control group filing probability of 3 per cent (col. 2). Also, the threat letter seems to work for companies only (col. 4). Likewise, informing about deregistration options has the same positive effect (1.1 pp) on filing rates noticed in Table 3, again driven by companies. Individuals seem more likely to respond to moral appeals (fiscal exchange and social norms). Notably, the social norm letter doubles the filing rate with respect to non-treated individuals, and strongly significantly so (col. 6). A similar impact is found when considering the number of past returns filed after the nudge as an outcome, reported in Appendix Table A16.

Table 7 Non-filers - impact on past filing probability

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.024***	0.016***	0.024**	0.024**	0.007	0.006	0.007	0.006
	(0.005)	(0.005)	(0.011)	(0.011)	(0.005)	(0.005)	(0.005)	(0.005)
Compliance costs	0.013***	0.005	0.001	0.000	0.005	0.005	0.005	0.005
	(0.004)	(0.004)	(0.010)	(0.010)	(0.005)	(0.005)	(0.005)	(0.005)
Deregistration	0.019***	0.011**	0.020*	0.021*	0.000	0.000	0.000	0.000
	(0.005)	(0.005)	(0.011)	(0.011)	(0.005)	(0.005)	(0.005)	(0.005)
Fiscal exchange							0.014**	0.014**
							(0.006)	(0.005)
Social norm							0.026***	0.026***
							(0.006)	(0.006)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.029	0.029	0.054	0.054	0.027	0.027	0.027	0.027
R-sq.	0.002	0.010	0.002	0.003	0.000	0.005	0.002	0.008
F joint test	0.000	0.001	0.042	0.038	0.436	0.449	0.000	0.000
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed a past (2013-2018) income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

[56] In the study sample, just 6% and 1% of nil- and non-filers are registered for VAT, respectively.

The fact that the deregistration message is consistently improving past compliance may be due to the fact that taxpayers need to clear their tax duties before deregistering from the authorities. However, this does not seem to be the mechanism in place here. If anything, taxpayers that eventually deregistered after the trial are *less* likely to file previous returns (1.4% vs 3.6% of non-deregistered ones), and file on average a smaller number of past returns (0.2 vs 0.8). It is more plausible that the deregistration nudge acted more as a reminder to file for past years, as it contained the explicit instruction to do so in order to exit the system (section 4.2). The other two taxpayer types do not amend their previous returns in any meaningful fashion.[57] More in general, non-filers seem to be more responsive to the experiment. It could be the case that, once a non-filer files for the current tax year, their compliance costs for filing for past years are negligible or, as stated before, that this category increases enforcement perceptions once nudged, to the point of complying with past filing obligations as well.

5.6 Unexpected impact on secondary outcomes

In addition to the main outcomes and fiscal spill-overs described above, nudges seem to have induced an unexpected response in a number of additional secondary outcomes. First, non-filers increase registration to the online e-tax filing system. In principle, we would have expected an impact from the compliance costs nudge only, since it included a reference to the online system. However, as shown in Appendix Table A17, T2 is significant without controls in col. 1 but turns insignificant in col. 2. Other nudges, such as deregistration and fiscal exchange ones, are more likely to push non-filers to register. Most importantly, the threat nudge boosts registration by 1 pp over a control mean of 1.4 per cent, and strongly significantly so (col. 2).

Second, active taxpayers are more likely to positively (non-zero) file once nudged. This finding is similar to what Mascagni and Nell (2020) get when nudging active taxpayers in Rwanda, even if stronger in significance. Results are reported in Appendix Table A18. Non-zero filing was not a first order outcome for active taxpayers (section 4.3), and 94 per cent of the control group positively file. However, both hard- and soft-toned letters increase positively filing significantly and much more so for companies, who are also more prone than individuals to fall into zero (nil-)filing (Santoro and Mdluli 2019). It results that while nudges do not increase tax liabilities, at least they partially avoid active taxpayers falling back to zero filing and reporting no tax.

5.7 Robustness checks

Our results are robust to a number of checks. First, in order to partially control for spill-over effects that have shown to matter in similar studies (Drago et al. 2015; Carrillo et al. 2017), we clusterise the error terms at the town level, and allow for error correlation within town. Cameron and Miller (2015) recommend clustering at the highest sub-national level, which in the case of Eswatini is the district. However, there are only four districts in the country and the number is too small to have precise estimates. For this reason, we refer to towns, the second highest administrative area, and larger in number than the typical cut-off of 50 clusters (Imbens and Rubin 2015).[58] While this is only an imperfect solution to the bias that information spill-overs can produce in a small country like Eswatini, it is also true that in a parallel survey study we ran on 1,000 PIT payers in the country, only 4 per cent reported getting information on tax matters from other taxpayers.[59] Also for this reason, we do not clusterise the error terms in our preferred specification discussed in section 4.3. To partly

[57] Only 1% and 0.6% of nil- and active filers amended previous returns, a very negligible response.

[58] Non-filers are spread over 63 towns, nil-filers are located in 54 different towns, while active in 57.

[59] The majority of the sample, 58%, get information from newspaper and radio. This is reassuring since the study was not made public. Also, 29% of the sample get information directly from SRA, which was prepared to handle taxpayers' queries according to a common protocol (see section 4.2).

confirm that spill-overs are not a threat to the analysis, the main results discussed in the previous section do not change. Appendix Tables A20, A21 and A22 report the coefficients from the clusterised regressions and compare them with the main ones from our preferred specification. No significant changes are noticed.

Second, for active taxpayers only, we operationalise the main outcome – tax liability – in alternative fashions: (i) amounts in USD, winsorised at the 99th percentile, (ii) the log of the tax liability with the addition of one unit so to include also cases of zero tax declared,[60] and (iii) the inverted hyperbolic sine transformation (IHS).[61] The sign of the coefficients in Table 5 remains the same using all these alternative tax outcomes. However, none of the estimates is significant, both with more (winsorised amounts) and less (log and IHS) skewed distributions. Appendix Table A19 reports the nudge impacts when using the IHS transformation, while other tables are omitted for brevity.

Third, as a last check, we consider only declarations taking place four weeks before the deadline. As explained in section 4.2, letters were mailed about six weeks before deadline. However, there is reason to believe that the experiment has been implemented with delays in the field. This is also shown in the response trend over time in Figure 2. While more detailed delivery reports providing information on the exact date of delivery are not available yet, the fact that most responses happen quite a time after the start of the experiment may hint to the existence of significant delays. By dropping the first two weeks after the start of the experiment, a period in which it is unsure whether letters actually reached taxpayer mailboxes, we can be more confident that filing responses are due to the treatment. Results remain consistent with those from our preferred specification, as shown in Appendix Tables A20, A21 and A22.

As a final consideration, it can be noticed that we have one main outcome for each filing category, therefore correcting for multiple hypothesis testing may be not necessary. A second typical correction consists in controlling for the randomisation process, through the randomisation inference method. However, in this case the samples are fairly large, with the smallest group (nil-filers) consisting of 3,500 units, so the process of randomisation should not have influenced the estimates we get. On top of that, there are currently no available programmes able to perform randomisation inference with multiple treatments. Therefore, we do not implement such a check in this paper.

6 Further analysis and mechanisms

6.1 Being contacted by the authority with *any* type of message

The results presented in section 5 are disaggregated by the type of nudge. However, the mere experience of receiving any communication from the revenue authority can plausibly influence compliance decisions as well, since taxpayers may perceive themselves to be more under the agency's radar. In order to test for this hypothesis (also formulated in section 4.2), we rerun our main specification by pooling all treatment arms together. Results are consistent with those in section 5. Namely, non-filers are mostly affected by receiving any type of message. As shown in Table 8, receiving any nudge increases the likelihood to file by 1.6 pp (col. 2), and more for companies (2.2 pp) than individuals (1.4 pp). On average, that

[60] However, by construction, log transformation cannot be performed on negative values of tax declared, which happens for a sixth of total declarations.

[61] IHS is defined as $\log(tax + (tax^2+1)^{1/2})$. Except for very small values of y, the inverse sine is approximately equal to log(2y) or log(2)+log(y), and so it can be interpreted in exactly the same way as a standard logarithmic dependent variable. It also accounts for negative values of tax.

implies a 20-24 per cent increase over the control group. Again, nil-filers (Appendix Table A23 Panel A) and active (Appendix Table A23 Panel B) taxpayers are unaffected.

Table 8 Non-filers - impact on filing probability - any treatment

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Any treatment	0.023***	0.016***	0.022**	0.022**	0.014***	0.014***
	(0.004)	(0.004)	(0.011)	(0.011)	(0.004)	(0.004)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.095	0.095	0.067	0.067
R-sq.	0.002	0.016	0.001	0.008	0.001	0.015
Observations	25289	25164	4231	4106	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

From Table 8 it emerges that it may be beneficial for SRA to just communicate with non-filers in order to improve their filing rates. This is linked to recent survey evidence collected in the country (Santoro et al. 2020), which shows that non-filers are often neglected by the tax authority. PIT non-filers are much less likely than active taxpayers to have had at least one interaction with SRA in a whole year, 29 per cent vs 51 per cent. They are also half as likely to be audited (9% vs 20%) or fined (17% vs 33%). If we interact the experience of an audit or check from the authority with the perceived audit probability, survey data supports the idea that taxpayers significantly increase their perception of enforcement when contacted by the authority.[62] In turn, the same survey data shows that perceived audit probability is one of the key factors correlated with active filing (Santoro et al. 2020). More in general, there is wide evidence on taxpayers having considerable uncertainty over audit probability, and almost systematically overestimating actual audit probability (Andreoni et al. 1998). When contacted by the authority, non-filers may update their priors on the risk of audit, even if actual audit probability does not change for them, and start complying with their filing obligations.

6.2 Compliance costs and reminder effect

Considering more in depth the most significant results of this paper, those on non-filers, additional evidence on the underlying mechanisms at work can be derived by focusing on timely declarations. We construct a new outcome variable that takes value one for on-time declarations and zero otherwise.[63] Coefficients of impact on on-file declarations are displayed in Appendix Table A24. Overall, about 4 per cent of the control group declare on time. The incremental impact of the nudges differs widely by companies and individuals, and by nudge time. First of all, the compliance costs nudge, which is the only nudge clearly stating the declaration deadline, is statistically significant only for individuals. This nudge implies a sizeable 28 per cent increase in on-time filing with respect to the control group. Secondly, the compliance costs nudge is not affecting companies, which are instead responding to the deterrence nudge with a 62 per cent increment over the control group mean. Thirdly, and unsurprisingly, the moral appeals targeted to PIT payers only do not influence on-time filing, despite impacting the probability to declare (Table 3).

These results shed light on how the compliance costs nudge improves compliance. The reminder explanation seems to be a reasonable candidate for individuals, who are less likely to benefit from the services of a tax accountant than companies. As shown in Santoro et al.

[62] The perceived audit likelihood is 74% for audited taxpayers vs 54% of non-audited ones.
[63] Taxpayers who did not file yet are considered as *late*, since they are potential filers.

(2020) knowledge of the deadline is much less for individual non-filers than active filers.[64] Companies, on the other hand, might be well aware of the filing deadline but strongly respond when the penalty associated with late filing is made salient. The deterrent letter may have worked as a reminder as well, given that reference was made to failure to file by the deadline. However, only companies seem to link the threat of a fine with timely filing, while individuals seem to interpret the content differently.

6.3 Do active filers report more deductions to offset tax due?

The immediate answer seems to be yes. Focusing on active taxpayers only, Appendix Table A25 reports how log incomes increase for both treatment arms, and significantly so for T1 deterrence. Therefore it seems that deterrence is disclosing more income, which would otherwise be underreported. This is at odds with previous findings on null (or even negative) impact on tax due (Table 5). It could well be that active taxpayers are reporting more income and offsetting this increase with more costs and deductions. Results from Appendix Table A26 confirm this hypothesis, and show that reported log costs increase as well.[65] When it comes to deductions, coefficients are also positive, but not statistically significant. This finding is in line with similar evidence on negative responses from previous studies (Ariel 2012; Carrillo et al. 2017; Slemrod et al. 2017), and needs further scrutiny. Both researchers and tax administrators could devote more attention to understanding how tax compliance strategies unfold.

6.4 Heterogeneous treatment effects

As a final exercise, we rerun the main specification in section 4.3 by splitting the sample according to different dimensions. As described below, overall average effects hide a number of underlying impact within subgroups. Based on this evidence, tax administrators may want to tailor nudging to those specific subgroups who are more likely to respond.

Filing history. A first important dimension is a taxpayer's filing history. It can be argued that the way in which taxpayers have filed in the past is likely to affect present compliance. For this reason, we split the sample in two subgroups according to whether taxpayers are persistent in their behaviour – they have kept filing in the same way in the six years before the experiment (2013-2018), or whether they kept changing their behaviour from one option to another – from positive to nil-filing or from non- to positive filing. For non-filers, 54 per cent of which are perpetual (sec. 3), Table 9 shows how perpetuals are less responsive than non-perpetuals when nudged with deterrence, compliance costs and fiscal exchange. Impact on non-perpetuals are about twice as large, suggesting that they are more responsive or easily intimidated by the tax authority, probably because they still exaggerate audit probability. This evidence can be interpreted as suggesting that perpetual non-filers have much more deeply rooted motivations for their behaviour that are more difficult to be addressed with a nudge.[66] These motivations can include, for example, a Bayesian updating of beliefs about tax debt collection enforcement. This translates into a perception of non-credibility of the nudging strategy, given that previous experience with the tax authority presumably convinced perpetuals that the SRA may not act on its sanction threats. Interestingly, the nudges for which perpetuals react more are deregistration and social norms. The findings on the social norm nudge are supported by the survey data in Santoro et al. (2020), in which adherence to a social norm is much more relevant for perpetuals than non-perpetual taxpayers.

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64 Only 16% of non-filing individuals in the survey sample are aware of the filing deadline, compared to 30% of active filers.

65 Due to limitations in the administrative data, expenses are available for CIT payers only.

66 One motivation could be that the firm is closed, for which deregistering might be the optimal choice. However, nudging impacts on deregistration are not different for perpetuals, and results are omitted for brevity.

Table 9 Non-filers - impact on filing probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**Perpetual**	**Perpetual**	**Non-perp.**	**Non-perp.**
Deterrence	0.036***	0.024***	0.029***	0.018**	0.043***	0.031***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.011)	(0.011)
Compliance costs	0.024***	0.011*	0.017**	0.005	0.033***	0.023**
	(0.006)	(0.007)	(0.007)	(0.007)	(0.011)	(0.011)
Deregistration	0.024***	0.012*	0.024***	0.014*	0.023**	0.012
	(0.006)	(0.006)	(0.007)	(0.008)	(0.010)	(0.011)
Fiscal exchange	0.010	0.013*	-0.001	0.002	0.023*	0.026**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.013)	(0.013)
Social norm	0.012	0.014*	0.017*	0.021**	0.004	0.007
	(0.008)	(0.008)	(0.009)	(0.009)	(0.012)	(0.012)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.044	0.044	0.098	0.098
R-sq.	0.002	0.016	0.002	0.034	0.002	0.024
Observations	25289	25164	13557	13465	11732	11699

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of perpetual and non-perpetual taxpayers, *Perpetual* indicates non-filers who have been failing to file since registration with the authority, while *Non-perp.* stands for taxpayers who have alternated non-filing with other filing behaviour (nil-filing, positive filing).

At the same time, non-perpetual actives (19% of the total) are much more likely to react than perpetual ones. Appendix Table A27 Panel A reports that the deterrence nudge implies a higher probability to increase taxes, which rises by about 25 per cent over the control group mean. Fiscal exchange has a positive impact as well, but insignificant. From this evidence two considerations can be formulated. First, non-persistent active taxpayers are probably underreporting their taxes and are worth targeting. Second, the negative/null results found in Table 5 are mostly driven by perpetual actives. This suggests that persistent active taxpayers are irritated by the nudges, probably due to the fact that they have always reported positive taxes and consider both the deterrent and fiscal exchange messages as inappropriate.[67] Lastly, nil-filers show no differential responses across the dimension of filing history, as reported in Appendix Table A27 Panel B.

From this exercise, it can be learnt that filing history matters in explaining nudge response. Taxpayers with a more irregular filing history are apparently more likely to be responsive to communication from the authority, which in turn could exploit this finding by giving more weight to previous filing behaviour when targeting taxpayers.

Newly-registered taxpayers. It is reasonable to expect that newly-registered taxpayers (or *young*) can be substantially different from those who have navigated the tax system for a longer period of time and interacted more with the tax authority. Considering the impact of nudges across this dimension further confirms that new taxpayers are a particularly important category to monitor (Mascagni et al. 2019), especially given that filing behaviour in the first year is likely to influence future behaviour (Dunning et al. 2017; Mascagni et al. 2019). As reported in Appendix Table A28 Panel A, results for non-filers (5% are new) are mostly

[67] According to the survey evidence in Santoro et al. (2020), active taxpayers are less satisfied with public services than non-filers.

driven by old taxpayers, which are strongly affected by treatments T1 to T4. Given the importance of tax education from similar settings (Mascagni et al. 2019), the fact that new taxpayers do not benefit from the compliance costs treatment is concerning. It could well be that the education nudge was not enough to address the knowledge barriers young taxpayers may face. Surprisingly, fiscal exchange backfires for young non-filers (6.4 pp). This can also explain the rather weak effects found for this type of nudge in Table 3. Conversely, new taxpayers are mostly influenced by the social norm message (11.5 pp), which almost doubles filing rates. Social norms do not work for older taxpayers. Interestingly, the only significant result in the whole trial on nil-filers comes from new taxpayers (see Appendix Table A28 Panel B): the deterrence nudge actually backfires with them (-0.09 pp) and significantly so, while it is positive but insignificant for older nil-filers, thus summing up to the insignificant overall impact (Table 4). New active taxpayers do not show any differential impact with respect to older ones (Table A28 Panel C).

In sum, it is important for the tax authority to carefully choose the correct communication strategy with newly-registered taxpayers. For example, tax knowledge could be increased for this subcategory by returning to a more intensive intervention than a letter, such as in-person training (Mascagni et al. 2019). Deterrence is unlikely to be effective, and could crowd out any intrinsic willingness to comply. At the same time, more research is needed in trying to understand why different types of soft-toned behavioural theories, such as fiscal exchange and social norms, work differently for this category.

Urban vs rural taxpayers. Another dimension of heterogeneity is taxpayers' location. Disentangling the main impact by an urban/rural indicator, it emerges that, while for nil-filers and active taxpayers there are no significantly different patterns (Appendix Table A29), nudges have a significantly different impact for non-filers, as reported in Table 10.

Table 10 Non-filers - impact on filing probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**Urban**	**Urban**	**Rural**	**Rural**
Deterrence	0.036***	0.024***	0.030***	0.020**	0.047***	0.032***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.011)	(0.011)
Compliance costs	0.024***	0.011*	0.028***	0.017**	0.018*	0.003
	(0.006)	(0.007)	(0.008)	(0.008)	(0.010)	(0.010)
Deregistration	0.024***	0.012*	0.030***	0.019**	0.016	0.002
	(0.006)	(0.006)	(0.008)	(0.008)	(0.010)	(0.011)
Fiscal exchange	0.010	0.013*	0.014	0.016	0.006	0.008
	(0.008)	(0.008)	(0.010)	(0.010)	(0.012)	(0.012)
Social norm	0.012	0.014*	0.019*	0.023**	0.000	0.001
	(0.008)	(0.008)	(0.010)	(0.010)	(0.011)	(0.011)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.065	0.065	0.075	0.075
R-sq.	0.002	0.016	0.003	0.015	0.003	0.020
Observations	25289	25164	15168	15082	10121	10082

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of urban and rural taxpayers, *Urban* indicates non-filers located in urban areas, while *Rural* stands for taxpayers are located in rural areas.

First, deterrence has more impact in rural (3.2 pp) than urban (2 pp) areas, even if highly statistically significant in both categories. This may suggest that taxpayers in remote areas are more likely to see the threat as credible, perhaps due to fewer interactions with the revenue authority. Survey data confirms this hypothesis: urban taxpayers are 43 per cent likely to have any type of interaction with the SRA, while rural taxpayers are 35 per cent likely.[68] It is also true that revenue authorities channel limited auditing resources to those areas that are considered to be more profitable, such as urban centres. However, this study shows how a cheap intervention can easily reach more neglected taxpayers, and still nudge them to comply.

Second, urban taxpayers are more induced to file when receiving the compliance costs (1.7 pp vs 0.3 pp), deregistration (2 pp vs 0.2 pp) and social norm (2.3 pp vs 0.1 pp) nudges. Rural taxpayers are totally unaffected by messages other than deterrence. Importantly, the social norm nudge, which was not strongly significant in Table 3, now turns significant at 5 per cent level and larger in magnitude for urban taxpayers, inducing a 30 per cent increase in the filing rate with respect to the control group.

This exercise is informative in the way it suggests that urban and rural taxpayers differ in the nature of motivational inducements that are more likely to have an impact. The fact that rural taxpayers are not influenced by non-deterrent messages is a finding that could be explored in future research.

Business size. It is possible to divide active taxpayers by business size, proxied by declared income at baseline.[69] Taxpayers in the top decile of the income distribution are categorised as large, and compared to taxpayers in the remaining deciles. These taxpayers are highly relevant in terms of revenue generation. At baseline, the top income decile remitted 12 times more income tax than the remaining nine deciles – US$4,367 vs US$361. As much as 60 per cent of total income tax at baseline was raised by the top-income decile. For this reason, it is important to realise that large taxpayers are reducing their tax due when nudged with any treatment, and significantly so when receiving the fiscal exchange one (see Appendix Table A30). The backfiring of the fiscal exchange treatment noticed in Table 5 is totally driven by top-income tax payers. Small and medium taxpayers either slightly increase reported liabilities (with the deterrence nudge), or do not respond at all (with the fiscal exchange one).

This result can be interpreted as larger taxpayers being more politically relevant and therefore being in a better position to reduce tax liability if frustrated by a wrong message. Large taxpayers enjoy more bargaining power in negotiating with the government (Giertz and Mortenson 2014), and are more likely to engage in aggressive tax planning schemes and recruit the services of financial experts to reduce their tax liability (Tanzi 2012). This evidence is also in line with the main results in Table 5. Companies are more likely to be large and get irritated by the fiscal exchange nudge if they are not satisfied with the provision of public services (such as infrastructure) on which their productivity depends. Lastly, large taxpayers are usually more targeted by audits, and when receiving a non-deterrent message that appeals to national development they might infer that, as Bardach (1989: 62) puts it, ‘the enforcement system cannot cope and must resort to rhetoric instead’.

Individual taxpayers’ demographics. As a final exercise, we consider individual (PIT) taxpayers for whom demographic characteristics are available from administrative data, such as age and marital status.[70] While active taxpayers show very little heterogeneity, with some only descriptive evidence that nudges to older taxpayers are more likely to back-fire

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68 e.g. taxpayers in Hhohho district, the district of the capital Mbabane, are 29% likely to receive an audit, while taxpayers in more remote districts such as Lubombo and Shiselweni are only about 5% likely.

69 This exercise is not possible for non- and nil-filers, since their baseline income is either missing or zero at baseline.

70 Demographics are not available for CIT payers, and not all PIT payers have valid information. Age is available for 86% of the taxpayer population, while civil status is known for only 53%.

(Appendix Table A31 Panel C),[71] and nil-filers do not react differently by age (Appendix Table A31 Panel B), more informative trends come up when looking at non-filers (Appendix Table A31 Panel A). With respect to the main results in Table 3, older taxpayers present larger effects of the fiscal exchange letter (2 pp vs 0.2 pp of younger).[72] Conversely, the significance of the social norm nudge is mostly due to younger individuals. There is also only descriptive evidence that older taxpayers react more when receiving the compliance costs nudge, probably due to the larger costs they face ex ante.[73] Being married correlates with age and therefore the results for married taxpayers resemble those of older ones: married non-filers respond more to reciprocity appeals and assistance with filing a return, as reported in Appendix Table A32 Panel A. However, these figures should be considered with more caution given that marital status is available for only 53 per cent of the PIT sample, and cannot be used for the nil-filer subsample given its small size to begin with. Results for active taxpayers are not significantly different across subgroups, and are reported in Appendix Table A32 Panel B.

7 Conclusions and policy recommendations

This paper contributes to the large literature on tax compliance, and specifically to the burgeoning literature on behavioural responses to tax nudges. Despite the presence of several recent studies on tax nudges, the focus has been mostly on developed countries, with little knowledge being produced from sub-Saharan Africa. In collaboration with the Eswatini Revenue Authority, this study implements a nationwide nudging experiment, targeting different populations out of 40,000 corporate and personal income tax payers, labelled as non-filers, nil-filers and active taxpayers, and causally estimating the impact of nudges on a range of compliance outcomes. The content of nudges is built on the main theoretical formulations on behavioural tax compliance, some of which are confirmed in the field. By doing so, this study adds to the limited existing evidence on the drivers of compliance in SSA, by exploring a country (Eswatini) that has not been studied before. Furthermore, it is the first study of its type targeting three different filing categories at the same time, including both companies and individuals (as already done in Mascagni and Nell (2020)). Much of the relevant literature, with few exceptions, has focused on positive filers only.

The results of the RCT present a nuanced and multi-faceted picture of tax compliance in Eswatini. While non-filers substantially increase their filing once nudged, lodging returns for both the current and previous tax years, nil-filers are more stuck in their behaviour and active taxpayers show negative (but fully rational) responses, mostly driven by top-income entities. Despite poor impact at the intensive margin of compliance, extra revenue generated by the experiment will compensate for the costs of implementation of about US$18,000.[74] In order to calculate the overall revenue gain associated with the experiment, we consider the statistically significant ITT results. First, non-filers in the treatment groups are more likely to file than those in the control group (see Table 8). About 235 extra non-filers lodged a return thanks to our experiment. These non-filers remitted a total of US$109,303. Second, the same non-filers, once nudged, started filing for previous years as well. The extra revenue generated by these extra taxpayers (187) amounts to US$25,505. Lastly, the nudges

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71 This is consistent with the fact that nudges to larger and incorporated taxpayers are likely to backfire, since the owners of these businesses are likely to be older.

72 Older taxpayers are defined as those who are older than the median in the population (about 50).

73 Survey data in Santoro et al. (2020) shows that the average index score for the young group (below 50 years) is 1.63 out of 5. The corresponding figure for older taxpayers is 1.47, or 10% less. The difference in the distribution of knowledge is statistically significant at the 5% level.

74 Total costs include postage fees, envelopes, printing and additional fees paid to SRA staff for their hours of work spent on implementation.

significantly pushed a small group of active taxpayers to continue to file positive tax, while they would have remitted no tax in the absence of the intervention. These 86 extra active taxpayers declared a total of US$69,269. Therefore, the extra revenue gains causally associated with the experiment total US$0.2 million, making the intervention highly cost-effective, with an overall cost-benefit ratio of about 1:11.

The aggregate revenue gains are small when compared to similar studies in SSA (Mascagni and Nell 2020). However, these studies focused on active taxpayers only, and thus were more likely to generate larger revenue. The cost-benefit ratio becomes more consistent when compared to nudge studies targeting non-filers only (Kettle et al. 2016; Brockmeyer et al. 2019). At the same time, the cost-benefit ratio above is likely to represent a lower bound of the actual one, as it is difficult to quantify the benefits associated with improved compliance at the extensive margin. Beyond immediate revenue considerations, the trial tackled important detrimental fiscal consequences of non-filing, such as horizontal inequality, perceptions of unfairness and production efficiency. In addition, non-filers start to be visible to the authority and share valuable information with the SRA. All these impacts, despite being crucial in building a culture of compliance, are almost impossible to quantify.

This study has clear policy implications for the Eswatini Revenue Authority and other tax agencies in low- and middle-income countries. First, non-filers are an easy target for the authority. By simply contacting them with any type of nudge, the authority could achieve a 20-24 per cent increase in filing. This impact could rise to about 80 per cent if all recipients are actually exposed to the treatment. This evidence links back to the survey data in Santoro et al. (2020), according to which non-filers are less likely to be reached by the authority. This result gains economic significance given that non-filers represent the majority of registered taxpayers in Eswatini, as well as in other SSA countries. In particular, the authority could implement a three-tiered approach in targeting non-filers, as formulated in the conceptual framework of voluntary compliance in Prichard et al. (2019) and Alm et al. (2010). In this setting, three complementary paradigms – deterrence, taxpayer assistance and moral appeals – are equally important for a tax administration that wishes to encourage voluntary compliance. The parallel study of Santoro et al. (2020) further documents that these three strategic pillars are strongly correlated with the probability of filing in Eswatini. Relatedly, the deterrent pillar of the framework seems to be more effective in boosting compliance from companies, which seem to pay more attention to penalties when made salient, while taxpayer assistance seems a viable solution to increase compliance of individuals. The latter strongly increases the probability of filing on time, on top of the likelihood of lodging a return at all, when nudged with the compliance costs nudge. In this sense, short nudges through SMS, automatically sent a little before the deadline, are likely to have an impact on individuals.

Second, alternative approaches should be pursued in increasing tax liabilities for nil- and active taxpayers. For the former, this study contributes to the almost non-existent evidence on how to address nil-filing. In a similar work from Rwanda (Mascagni et al. 2020), the vast majority of nil-filers continued to do so after being nudged. The trial on Eswatini nil-filers is ineffective as well: deterrence significantly backfires for newly-registered taxpayers, and that may suggest that other non-conventional messages are more likely to work with this category. The argument can be made that these taxpayers are actually not operating yet and legitimately filing nil, but further research is needed to shed light on this category. For active taxpayers, this trial shows how difficult it can be to build on non-deterrent motivations, such as reciprocity, in a country where satisfaction with public services is low (Santoro et al. 2020). Alternative messages could be based on comparison to peers, which proved to play a role in the parallel survey study. At the same time, the authority could also explore alternative enforcement channels. While it is documented that standard audit perceptions are linked with the extensive margin of compliance – with filing a return (Santoro et al. 2020), this trial suggests that they are unlikely to be effective at the intensive margin as well – increasing tax

due. If anything, active taxpayers seem both to update their perceived enforcement likelihood and strengthen their willingness to contribute to national development to the point of being more likely to positively file (avoiding nil returns), but not as much as to increase their tax due. More credible and salient enforcement messages than the one-page letter of this study could be tested on this category, in much the same vein as already explored in Latin America (Pomeranz 2015; Bergolo et al. 2019).

Third, the inherent heterogeneity in this large nationwide experiment should be taken into account by the SRA when designing its compliance strategy. The authority could build more tailored communication strategies based on the results presented in this paper, to focus on those subgroups that are more likely to respond, without wasting (the already limited) resources on those taxpayers whose filing behaviour is more resistant to change. Immediate recommendations may consist in, for example: (i) implementing more incisive interventions for both perpetual and newly-registered taxpayers, such as direct contact from the authority for the former and workshops and training for the latter, which also proved to be effective in similar contexts (Mascagni et al. 2019);[75] (ii) exploiting more standard deterrent messages in rural areas, while appealing to moral factors in more urbanised settings; (iii) targeting top income tax payers with more sophisticated deterrent measures, such as deploying the most qualified auditors.

Lastly, the nudging method could be improved, and the authority could find better ways to reach certain filing categories. While letter delivery was successful for companies, it was dismally low for individuals, especially non-filers. Much larger compliance gains could have been achieved if individual taxpayers were reached adequately. One way forward could be to update the contact information (especially location and mailbox) of individual taxpayers in the registry. A second option would explore alternative tools, such as email or SMS.[76] More specifically, emails have the advantage of being cheaper and more easy to track, but also inevitably rely on the quality of taxpayer contact information. Before implementing this trial, the author ran a quality check on the taxpayer registry, realising that email addresses were available in 25 per cent of cases and poorly representative of the entire population.[77] In sum, the authority could devote more effort to cleaning its registry, which, in turn, could serve as a valid basis for reaching individual taxpayers in future nudging exercises. Future experiments could test alternative methods characterised by higher salience of the delivery device and add to the corresponding limited literature (Doerrenberg and Schmitz 2015; Ortega and Scartascini 2016; Mascagni and Nell 2020).

We conclude by highlighting three directions for future research. First, it will be important to track nudged taxpayers over time and observe their filing behaviour in the following years, to gauge whether the gains are long-lived. Tax returns data for future years will be analysed to add to the growing evidence on mid- to long-term effects of letter interventions (Allcott and Rogers 2014; Cronqvist et al. 2018; Brockmeyer et al. 2019). Second, this study has produced both ITT and LATE estimates, with the second being measurable thanks to delivery reports shared by the national post office. However, future data on the actual date of delivery to the recipients' mailbox will be shared and used to more carefully calculate treatment effects *after* the letter is picked up. As a final point, future research could dig deeper into disentangling different components at work within a given treatment letter. For example, the deterrence arm could work either through increases in the salience of the penalty structure or in the perceived probability of audits (Bergolo et al. 2019). At the same

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75 Relatedly, the fact that non-perpetual active and non-filers are more responsive may suggest that the authority could benefit from an automated system tracking filing behaviour and flagging cases in which a previously active taxpayer stops filing, or, conversely, a previous non-filer suddenly starts filing. In the latter case, as this trial shows, the tax authority could investigate whether previous returns should also have been filed.

76 In principle, SMSs also represent a viable option, but they are limited in size and do not allow for sending more official documentation. However, they could potentially be used to send short deadline reminders, a mechanism that seems to be at play with non-filers.

77 Active, large and urban taxpayers were more likely to have a valid email address.

time, the combination of different treatments, say, on reducing compliance costs and appealing to national development, could be more effective in increasing compliance. For reasons of limited sample size, this study was unable to test additional, more specific or combined treatments.

There is much exciting future research to be carried out in this direction.

Appendices

A Research background

Table A1 Governance and country indicators

	Eswatini	Southern Africa	Year
Tax to GDP ratio[a]	14.7%	22.3%	2018
Tax revenue per capita (USD)[a]	444	949	2015
Informality (% national income)[b]	40.1	32.3	2005-2015
CPI[c]	39	47	2017
Governance indicators[d]			
Control of corruption	-0.44	0.18	2016
Rule of law	-0.32	0.10	2016
Regulatory quality	-0.58	-0.07	2016
Government effectiveness	-0.56	-0.08	2016
Political stability	-0.49	0.19	2016
Voice and accountability	-1.42	0.06	2016
Index of economic freedom[e]	55.9	60.2	2018
Tax burden	74.8	64.9	2018
Government integrity	27	41.4	2018
Judicial effectiveness	35.3	52.6	2018
Business freedom	61.1	63.2	2018
Doing business indicator[f]	59.5	62.3	2018
Starting a business	77.2	79	2018
Registering property	60.8	57	2018
Paying taxes	77.1	76.2	2018
Bank account ownership[g]	29%	42%	2017

Southern Africa: Botswana, Lesotho, Namibia, South Africa and Eswatini.

a Annual Report of the SRA

b Schneider and Medina (2018)

c Transparency International Corruption Perceptions Index. Range: 0-100.

d World Bank (2017). Range: -2.5 (weak) to 2.5 (strong).

e The Heritage Foundation. Range: 0-100.

f World Bank (2018). Range: 0-100.

g Global Findex (2017). Adults (+15 yo) in labour force. Burundi excluded.

B Randomisation balance

Table A2 Balance table - CIT non-filers

	(1) Control		(2) T1 Deterrence		(3) T2 Costs		(4) T3 Dereg.		T-test P-value		
Variable	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**(1)-(2)**	**(1)-(3)**	**(1)-(4)**
Hhohho	1065	0.45 (0.02)	1055	0.45 (0.02)	1056	0.45 (0.02)	1055	0.45 (0.02)	0.95	0.96	0.95
Lubombo	1065	0.10 (0.01)	1055	0.10 (0.01)	1056	0.10 (0.01)	1055	0.10 (0.01)	1.00	0.95	1.00
Manzini	1065	0.42 (0.02)	1055	0.42 (0.02)	1056	0.42 (0.02)	1055	0.42 (0.02)	0.92	0.94	0.92
Shiselweni	1065	0.04 (0.01)	1055	0.03 (0.01)	1056	0.03 (0.01)	1055	0.03 (0.01)	0.66	0.66	0.66
First year	1065	0.07 (0.01)	1055	0.07 (0.01)	1056	0.07 (0.01)	1055	0.07 (0.01)	0.72	0.78	0.72
# returns	1065	4.23 (0.05)	1055	4.21 (0.05)	1056	4.14 (0.05)	1055	4.25 (0.05)	0.73	0.22	0.83
Perpetual	1065	0.49 (0.02)	1055	0.49 (0.02)	1056	0.54 (0.02)	1055	0.50 (0.02)	1.00	0.03**	0.76
Trading	1065	0.35 (0.01)	1055	0.33 (0.01)	1056	0.36 (0.01)	1055	0.33 (0.01)	0.42	0.49	0.39
F-test of joint significance (p-value)									0.98	0.41	0.99
F-test, number of observations									2120	2121	2120

Notes: The value displayed for t-tests and F-tests are p-values. ***, **, and * - 1, 5, and 10 per cent level.

Table A3 Balance table - PIT non-filers

	(1) Control		(2) T1 Deterr.		(3)T2 Costs		(4) T3 Dereg.		(5) T4 FE		(6) T5 Norms		T-test P-value				
Variable	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**(1)-(2)**	**(1)-(3)**	**(1)-(4)**	**(1)-(5)**	**(1)-(6)**
Sole trader	14201	0.17 (0.00)	1376	0.18 (0.01)	1373	0.16 (0.01)	1369	0.17 (0.01)	1373	0.17 (0.01)	1366	0.19 (0.01)	0.67	0.33	0.87	0.90	0.19
Hhohho	14201	0.36 (0.00)	1376	0.37 (0.01)	1373	0.36 (0.01)	1369	0.36 (0.01)	1373	0.36 (0.01)	1366	0.35 (0.01)	0.63	0.96	0.93	1.00	0.25
Lubombo	14201	0.16 (0.00)	1376	0.16 (0.01)	1373	0.16 (0.01)	1369	0.15 (0.01)	1373	0.17 (0.01)	1366	0.17 (0.01)	0.84	0.97	0.41	0.70	0.69
Manzini	14201	0.39 (0.00)	1376	0.39 (0.01)	1373	0.39 (0.01)	1369	0.40 (0.01)	1373	0.37 (0.01)	1366	0.40 (0.01)	0.63	0.74	0.40	0.41	0.26
Shiselweni	14201	0.09 (0.00)	1376	0.08 (0.01)	1373	0.08 (0.01)	1369	0.09 (0.01)	1373	0.10 (0.01)	1366	0.09 (0.01)	0.17	0.53	0.82	0.36	0.63
First year	14201	0.06 (0.00)	1376	0.05 (0.01)	1373	0.05 (0.01)	1369	0.06 (0.01)	1373	0.06 (0.01)	1366	0.05 (0.01)	0.48	0.57	0.83	0.98	0.33
# returns	14201	4.36 (0.01)	1376	4.39 (0.03)	1373	4.35 (0.03)	1369	4.37 (0.03)	1373	4.37 (0.03)	1366	4.41 (0.03)	0.39	0.76	0.74	0.78	0.10*
Perpetual	14201	0.54 (0.00)	1376	0.54 (0.01)	1373	0.55 (0.01)	1369	0.55 (0.01)	1373	0.54 (0.01)	1366	0.53 (0.01)	0.99	0.49	0.81	0.58	0.28
Trading	14201	0.08 (0.00)	1376	0.08 (0.01)	1373	0.07 (0.01)	1369	0.08 (0.01)	1373	0.08 (0.01)	1366	0.09 (0.01)	0.47	0.18	0.50	0.97	0.19
F-test of joint significance (p-value)													0.81	0.84	0.99	0.99	0.48
F-test, number of observations													15577	15574	15570	15574	15567

Notes: The value displayed for t-tests are p-values. The value displayed for F-tests are p-values. ***, **, and * indicate significance at the 1, 5, and 10 per cent critical level.

Table A4 Balance table - CIT nil-filers

		(1) Control		(2) T1 Deterrence		(3) T2 Dereg.	T-test P-value	
Variable	N	Mean/SE	N	Mean/SE	N	Mean/SE	(1)-(2)	(1)-(3)
Hhohho	453	0.47	448	0.47	451	0.47	0.97	0.89
		(0.02)		(0.02)		(0.02)		
Lubombo	453	0.08	448	0.08	451	0.08	0.94	0.98
		(0.01)		(0.01)		(0.01)		
Manzini	453	0.41	448	0.42	451	0.42	0.84	0.85
		(0.02)		(0.02)		(0.02)		
Shiselweni	453	0.04	448	0.03	451	0.04	0.74	0.87
		(0.01)		(0.01)		(0.01)		
First year	453	0.14	448	0.14	451	0.14	0.98	0.90
		(0.02)		(0.02)		(0.02)		
# returns	453	3.97	448	4.00	451	3.99	0.80	0.90
		(0.09)		(0.08)		(0.09)		
Perpetual	453	0.79	448	0.76	451	0.78	0.30	0.78
		(0.02)		(0.02)		(0.02)		
Trading	453	0.32	448	0.31	451	0.36	0.75	0.27
		(0.02)		(0.02)		(0.02)		
F-test of joint significance (p-value)							0.99	0.98
F-test, number of observations							901	904

Notes: ***, **, and * - 1, 5, and 10 per cent level.

Table A5 Balance table - PIT nil-filers

		(1) Control		(2) T1 Deterrence		(3) T2 Dereg.	T-test P-value	
Variable	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**(1)-(2)**	**(1)-(3)**
Sole trader	729	0.41	714	0.41	713	0.41	0.99	0.94
		(0.02)		(0.02)		(0.02)		
Hhohho	729	0.36	714	0.36	713	0.37	0.98	0.96
		(0.02)		(0.02)		(0.02)		
Lubombo	729	0.14	714	0.14	713	0.14	0.95	0.98
		(0.01)		(0.01)		(0.01)		
Manzini	729	0.42	714	0.43	713	0.42	0.94	0.97
		(0.02)		(0.02)		(0.02)		
Shiselweni	729	0.07	714	0.07	713	0.07	1.00	0.84
		(0.01)		(0.01)		(0.01)		
First year	729	0.05	714	0.04	713	0.04	0.20	0.20
		(0.01)		(0.01)		(0.01)		
# returns	729	3.84	714	3.92	713	3.97	0.33	0.09*
		(0.06)		(0.05)		(0.05)		
Perpetual	729	0.52	714	0.47	713	0.49	0.07*	0.27
		(0.02)		(0.02)		(0.02)		
Trading	729	0.22	714	0.23	713	0.22	0.69	0.82
		(0.02)		(0.02)		(0.02)		
F-test of joint significance (p-value)							0.82	0.88
F-test, number of observations							1443	1442

Notes: The value displayed for t-tests and F-tests are p-values. ***, **, and * - 1, 5, and 10 per cent level.

Table A6 Balance table - CIT active

	(1) Control		(2) T1 Deterrence		(3) T2 FE		T-test P-value	
Variable	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**(1)-(2)**	**(1)-(3)**
Turnover 2018	1041	12.44 (0.13)	1026	12.39 (0.13)	1027	12.54 (0.12)	0.79	0.54
Tax 2018	1041	1.83 (0.22)	1026	1.36 (0.23)	1027	1.66 (0.22)	0.14	0.59
Hhohho	1041	0.44 (0.02)	1026	0.44 (0.02)	1027	0.44 (0.02)	0.91	0.93
Lubombo	1041	0.09 (0.01)	1026	0.09 (0.01)	1027	0.09 (0.01)	0.96	0.95
Manzini	1041	0.42 (0.02)	1026	0.43 (0.02)	1027	0.43 (0.02)	0.85	0.83
Shiselweni	1041	0.05 (0.01)	1026	0.05 (0.01)	1027	0.05 (0.01)	0.52	0.52
First year	1041	0.09 (0.01)	1026	0.08 (0.01)	1027	0.08 (0.01)	0.83	0.89
# returns	1041	4.61 (0.05)	1026	4.69 (0.05)	1027	4.68 (0.05)	0.31	0.42
Perpetual	1041	0.80 (0.01)	1026	0.79 (0.01)	1027	0.81 (0.01)	0.35	0.53
Trading	1041	0.38 (0.02)	1026	0.37 (0.02)	1027	0.38 (0.02)	0.74	0.77
F-test of joint significance (p-value)							0.85	0.98
F-test, number of observations							2067	2068

Notes: The value displayed for t-tests and F-tests are p-values. ***, **, and * - 1, 5, and 10 per cent level.

Table A7 Balance table - PIT active

	(1) Control		(2) T1 Deterrence		(3) T2 FE		T-test P-value	
Variable	**N**	**Mean/SE**	**N**	**Mean/SE**	**N**	**Mean/SE**	**(1)-(2)**	**(1)-(3)**
Turnover 2018	2566	3.00 (0.09)	2548	2.76 (0.09)	2551	2.77 (0.09)	0.05**	0.06*
Tax 2018	2566	1.92 (0.12)	2548	1.51 (0.12)	2551	1.80 (0.12)	0.02**	0.48
Sole trader	2566	0.37 (0.01)	2548	0.37 (0.01)	2551	0.37 (0.01)	0.95	0.97
Hhohho	2566	0.42 (0.01)	2548	0.42 (0.01)	2551	0.42 (0.01)	0.97	0.95
Lubombo	2566	0.12 (0.01)	2548	0.12 (0.01)	2551	0.12 (0.01)	0.94	0.96
Manzini	2566	0.37 (0.01)	2548	0.37 (0.01)	2551	0.37 (0.01)	0.98	0.99
Shiselweni	2566	0.09 (0.01)	2548	0.09 (0.01)	2551	0.09 (0.01)	0.98	0.97
First year	2566	0.02 (0.00)	2548	0.02 (0.00)	2551	0.02 (0.00)	0.50	0.50
# returns	2566	4.10 (0.03)	2548	4.14 (0.03)	2551	4.09 (0.03)	0.32	0.74
Perpetual	2566	0.82 (0.01)	2548	0.81 (0.01)	2551	0.81 (0.01)	0.26	0.41
Trading	2566	0.21 (0.01)	2548	0.21 (0.01)	2551	0.20 (0.01)	0.84	0.31
F-test of joint significance (p-value)							0.17	0.58
F-test, number of observations							5114	5117

Notes: The value displayed for t-tests and F-tests are p-values. ***, **, and * - 1, 5, and 10 per cent level.

Table A8 Types of messages from SRA

Notice	Channel	Content	From	Timing
1. Annual notice for filling for income tax, VAT, PAYE	Newspaper, billboards	A call to all eligible taxpayers to submit income tax returns. The message is comprehensive and includes information on submission deadlines.	Domestic Tax (DT)	Approx. 5 days, but it varies. Billboards are placed throughout the country for a specific duration.
2. Topical announcements	Radio, TV	Topical matters such as VAT with a stress on submission deadlines	DT Customs	Radio once a week; TV - a certain number of slots are purchased and presentations are on an ad hoc basis. Mostly it depends when the need arises.
3. Notice of assessment	letter	Advice taxpayer on the outcome of the tax assessed and also mention the right to object/dispute	DT	Immediately upon closure of the tax assessment. One NOA per year for each taxpayer.
4. Debt notice	letter, phone call, physical visits	Advice taxpayer on the taxes due	DT	(i) Calls 7 days after deadline (ii) Letters of demand: 7 and 14 days after (iii) Final demand letter 14 days after
5. PAYE and VAT non-filers	letter, phone call, email, physical visits	Nudge on un-submitted PAYE and VAT returns	DT	Every month, after deadline. Site visit for defaulter more than 5 to 6 times consecutively.
6. Provisional tax	letter	pre-payment of taxes.	DT	twice a year

C Main results

Table A9 Non-filers - impact on deregistration probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	CIT	CIT	PIT	PIT	PIT	PIT
Deterrence	0.004	0.002	-0.005	-0.004	0.006	0.005	0.006	0.005
	(0.003)	(0.003)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Compliance costs	0.005	0.003	0.004	0.005	-0.000	0.000	-0.000	0.000
	(0.003)	(0.003)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Deregistration	0.007**	0.005	0.004	0.008	0.002	0.002	0.002	0.002
	(0.003)	(0.003)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)
Fiscal exchange							0.005	0.005
							(0.004)	(0.004)
Social norm							0.009**	0.009**
							(0.004)	(0.004)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.017	0.017	0.026	0.026	0.017	0.017	0.017	0.017
R-sq.	0.000	0.004	0.001	0.018	0.000	0.003	0.000	0.005
F joint test	0.070	0.354	0.442	0.328	0.534	0.573	0.227	0.258
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having deregistered from the tax system. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A10 Non-filers - impact on log tax declared

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	CIT	CIT	PIT	PIT	PIT	PIT
Deterrence	0.013	0.020	-0.016	-0.012	0.013	0.013	0.013	0.013
	(0.024)	(0.025)	(0.049)	(0.050)	(0.031)	(0.030)	(0.031)	(0.030)
Compliance costs	0.010	0.016	-0.087**	-0.091**	0.063*	0.063*	0.063*	0.062*
	(0.024)	(0.025)	(0.043)	(0.044)	(0.036)	(0.036)	(0.036)	(0.036)
Deregistration	0.022	0.028	-0.000	0.000	0.017	0.017	0.017	0.017
	(0.024)	(0.025)	(0.050)	(0.051)	(0.031)	(0.031)	(0.031)	(0.031)
Fiscal exchange							-0.003	-0.001
							(0.029)	(0.029)
Social norm							-0.012	-0.012
							(0.028)	(0.028)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.125	0.125	0.158	0.158	0.123	0.123	0.123	0.123
R-sq.	0.000	0.005	0.001	0.007	0.000	0.006	0.000	0.007
Observations	22399	22274	4210	4085	18189	18189	20906	20906

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is the log(tax+1) declared. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A11 Nil-filers - impact on deregistration probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	CIT	CIT	PIT	PIT
Deterrence	0.005	0.005	0.005	0.004	0.006	0.005
	(0.004)	(0.004)	(0.009)	(0.009)	(0.004)	(0.004)
Deregistration	0.004	0.004	0.000	0.000	0.007⇤	0.005
	(0.004)	(0.004)	(0.009)	(0.009)	(0.004)	(0.004)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.008	0.008	0.018	0.018	0.003	0.003
R-sq.	0.000	0.010	0.000	0.006	0.001	0.020
F joint test	0.439	0.439	0.844	0.844	0.231	0.231
Observations	3508	3508	1352	1352	2156	2156

⇤ $p < 0.10$, ⇤⇤ $p < 0.05$, ⇤⇤⇤ $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having deregistered from the tax system. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A12 VAT discrepancy - impact on higher tax declared

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Non-Active	Non-Active	Active	Active
Deterrence	-0.022	-0.005	-0.146	-0.111	-0.016	0.003
	(0.040)	(0.041)	(0.131)	(0.133)	(0.041)	(0.043)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.381	0.381	0.263	0.263	0.390	0.390
R-sq.	0.001	0.011	0.034	0.117	0.000	0.011
Observations	600	600	36	36	564	564

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having increased the income tax remitted. All coefficients are OLS estimates from a LPM. *All* refers to the total of non-active and active taxpayers, *Non-active* indicates non- and nil-filers, while *Active* stands for positive filing taxpayers.

4 LATE estimates

Table A13 Nil-filers - Impact on active filing probability - LATE

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	CIT	CIT	PIT	PIT
Deterrence	-0.004	-0.003	-0.011	-0.013	0.010	-0.004
	(0.027)	(0.027)	(0.018)	(0.018)	(0.064)	(0.065)
Deregistration	0.008	0.005	-0.007	-0.005	0.038	0.021
	(0.027)	(0.027)	(0.018)	(0.017)	(0.069)	(0.068)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.168	0.168	0.075	0.075	0.225	0.225
R-sq.	.	0.011	.	0.029	0.002	0.017
F-stat	785.73	1840.09	3917.22	3924.23	181.52	452.76
Observations	3508	3508	1352	1352	2156	2156

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed a non-zero income tax return. All coefficients are LATE estimates where actual exposure to the treatment is instrumented by the random assignment to it. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A14 Active - impact on the probability to increase tax declared - LATE

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	0.017	0.017	0.016	0.016	0.017	0.017
	(0.024)	(0.024)	(0.025)	(0.025)	(0.044)	(0.044)
Fiscal exchange	-0.023	-0.023	-0.058**	-0.058**	0.020	0.020
	(0.024)	(0.024)	(0.024)	(0.024)	(0.044)	(0.043)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.348	0.348	0.280	0.280
R-sq.	0.001	0.014	0.003	0.012	.	0.017
F-stat	1435.30	3328.82	6483.64	6473.84	483.18	1167.01
Observations	8678	8678	2497	2497	6181	6181

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are LATE estimates where actual exposure to the treatment is instrumented by the random assignment to it. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

5 Additional results

Table A15 Active - impact on VAT outcomes

	(1)	(2)	(3)	(4)
	Filing	**Filing**	**IHS VAT**	**IHS VAT**
Deterrence	0.023	0.024	0.128	0.120
	(0.022)	(0.022)	(0.502)	(0.516)
Fiscal exchange	0.013	0.017	0.269	0.158
	(0.023)	(0.022)	(0.493)	(0.507)
Controls	No	Yes	No	Yes
Mean of Y	0.843	0.843	6.745	6.678
R-sq.	0.001	0.034	0.000	0.012
Observations	1578	1578	1302	1192

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. All coefficients are OLS estimates. *Filing* refers to the probability of filing a VAT return while *PIT* stands for the VAT amount remitted.

Table A16 Non-filers - impact on number of past returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.043***	0.023*	0.036	0.032	0.019	0.018	0.019	0.018
	(0.012)	(0.012)	(0.026)	(0.026)	(0.015)	(0.015)	(0.015)	(0.015)
Compliance costs	0.021*	0.003	0.011	0.009	-0.000	-0.000	-0.000	-0.000
	(0.011)	(0.011)	(0.025)	(0.026)	(0.012)	(0.012)	(0.012)	(0.012)
Deregistration	0.038***	0.021*	0.048*	0.050*	0.000	0.001	0.000	0.001
	(0.012)	(0.012)	(0.027)	(0.028)	(0.013)	(0.013)	(0.013)	(0.013)
Fiscal exchange							0.024*	0.024*
							(0.014)	(0.014)
Social norm							0.028**	0.028**
							(0.013)	(0.013)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.065	0.065	0.107	0.107	0.062	0.062	0.062	0.062
R-sq.	0.001	0.005	0.001	0.002	0.000	0.003	0.000	0.004
F joint test	0.000	0.105	0.250	0.266	0.637	0.685	0.143	0.157
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is a continuous variable for the number of past (2013-2018) returns filed. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A17: Non-filers - impact on e-tax registration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.014***	0.010***	0.004	0.006	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.008)	(0.009)	(0.004)	(0.004)	(0.004)	(0.004)
Compliance costs	0.008***	0.005	-0.003	-0.003	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)	(0.003)
Deregistration	0.009***	0.006*	-0.002	0.001	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)	(0.003)
Fiscal exchange							0.007*	0.007*
							(0.004)	(0.004)
Social norm							-0.003	-0.003
							(0.003)	(0.003)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.014	0.014	0.038	0.038	0.012	0.012	0.012	0.012
R-sq.	0.002	0.007	0.000	0.019	0.000	0.003	0.000	0.004
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having registered for the e-tax system. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A18 Active - impact on positive filing probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	0.013**	0.013**	0.023**	0.027***	0.008	0.008
	(0.006)	(0.006)	(0.010)	(0.010)	(0.007)	(0.007)
Fiscal exchange	0.017***	0.017***	0.026***	0.028***	0.013*	0.012*
	(0.006)	(0.006)	(0.009)	(0.010)	(0.007)	(0.007)
Baseline income		0.001***		0.000		0.002***
		(0.000)		(0.000)		(0.000)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.943	0.943	0.948	0.948	0.940	0.940
R-sq.	0.001	0.010	0.004	0.006	0.001	0.013
Observations	8678	8500	2497	2361	6181	6139

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed a non-zero income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A19 Active - impact on IHS tax amounts declared

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	-0.172	0.046	0.065	0.124	-0.260	0.030
	(0.167)	(0.135)	(0.352)	(0.321)	(0.187)	(0.139)
Fiscal exchange	-0.178	-0.100	-0.266	-0.229	-0.143	-0.062
	(0.165)	(0.133)	(0.346)	(0.313)	(0.186)	(0.138)
Baseline income		0.582***		0.402***		0.673***
		(0.012)		(0.024)		(0.012)
Controls	No	Yes	No	Yes	No	Yes
Control mean baseline	1.87	1.87	1.88	1.88	1.86	1.86
Control mean endline	2.01	2.01	1.51	1.51	2.19	2.19
R-sq.	0.000	0.346	0.000	0.171	0.000	0.458
Observations	8504	8422	2370	2308	6134	6114

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is the tax amount remitted. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

6 Discussion of results

Table A20 Non-filers - impact on filing probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**	**PIT**	**PIT**
Deterrence	0.036***	0.026***	0.038***	0.039***	0.017**	0.017**	0.017**	0.017**
	(0.007)	(0.007)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.008)
Cluster town	0.036***	0.026**	0.038***	0.039***	0.017*	0.017*	0.017*	0.017*
	(0.004)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Drop weeks 5-6	0.032***	0.024***	0.034***	0.034***	0.016**	0.016**	0.016**	0.016**
	(0.006)	(0.006)	(0.013)	(0.013)	(0.007)	(0.007)	(0.007)	(0.007)
Compliance costs	0.024***	0.013**	0.007	0.006	0.018**	0.018**	0.018**	0.018**
	(0.006)	(0.006)	(0.013)	(0.013)	(0.008)	(0.008)	(0.008)	(0.008)
Cluster town	0.024***	0.013***	0.007	0.006	0.018*	0.018**	0.018*	0.018**
	(0.002)	(0.002)	(0.008)	(0.008)	(0.007)	(0.006)	(0.007)	(0.006)
Drop weeks 5-6	0.022***	0.014**	0.005	0.004	0.020***	0.020***	0.020***	0.020***
	(0.006)	(0.006)	(0.012)	(0.012)	(0.007)	(0.007)	(0.007)	(0.007)
Deregistration	0.024***	0.014**	0.021	0.021	0.009	0.009	0.009	0.009
	(0.006)	(0.006)	(0.013)	(0.014)	(0.007)	(0.007)	(0.007)	(0.007)
Cluster town	0.024**	0.014*	0.021**	0.021**	0.009	0.009	0.009	0.009
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Drop weeks 5-6	0.025***	0.016***	0.028**	0.028**	0.007	0.007	0.007	0.007
	(0.006)	(0.006)	(0.012)	(0.013)	(0.007)	(0.007)	(0.007)	(0.007)
Fiscal Exchange							0.012	0.013*
							(0.008)	(0.008)
Cluster town							0.012	0.013
							(0.007)	(0.007)
Drop weeks 5-6							0.012*	0.012*
							(0.007)	(0.007)
Social Norm							0.013*	0.014*
							(0.008)	(0.008)
Cluster town							0.013	0.014*
							(0.007)	(0.006)
Drop weeks 5-6							0.018**	0.019***
							(0.007)	(0.007)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
C. Mean	0.069	0.069	0.095	0.095	0.067	0.067	0.067	0.067
C. Mean drop week 5-6	0.054	0.054	0.075	0.075	0.052	0.052	0.052	0.052
R-sq.	0.003	0.016	0.002	0.009	0.001	0.015	0.001	0.015
F joint test	0.000	0.000	0.036	0.027	0.015	0.015	0.017	0.014
Observations	22550	22425	4231	4106	18319	18319	21058	21058

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A21 Nil-filers - impact on positive filing probability

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	-0.002	-0.002	-0.010	-0.012	0.003	-0.002
	(0.015)	(0.015)	(0.017)	(0.017)	(0.022)	(0.022)
Cluster town	-0.002	-0.001	-0.010	-0.012	0.003	-0.003
	(0.014)	(0.013)	(0.009)	(0.010)	(0.024)	(0.023)
Drop weeks 5-6	0.007	0.005	-0.020	-0.014	0.028	0.022
	(0.030)	(0.029)	(0.035)	(0.033)	(0.042)	(0.042)
Deregistration	0.004	0.003	-0.006	-0.005	0.012	0.007
	(0.016)	(0.015)	(0.017)	(0.017)	(0.022)	(0.022)
Cluster town	0.004	0.006	-0.006	-0.005	0.012	0.006
	(0.012)	(0.010)	(0.015)	(0.015)	(0.023)	(0.025)
Drop weeks 5-6	0.022	0.017	-0.019	-0.016	0.050	0.043
	(0.030)	(0.030)	(0.035)	(0.034)	(0.042)	(0.042)
Controls	No	Yes	No	Yes	No	Yes
C. Mean	0.168	0.168	0.075	0.075	0.225	0.225
C. Mean drop week 5-6	0.298	0.298	0.153	0.153	0.404	0.404
R-sq.	0.000	0.011	0.000	0.030	0.000	0.017
F joint test	0.912	0.958	0.830	0.773	0.856	0.924
Observations	3508	3508	1352	1352	2156	2156

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed a non-zero income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A22 Active - impact on the probability to increase tax

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
Deterrence	0.008	0.008	0.015	0.015	0.005	0.006
	(0.012)	(0.012)	(0.023)	(0.023)	(0.014)	(0.014)
Cluster town	0.008	0.008	0.015	0.015	0.005	0.006
	(0.013)	(0.013)	(0.019)	(0.019)	(0.014)	(0.014)
Drop weeks 5-6	0.018	0.018	0.023	0.025	0.016	0.016
	(0.015)	(0.015)	(0.028)	(0.027)	(0.018)	(0.017)
Fiscal exchange	-0.011	-0.012	-0.056**	-0.055**	0.006	0.007
	(0.012)	(0.012)	(0.023)	(0.023)	(0.014)	(0.014)
Cluster town	-0.011	-0.012	-0.056***	-0.055***	0.006	0.007
	(0.011)	(0.011)	(0.018)	(0.018)	(0.011)	(0.010)
Drop weeks 5-6	-0.008	-0.009	-0.057**	-0.056**	0.014	0.013
	(0.015)	(0.015)	(0.027)	(0.027)	(0.018)	(0.017)
Controls	No	Yes	No	Yes	No	Yes
C. Mean	0.300	0.300	0.348	0.348	0.280	0.280
C. Mean drop weeks 5-6	0.323	0.323	0.358	0.358	0.308	0.308
R-sq.	0.000	0.014	0.004	0.013	0.000	0.017
F joint test	0.000	0.000	0.000	0.000	0.000	0.000
Observations	8678	8678	2497	2497	6181	6181

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A23 Nudge impact by receiving any T

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**CIT**	**CIT**	**PIT**	**PIT**
	Panel A: Nil-filers - prob. to positively file					
Any nudge	0.001	0.001	-0.008	-0.008	0.008	0.003
	(0.013)	(0.013)	(0.015)	(0.015)	(0.019)	(0.019)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.168	0.168	0.075	0.075	0.225	0.225
R-sq.	0.000	0.011	0.000	0.030	0.000	0.017
Observations	3508	3508	1352	1352	2156	2156
	Panel B: Actives – prob. to increase tax liability					
Any nudge	-0.002	-0.002	-0.020	-0.020	0.006	0.006
	(0.010)	(0.010)	(0.020)	(0.020)	(0.012)	(0.012)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.348	0.348	0.280	0.280
R-sq.	0.000	0.013	0.000	0.010	0.000	0.017
Observations	8678	8678	2497	2497	6181	6181

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. In panel A, the dependent variable is an indicator variable for having filed a non-zero income tax return. In panel B, the dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A24 Non-filers - impact on on-time filing probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	CIT	CIT	PIT	PIT	PIT	PIT
Deterrence	0.013***	0.008	0.026**	0.028***	0.002	0.002	0.002	0.002
	(0.005)	(0.005)	(0.010)	(0.010)	(0.006)	(0.006)	(0.006)	(0.006)
Compliance costs	0.013**	0.007	0.012	0.012	0.012*	0.012*	0.012*	0.012*
	(0.005)	(0.005)	(0.010)	(0.010)	(0.006)	(0.006)	(0.006)	(0.006)
Deregistration	0.014***	0.008	0.017*	0.017*	0.011*	0.011*	0.011*	0.011*
	(0.005)	(0.005)	(0.010)	(0.010)	(0.006)	(0.006)	(0.006)	(0.006)
Fiscal exchange							0.004	0.004
							(0.006)	(0.006)
Social norm							0.002	0.002
							(0.006)	(0.006)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Control mean	0.043	0.043	0.045	0.045	0.043	0.043	0.043	0.043
R-sq.	0.001	0.007	0.002	0.005	0.000	0.009	0.000	0.009
F joint test	0.000	0.147	0.066	0.054	0.121	0.111	0.310	0.288
Observations	22544	22419	4226	4101	18318	18318	21057	21057

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return on time (by the date of the deadline). All coefficients are OLS estimates from a LPM. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A25 Active - impact on log income declared

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	CIT	CIT	PIT	PIT
Deterrence	0.320**	0.380**	0.274	0.356*	0.307	0.335*
	(0.161)	(0.153)	(0.258)	(0.199)	(0.190)	(0.188)
Fiscal exchange	0.120	0.143	0.262	0.093	0.060	0.090
	(0.161)	(0.152)	(0.259)	(0.200)	(0.188)	(0.187)
Baseline income		0.384***		0.908***		0.160***
		(0.017)		(0.024)		(0.021)
Controls	No	Yes	No	Yes	No	Yes
C. Mean baseline	5.59	5.59	12.24	12.24	3.00	3.00
C. Mean endline	9.46	9.46	11.80	11.80	8.55	8.55
Observations	8591	8571	2410	2390	6181	6181

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is log income declared. All coefficients are OLS estimates. *All* refers to the total of corporate and individual taxpayers, *CIT* indicates companies only while *PIT* stands for individual income tax payers.

Table A26: Active - impact on log expenses and log deductions declared (CIT only)

	Expenses	Expenses	Deductions	Deductions
Deterrence	0.148	0.253*	0.142	0.261
	(0.212)	(0.152)	(0.284)	(0.263)
Fiscal exchange	0.228	0.149	0.166	0.138
	(0.212)	(0.151)	(0.285)	(0.261)
Baseline expenses		1.118***		0.522***
		(0.044)		(0.022)
Controls	No	Yes	No	Yes
Control mean baseline	12.85	12.85	3.80	3.80
Control mean endline	11.68	11.68	3.69	3.69
Observations	2472	2357	2411	2383

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. *Expenses* indicate the amount of costs declared, while *Expenses* stand for the amount of deductions.
All coefficients are OLS estimates from a LPM.

Table A27 Active - impact on the probability to increase tax declared

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Perpetual	Perpetual	Non-perp.	Non-perp.
	Panel A: Actives - prob. to increase tax liability					
Deterrence	0.008	0.008	-0.001	-0.001	0.056**	0.054**
	(0.012)	(0.012)	(0.014)	(0.014)	(0.025)	(0.025)
Fiscal exchange	-0.011	-0.012	-0.019	-0.019	0.025	0.026
	(0.012)	(0.012)	(0.013)	(0.013)	(0.025)	(0.025)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.323	0.323	0.194	0.194
R-sq.	0.000	0.014	0.000	0.013	0.003	0.026
Observations	8678	8678	7063	7063	1615	1615
	Panel B: Nil-filers - prob. to positively file					
Deterrence	-0.002	-0.002	-0.015	-0.015	-0.002	0.001
	(0.015)	(0.015)	(0.016)	(0.015)	(0.029)	(0.029)
Deregistration	0.004	0.003	-0.001	0.001	0.003	0.003
	(0.016)	(0.015)	(0.016)	(0.016)	(0.030)	(0.030)
Controls	No	Yes	No	Yes	No	Yes
Mean of Y	0.168	0.168	0.097	0.097	0.276	0.276
R-sq.	0.000	0.011	0.001	0.032	0.000	0.010
Observations	3508	3508	2115	2115	1393	1393

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. In panel A, the dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. In panel B, the dependent variable is an indicator variable for having filed a non-zero income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of perpetual and non-perpetual taxpayers, *Perpetual* indicates taxpayers who have been actively filing (panel A) or nil-filing (panel B) since registration with the authority, while *Non-perp.* stands for taxpayers who have alternatively opted for the 3 filing behaviours.

Table A28 Nudge impact by registration year

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**All**	**First**	**First**	**2nd+**	**2nd+**
	Panel A: Non-filers - prob. to file					
Deterrence	0.036***	0.024***	0.029	-0.003	0.037***	0.026***
	(0.007)	(0.007)	(0.034)	(0.035)	(0.007)	(0.007)
Compliance costs	0.024***	0.011*	0.013	-0.021	0.024***	0.014**
	(0.006)	(0.007)	(0.032)	(0.034)	(0.006)	(0.007)
Deregistration	0.024***	0.012*	0.024	-0.009	0.024***	0.014**
	(0.006)	(0.006)	(0.033)	(0.034)	(0.006)	(0.007)
Fiscal exchange	0.010	0.013*	-0.072**	-0.064**	0.016**	0.018**
	(0.008)	(0.008)	(0.032)	(0.032)	(0.008)	(0.008)
Social norm	0.012	0.014*	0.109**	0.115**	0.007	0.009
	(0.008)	(0.008)	(0.054)	(0.053)	(0.007)	(0.007)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.069	0.069	0.148	0.148	0.064	0.064
R-sq.	0.002	0.016	0.007	0.020	0.002	0.013
Observations	25289	25164	1494	1493	23795	23671
	Panel B: Nil-filers - prob. to positively file					
Deterrence	-0.002	-0.002	-0.090	-0.092*	0.006	0.007
	(0.015)	(0.015)	(0.056)	(0.055)	(0.016)	(0.016)
Deregistration	0.004	0.004	-0.029	-0.012	0.008	0.006
	(0.016)	(0.016)	(0.059)	(0.059)	(0.016)	(0.016)
Controls	No	No	No	Yes	No	Yes
Control mean	0.168	0.168	0.233	0.233	0.161	0.161
R-sq.	0.000	0.000	0.009	0.056	0.000	0.012
Observations	3508	3508	287	287	3221	3221
	Panel C: Actives - prob. to increase tax liability					
Deterrence	0.008	0.008	-0.042	-0.053	0.010	0.011
	(0.012)	(0.012)	(0.067)	(0.067)	(0.012)	(0.012)
Fiscal exchange	-0.011	-0.012	-0.038	-0.053	-0.010	-0.010
	(0.012)	(0.012)	(0.064)	(0.065)	(0.012)	(0.012)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.324	0.324	0.299	0.299
R-sq.	0.000	0.014	0.002	0.020	0.000	0.014
Observations	8678	8678	291	291	8387	8387

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. In panel A, the dependent variable is an indicator variable for having filed an income tax return. In panel B, the dependent variable is an indicator variable for having filed a non-zero income tax return. In panel C, the dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of young and old taxpayers, *First year* indicates taxpayers who filed for the first time in the baseline year 2018, while *2nd Year and more* stands for taxpayers who were at their second year of more when they filed in in the baseline year 2018.

Table A29 Nudge impact by urban/rural location

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Urban	Urban	Rural	Rural
	Panel A: Nil-filers - prob. to positively file					
Deterrence	-0.002	-0.002	0.009	0.009	-0.022	-0.019
	(0.015)	(0.015)	(0.019)	(0.019)	(0.026)	(0.026)
Deregistration	0.004	0.004	0.008	0.004	-0.003	0.001
	(0.016)	(0.016)	(0.019)	(0.019)	(0.027)	(0.027)
Controls	No	No	No	Yes	No	Yes
Control mean	0.168	0.168	0.233	0.233	0.161	0.161
R-sq.	0.000	0.000	0.000	0.019	0.001	0.009
Observations	3508	3508	2167	2167	1341	1341
	Panel B: Actives – prob. to increase tax liability					
Deterrence	0.008	0.008	0.010	0.009	0.005	0.007
	(0.012)	(0.012)	(0.016)	(0.016)	(0.019)	(0.019)
Fiscal exchange	-0.011	-0.012	-0.002	-0.004	-0.027	-0.023
	(0.012)	(0.012)	(0.016)	(0.016)	(0.018)	(0.018)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.318	0.318	0.272	0.272
R-sq.	0.000	0.014	0.000	0.011	0.001	0.020
Observations	8678	8678	5251	5251	3427	3427

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. In panel A, the dependent variable is an indicator variable for having filed a non-zero income tax return. In panel B, the dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of urban and rural taxpayers, *Urban* indicates non-filers located in urban areas, while *Rural* stands for taxpayers are located in rural areas.

Table A30 Active - impact on the probability to increase tax

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Dec. 1	Dec. 1	Dec. 2-10	Dec. 2-10
Deterrence	0.008	0.008	-0.018	-0.018	0.012	0.012
	(0.012)	(0.012)	(0.038)	(0.038)	(0.013)	(0.013)
Fiscal exchange	-0.011	-0.012	-0.062*	-0.070*	-0.005	-0.005
	(0.012)	(0.012)	(0.038)	(0.038)	(0.013)	(0.013)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.300	0.300	0.384	0.384	0.289	0.289
R-sq.	0.000	0.014	0.003	0.015	0.000	0.014
Observations	8678	8678	971	971	7707	7707

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of small and large taxpayers, *Dec. 1* indicates taxpayers for the top income decile, while *Dec. 2-10* stands taxpayers in all remaining deciles.

Table A31 Nudge impact by age (PIT only)

	(1)	(2)	(3)	(4)	(5)	(6)
	All PIT	All PIT	Young	Young	Old	Old
	Panel A: Non-filers - prob. to file					
Deterrence	0.017**	0.017**	0.013	0.013	0.030	0.028
	(0.006)	(0.006)	(0.014)	(0.013)	(0.023)	(0.022)
Compliance costs	0.018*	0.018**	-0.004	-0.003	0.039	0.041
	(0.007)	(0.006)	(0.007)	(0.008)	(0.019)	(0.018)
Deregistration	0.009	0.009	0.001	-0.000	0.014	0.016
	(0.006)	(0.006)	(0.004)	(0.003)	(0.010)	(0.012)
Fiscal exchange	0.012	0.013*	0.002	0.002	0.020*	0.020*
	(0.007)	(0.007)	(0.010)	(0.010)	(0.008)	(0.008)
Social norm	0.013*	0.014*	0.013*	0.013*	0.018	0.018
	(0.007)	(0.006)	(0.005)	(0.004)	(0.013)	(0.011)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.067	0.067	0.069	0.069	0.071	0.071
R-sq.	0.001	0.015	0.000	0.017	0.002	0.030
Observations	21058	21058	9909	9909	9362	9362
	Panel B: Nil-filers - prob. to positively file					
Deterrence	0.003	0.003	0.007	0.006	0.009	-0.000
	(0.022)	(0.022)	(0.031)	(0.031)	(0.033)	(0.033)
Deregistration	0.012	0.012	-0.004	-0.008	0.029	0.024
	(0.022)	(0.022)	(0.031)	(0.031)	(0.033)	(0.033)
Controls	No	No	No	Yes	No	Yes
Control mean	0.225	0.225	0.217	0.217	0.241	0.241
R-sq.	0.000	0.000	0.000	0.016	0.001	0.035
Observations	2156	2156	1065	1065	1011	1011
	Panel C: Actives – prob. to increase tax liability					
Deterrence	0.005	0.006	0.023	0.022	-0.013	-0.010
	(0.014)	(0.014)	(0.020)	(0.020)	(0.020)	(0.020)
Fiscal exchange	0.006	0.007	0.006	0.008	0.008	0.007
	(0.014)	(0.014)	(0.020)	(0.019)	(0.020)	(0.020)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.280	0.280	0.277	0.277	0.283	0.283
R-sq.	0.000	0.017	0.000	0.028	0.000	0.013
Observations	6181	6181	3124	3124	3021	3021

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. In panel A, the dependent variable is an indicator variable for having filed an income tax return. In panel B, the dependent variable is an indicator variable for having filed a non-zero income tax return. In panel C, the dependent variable is an indicator variable for having increased the tax declared compared to the baseline year. All coefficients are OLS estimates from a LPM. *All* refers to the total of young and old taxpayers, *Young* indicates taxpayers who are younger than the median age in the sample (50), while *2nd Year and more* stands for taxpayers who are older than the median age.

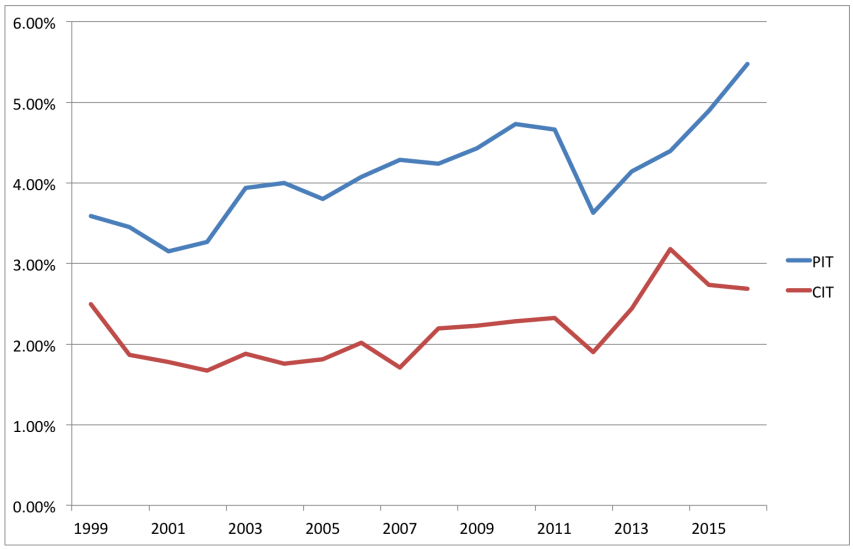
Table A32 Nudge impact by civil status (PIT only)

	(1)	(2)	(3)	(4)	(5)	(6)
	All PIT	All PIT	Married	Married	Non-married	Non-married
	Panel A: Non-filers - prob. to file					
Deterrence	0.017**	0.017**	0.020	0.017	-0.001	0.002
	(0.008)	(0.008)	(0.016)	(0.016)	(0.013)	(0.013)
Compliance costs	0.018**	0.018**	-0.010	-0.009	0.006	0.009
	(0.008)	(0.008)	(0.013)	(0.013)	(0.014)	(0.014)
Deregistration	0.009	0.009	0.022	0.021	0.012	0.011
	(0.007)	(0.007)	(0.016)	(0.016)	(0.014)	(0.014)
Fiscal exchange	0.012	0.013*	-0.004	-0.007	0.026*	0.026*
	(0.008)	(0.008)	(0.014)	(0.014)	(0.015)	(0.015)
Social norm	0.013*	0.014*	0.023	0.024	0.018	0.019
	(0.008)	(0.008)	(0.016)	(0.016)	(0.014)	(0.014)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.067	0.067	0.084	0.084	0.058	0.058
R-sq.	0.001	0.015	0.001	0.025	0.001	0.025
Observations	21058	21058	6166	6166	5555	5555
	Panel B: Actives - prob. to increase tax liability					
Deterrence	0.005	0.006	-0.029	-0.027	0.012	0.009
	(0.014)	(0.014)	(0.023)	(0.023)	(0.034)	(0.033)
Fiscal exchange	0.006	0.007	0.027	0.027	-0.045	-0.046
	(0.014)	(0.014)	(0.024)	(0.024)	(0.033)	(0.033)
Controls	No	Yes	No	Yes	No	Yes
Control mean	0.280	0.280	0.296	0.296	0.279	0.279
R-sq.	0.000	0.017	0.003	0.018	0.003	0.045
Observations	6181	6181	2236	2236	1051	1051

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. The dependent variable is an indicator variable for having filed an income tax return. All coefficients are OLS estimates from a LPM. *All* refers to the total of married and non-married taxpayers, *Married* indicates non-filers who are married, while *Non-married* stands for taxpayers who are not married.

6 Figures

Figure A1 PIT vs CIT shares over GDP



Source: ICTD Government Revenue Dataset.

Figure A2 Deregistrations from the tax system

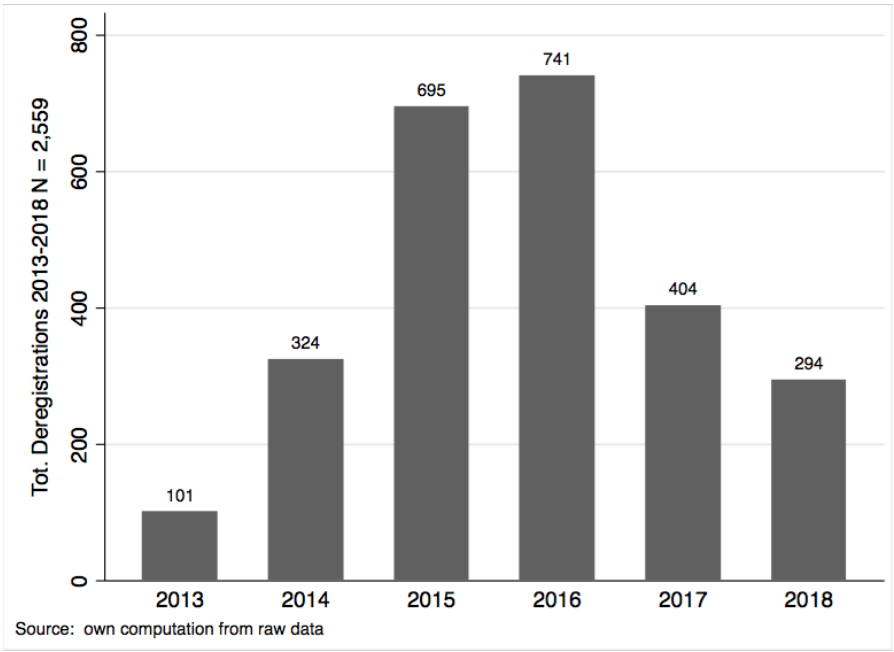


Figure A3 Experiment letter

Eswatini Revenue Authority

HEADQUARTERS
Portion 419 of Farm 50
Ezulwini
Along MR 103 (Mvutshini-Gables Road)
GPS Coordinates: S 26 25.120 E 31 10.823

PO Box 5628, Mbabane, Eswatini
Tel: +268-2406 4000 Fax: +268-2406 4001
E-mail: info@sra.org.sz
Website: www.sra.org.sz

Our Ref: SRA11/6/«TIN»/ZN Date: **23/10/2019**

«Taxpayername»
«POBox_2»
«Town_2»

Dear Sir / Madam,

RE: COMPLY TO AVOID PENALTIES AND FINES FOR FAILURE TO FILE

According to the records of the Eswatini Revenue Authority (SRA), you did not submit your income tax return for the tax year 2018. For this reason, SRA wants to inform you that:

- SECTION 66 of the INCOME TAX ORDER (1975): a taxpayer who fails to submit a return within the stipulated period commits an offence and may be liable on conviction to a fine of **E 10,000**, or imprisonment for a period of up to **one year**, or both.
- SECTION 40 of the INCOME TAX ORDER (1975): a taxpayer who defaults in submitting a return for any year of assessment is liable to pay additional tax of an amount equal to **twice the tax chargeable** in respect to his taxable income for such year of assessment

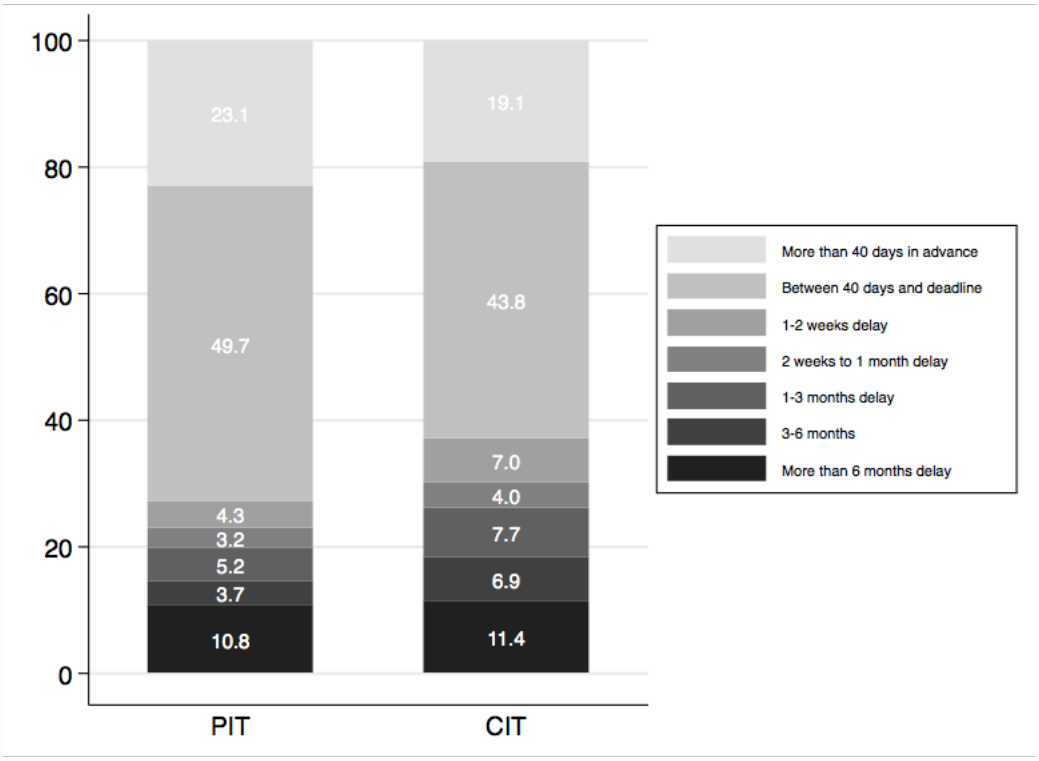
Please, comply with your tax obligations and to ensure your declarations are correct to avoid fines and penalties.

You can get further information or assistance by contacting the SRA Service Center at: Tel +268 2406 4000; Fax +268 2406 4001. You can also email us at: info@sra.org.sz. Please, always mention your taxpayer identification number (TIN) in all correspondence with the SRA.

Yours faithfully,

Director of Compliance
Domestic Taxes

Figure A4 Timing of filing of income tax return 2013-2018



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