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Harnessing Deductions to Increase Tax Compliance and Formalization

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Abstract

We evaluate a tax reform in Ecuador that introduced generous deductions from personal income taxes (PIT), encouraging consumers to request receipts. The reform addresses tax evasion by targeting small self-employed businesses that mainly sell goods or services not subject to VAT but often evade income taxes. Exploiting plausibly exogenous variation in receipt demand due to the distribution of taxpayers across regions and professions, we find significant increases in reported profits among self-employed businesses exposed to the reform. We document spillover effects on the VAT system. Our net-revenue impact analysis suggests that the additional tax payments outweigh the foregone tax revenue.

Keywords: Formalization, Tax Avoidance, VAT, Personal Income Tax
JEL Codes: O17, H26, H24, H25

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1 Introduction

To curb the participation of businesses in the informal sector and to increase tax compliance, many developing countries have enacted policies that generate paper trails and automatic third-party reporting (Kleven, Kreiner, and Saez, 2016), mainly within the VAT system (Pomeranz, 2015; Naritomi, 2019). However, due to frequent 0%-ratings and exemptions based on firm size, industry, or product category, substantial parts of economies often legally operate outside of the VAT system. It is unclear how to induce third party reporting and paper trail generation for sectors of the economy not subject to VAT.

This paper evaluates a unique reform aimed at increasing the demand for receipts by final consumers, thereby creating paper trails for business-to-customer sectors of the economy previously marred by tax avoidance and evasion. The demand for receipts is stimulated through extensive deduction possibilities in personal income tax (PIT). The introduction of these deduction opportunities is a key driver of a large increase in formalization in Ecuador, as evidenced by a strong increase in the number of taxpayers and an increase in the tax-to-gdp ratio from 10 to 21% between 2000 and 2015 (Modica, Laudage, and Harding, 2018). The deduction opportunities were first introduced in 2008 and allow taxpayers to deduct expenditures on health, education, housing, food and clothing. Importantly, a large part of the deductible goods are 0%-rated within the VAT system such that alternative policies targeting VAT transactions will not be effective.[1] Moreover, a large part of the deductible goods and services are offered by self-employed individuals, a group that is particularly prone to tax evasion and avoidance, either by completely operating in the informal sector or by flexibly shifting income between formal and informal accounts (e.g., Saez, 2010; Mortenson and Whitten, 2020).

The possibility to deduct expenditures in health, education, housing, food and clothing increased the demand for formal receipts, which are required to claim deductions on the purchase of related goods by consumers. Consequently, businesses might experience an increased pressure to issue such formal receipts and hence operate in the formal sector.[2] In order to estimate the effect of the deduction policy on formalization, we exploit regional variation in the exposure to the reform. PIT in Ecuador is levied at relatively high levels of income above 10,000 USD. Consequently, only high-income earners have an incentive to demand and collect formal receipts in order to reduce their tax liability. Across 219 administrative regions within Ecuador, we find substantial regional variation in the (pre-reform) share of high-income individuals among the population, resulting in substantial variation in the demand for formal receipts. Drawing on detailed administrative data, we estimate a difference-in-differences framework with a continuous measure of treatment intensity (Callaway, Goodman-Bacon, and Sant'Anna, 2024), exploiting the regional heterogeneity in the bite of the reform given by the pre-reform fraction of high-income individuals. We present five main results.

First, we show that deduction possibilities for the population of personal income taxpayers

[1] Limits for the maximum amount of deductions apply. Please refer to Section 2 for details. Expenditures on health and education are generally 0% VAT-rated. In housing, rental and mortgage payments are 0%-rated, and in the food category, only basic food items are 0%-rated. We exploit the difference in the VAT status to separate between direct and indirect spillovers of PIT deductions on VAT payments.

[2] Formal receipts are issued including the name and id number of the customer and can be used by tax authorities as a third-party reported device for tax audits.

have a large impact on reported profits of self-employed business owners. Prior to the reform, the trends in reported profits do not differ significantly between strongly and less strongly exposed regions. After the reform, business owners in regions with a stronger demand for formal receipts report significantly higher profits relative to business owners in regions with lower demand. To a large extent, the increase in high-exposure regions is driven by the new filings of self-employed business owners who never reported positive profits before the reform. The effects of the reform are large and highly significant for smaller self-employed businesses that have substantial leeway in their tax reporting duties. Quite in contrast, for self-employed owners of larger businesses—who face substantially stricter reporting requirements and external control by accountants—the reform had no discernible effect.

Second, we examine differences between business owners working in occupations that are directly affected by the demand for receipts (because they offer deductible goods or services) and those working in unaffected occupations (because they do not offer deductibles). We use this additional source of variation to address potential concerns about differential trends of strongly exposed regions compared to less exposed regions that could arise because we observe only a short pre-treatment period. Combining the tax returns with data on registered professions from the civil registry, we observe whether the services offered by a particular profession are included in the deduction categories and hence face increased demand for receipts. In a first approach, we compare medical doctors and dentists (whose services can be deducted) to veterinary physicians (whose business activities are somewhat comparable but cannot be deducted). In triple-difference regressions, we show that the difference in reported profits between doctors and veterinarians is substantially larger in stronger exposed regions than in less exposed regions after the reform. We show similar results for the comparison of self-employed individuals with a university degree in education (deductible) to those with a university degree in other (non-deductible) social professions. In a more general approach, we find similar results when we use a machine-learning algorithm to classify occupations into those affected by the reform and those unaffected, suggesting that our findings are not limited to health care professionals and teachers.

Third, we use a similar identification strategy to assess potential spillovers onto the VAT system. We find that—after the reform—the difference in VAT liability between firms in sectors whose products can be deducted from PIT and firms in sectors whose products cannot be deducted increases significantly more in regions with a higher share of high-income earners. We distinguish between direct effects for VAT on sectors that predominantly sell goods and services liable to regular VAT rates (and hence have an additional VAT-induced incentive to avoid reporting sales) and indirect effects on sectors that predominantly sell 0%-VAT rated goods and services (and have no VAT-induced incentive to avoid reporting sales of these goods). We find evidence for direct effects of PIT deductions on VAT payments by comparing expenses for food consumed in restaurants (subject to VAT and deductible from PIT) to expenses for stays in hotels (liable to VAT but not deductible from PIT). Moreover, we find smaller but significant indirect effects of PIT deductions on VAT payments by comparing expenses for basic food items in the retail industry (not liable to VAT and facing demand from PIT payers) to those in the wholesale industry (not liable to VAT and not facing demand from PIT payers). Our results

suggest that these indirect effects are driven by firms that sell both VAT-liable and 0%-VAT rated goods, but cannot provide separate receipts to customers. We confirm that our findings extend beyond the food industry using a machine-learning based classification algorithm.

Fourth, we assess whether the introduction of the possibility to deduct expenses for certain goods influenced household consumption patterns. For taxpayers who claim deductions, deductible goods and services experience a decline in their relative price, which could lead to increases in their consumption and confound the effect on increased profits of self-employed businesses. Drawing on household survey data on consumption behavior, we compare spending patterns of households who benefit from claiming deductions because their income level is high enough that they have to pay personal income taxes to a control group of households with slightly lower income. We do not find systematic evidence that households who benefit from the deductions increase their spending on deductible goods more than the control households. In particular, our survey data show parallel trends in expenditures for both groups—even when controlling for demographics and household composition in difference-in-differences regressions based on a pseudo-panel from the repeated cross-sections in the survey.

Finally, we conduct a net revenue impact analysis contrasting the fiscal gains due to the increased reporting of self-employed business owners with the fiscal costs of the policy in terms of foregone PIT payments due to the deductions. Our estimates suggest that the fiscal gains accruing to PIT outweigh the costs initially. However, as more and more consumers learn about the possibility to deduct their expenses, the fiscal costs increase over time and exceed the fiscal gains from PIT revenue of additionally reported self-employment profits. Only when also considering effects on VAT reporting, the policy has a positive net revenue impact. Therefore, our results suggest that inducing self-employed business owners and VAT liable firms to correctly report their business activity by creating pressure through customers' demand for formal receipts forms a cost-effective way to lower the compliance gap between taxes legally due and taxes actually paid. Importantly, as Keen and Slemrod (2017) note, cost-effectiveness is not necessarily welfare-improving as higher tax compliance could also distort incentives for real business activity and imply that certain transactions in the economy are not undertaken. However, the limited evidence for changes in consumption patterns suggests that the deduction reform affected tax compliance, but not overall demand.

Our paper contributes to several strands of the literature. Recent papers look into improving tax compliance of developing economies using third-party information (Kumler, Verhoogen, and Frías, 2020; Pomeranz, 2015; Gerard and Gonzaga, 2021; Naritomi, 2019; Brockmeyer, Smith, Hernandez, and Kettle, 2019; Rocha, Ulyssea, and Rachter, 2018). The theoretical basis for the importance of third party information is discussed in Kleven et al. (2016). In practice, various approaches have been proposed to expand third-party reporting by providing financial incentives for consumers to ask and in some cases to report receipts. These incentives often take the form of direct rebates or lottery ticket rewards (Naritomi, 2019; Fabbri, 2015; Marchese, 2009). An alternative approach, closely related to our setting, lies in providing deductions within the personal income tax system.[3] Buettner, Madzharova, and Zaddach (2023) examine

[3]In addition to incentivizing paper trails, deductions also influence behavioral responses to personal income taxes as shown in recent estimates of the elasticity of taxable income (Doerrenberg, Peichl, and Siegloch, 2017;

spillover effects of deductions on the evasion of VAT in Germany. Similarly, Doerr and Necker (2021); Burgstaller, Doerr, and Necker (2023); Harju, Jysmä, Koivisto, and Kosonen (2021) study the impact of income tax credits that households in Germany, Sweden, and Finland receive when buying particular household services such as cleaning. The key difference of our setting lies in the scope: While the policies above focus on specific sectors (e.g., a limited set of services), certain types of sales outlets, or localized regions, the Ecuadorian policy affected a large fraction of offered goods and services, accounting for more than 50% of all eligible households' expenditures.

Compared to the two closest studies, we document substantially larger effects on affected businesses - in our setting affected self-employed double their reported profits, while Naritomi (2019) finds increased revenue of 21% and Buettner et al. (2023) estimate sales increases of 27 to 48%. All these policies, including the one in Ecuador, lead to true increases in reported profits and tax liabilities which are not offset by increases in reported costs. In contrast to previous studies, we document a strong extensive margin response to the policy, with a large increase in the number of tax declarations of self-employed. In line with the findings of Naritomi (2019) and in contrast to Buettner et al. (2023), we find positive net revenue effects of the deductions policy.

A related policy approach to address tax evasion has been to accelerate the use of electronic payment methods and thereby digitize paper trails of business transactions. Examples of these approaches include VAT rebates for electronic transactions in Uruguay (Brockmeyer and Saenz Somarriba, forthcoming), a demonetization campaign in India (Das, Gadenne, Nandi, and Warwick, 2023), electronic VAT annexes (Fan, Liu, Qian, and Wen, 2023) or electronic sales register machines (Ali, Shifa, Shimeles, and Woldeyes, 2021). While many of these policies have improved tax compliance, in particular the policies establishing consumer incentives to pay electronically have not been so successful in increasing tax collection (Brockmeyer and Saenz Somarriba, forthcoming). In contrast, the deduction policy in Ecuador was not targeted to a specific payment technology but applied generally to a large part of transactions in the country.

More generally, our paper is embedded into a growing literature on taxation and development. This literature has recently explored the rising importance of PIT (Besley and Persson, 2013; Jensen, 2022), frequent evasion of VAT (de Paula and Scheinkman, 2010; Pomeranz, 2015; Waseem, 2023), and the role of firms (Carrillo, Pomeranz, and Singhal, 2017; Asatryan and Peichl, 2017; Bachas and Soto, 2021; Almunia, Hjort, Knebelmann, and Tian, 2022). We combine these strands by focusing on arguably the smallest firms, self-employed, and by studying both PIT and VAT liability.

Finally, our paper speaks to the large literature on tax compliance and evasion (Allingham and Sandmo, 1972; Slemrod, 2007; Kleven, Knudsen, Kreiner, Pedersen, and Saez, 2011; Dwenger, Kleven, Rasul, and Rincke, 2016), including the behavior of self-employed (Chetty, Friedman, Olsen, and Pistaferri, 2011; Bastani and Selin, 2014; Kleven and Waseem, 2013). We study a unique enforcement policy where individual incentives of one agent (in this case the consumer) are harnessed to impact other agents (e.g. sellers). This is in line with a recent ap-

Matikka, 2018; Hamilton, 2018)

proach to tackle ghost firms by directing enforcement efforts not on the ghost firms themselves, but the client firms benefiting from their receipts (Carrillo, Donaldson, Pomeranz, and Singhal, 2023).

The paper is organized as follows. Section 2 provides information on the deduction policy and the taxation of self-employed individuals in Ecuador. Section 3 introduces our data sources and provides descriptive statistics. Section 4 presents the research design and the results at the aggregated regional level, at the level of individual self-employed, and for firms within the VAT system. Section 5 details our analysis on demand effects. Section 6 provides a net revenue impact analysis of the reform. Section 7 concludes.

2 Deductions Policy and Institutional Background

Ecuador, as many countries in Latin America, focused on reducing tax evasion and increasing formality over the past years. Most of the Ecuadorian tax reforms were carried out in 2008 along with a series of policies aimed at expanding social programs, improving public service delivery, and making vital infrastructure investments. These policies were largely unchanged up to 2015 due to a long period of political stability, sustained economic growth, and high oil revenues. The enforcement efforts were accompanied by an increase of top marginal income taxes introducing two additional brackets. Consequently, overall government tax revenue doubled, increasing from 10.3% of GDP in 2000 to 21.1% in 2015 (Modica et al., 2018). Tax revenue in Ecuador can be broadly categorized into a value-added tax (VAT) with a tax rate of 12%, personal income taxes (PIT) levied on wage and self-employment income with a step function for the marginal tax rate, corporate taxes (22% of profits), and a number of special taxes such as excise taxes on certain consumption goods and levies on transferring money abroad.

Personal Income Taxes (PIT) All sources of individual income in Ecuador are subject to a personal income tax (PIT) scheme, including regular wage income as well as profits from self-employed business activities.[4] The tax scheme is progressive, with numerous tax brackets, starting at 5% marginal tax rate for income immediately above the exemption threshold and increasing up to 35% for top incomes above 103,810 USD. The exemption threshold at which PIT first kicks in is relatively high at 10,180 USD annual earnings in 2013.[5] Consequently, only a relatively small fraction of the population generates income above this threshold (refer to Section 3 for descriptive statistics).

Deductions Policy Two major changes affected the Ecuadorian personal income tax (PIT) code in the 2008 reform. To reduce inequality and promote tax equity, two additional progressive

[4] Important exceptions include payments from the social security system (pensions, stipends, disability benefits, etc.), severance payments, certain mandatory end-of-year wage benefits, and a range of specific capital income including interests on certain saving accounts, occasional capital gains and returns from investment funds or long-term deposits.

[5] The exemption threshold is adjusted to inflation every year according to the yearly change in the consumer price index in urban areas published by the national statistical agency INEC. Throughout this paper, all nominal values are deflated to the year 2013 according to this index and the exemption threshold thereby remains constant in real terms.

income tax brackets were established (Cano, 2017). To fight tax evasion and formalize the economy, extensive deduction possibilities were introduced (Dirección Nacional Jurídica, 2007).[6]

Since 2008, individuals liable to pay PIT can deduct expenses in health, education, food, clothing and housing for themselves or their dependents to reduce their taxable income (Villacreses, 2014). A list of deduction categories and examples for deductible items is provided in the Online Appendix Table A.1. Deduction possibilities are sizeable: if used extensively, deductions effectively double the exemption threshold to about 20,000 USD. Nonetheless, limits apply to both the overall deductible amount and each individual deductible category.[7] To claim the deductions, taxpayers are legally obliged to collect and retain the receipts containing customer information including the name and personal identification number of the taxpayer or their dependents.[8] However, they only need to actively present the receipts to the tax authority in case the overall value exceeds a reporting threshold set at 0.5 times the exemption threshold (corresponding to 5,090 USD in 2013).[9] Deductions can only reduce the personal income tax liability to zero (i.e. no tax refunds resulting in a negative tax liability) and cannot be carried forward to subsequent periods.[10]

Taxation of Self-Employed Individuals with self-employed business activities are obliged to pay PIT on their business profits. In order to assess their tax liability, they must submit a self-employed tax declaration form. This form includes information on the different types of income and the costs generated by the relevant business activity (e.g. the expenses of maintaining a doctor's practice can be subtracted from the revenue a doctor generates). Throughout this paper, we look at profits generated by self-employed individuals as the difference between income and costs, aggregating over all income categories in our data.[11]

The specific version of the tax declaration form that self-employed business owners submit depends on the size of their business activities. There are three different categories of self-employed individuals. First, micro-businesses with yearly turnover below 60,000 USD face a

[6]The preamble of the law lists the motivation behind the new legislation. Three out of six economic arguments pertain to the goal of redistribution, while two address tax compliance and the fight against tax evasion (Dirección Nacional Jurídica, 2007). Article 73 introduces the deductions and emphasizes the creation of a paper trail as a first-order issue. While only one paragraph provides a brief definition of the deductibles (important details are left to further regulation), the bill devotes two paragraphs to discussing how the taxpayer needs to document and prove these deductions. In fact, the deduction policy adds a regressive element to the tax scheme: Individuals in higher tax brackets benefit more from the policy as they can reduce their tax payments by a larger fraction. Furthermore, analyses of the effect of the deductions on the income distribution have shown that higher-income individuals use deductions to a larger extent (Cano, 2017; Villacreses, 2014). Therefore, within the 2008 tax reform, the deductions can primarily be seen as a policy tool to formalize the economy.

[7]The total deductible amount is limited to the smaller of 50% of gross income or 1.3 times the exemption threshold. Additionally, a limit of 0.35 times the exemption threshold applies to each deduction category, except health expenses, which are only capped in case the overall limit is reached.

[8]In practice, sellers ask whether clients need a standard receipt ("nota de venta") without name and id number, or the enhanced version required by the tax authority ("factura").

[9]Before 2011, this reporting threshold was set at the fixed amount of 7,500 USD.

[10]Bohne and Nimczik (2024) examine how the deduction policy in Ecuador induced wage earners to reduce their taxable income to values just below the tax exemption threshold. They find that initial take-up of the policy was limited but increased over time. Carrillo et al. (2023) show that in Ecuador, some firms use receipts for inputs fraudulently to inflate costs and reduce tax liability. It is however unclear whether this also presents an issue in individual income taxation.

[11]The income categories reported on the tax form include business profits, professional income, rental income, agricultural income, dividends, financial returns, foreign income sources as well as income from the banana sector and the exploitation of natural resources.

simplified tax regime (*RISE - Régimen Impositivo Simplificado*) that replaces both PIT and VAT liability by small monthly lump-sum payments depending on the reported yearly income and industry. Due to the lump-sum nature of their tax liability and very lax reporting requirements, these micro-businesses are effectively outside of the regular tax system. We do not have access to data for RISE registrations. Importantly for our analysis, freelance professionals with university degrees (e.g. doctors, veterinarians, educators, etc.) are not eligible for this simplified tax regime. We therefore exclude these micro-businesses from our analysis.[12]

Second, self-employed individuals who are not subject to the simplified tax regime fill out the tax declaration form F102A (see Figure A.1 in the Appendix). They need to specify income and costs in the different income categories. These self-employed individuals and their reported profits are the main focus of our analysis.

Third, self-employed individuals with capital above 60,000 USD and annual income above 100,000 USD need to fill out the extensive tax declaration form F102. In addition to the information on the form F102A, this form requires comprehensive accounting information that substantiates the reported business profits, including a revenue and expense statement according to Ecuadorian accounting rules. Moreover, their declaration needs to be co-signed by a legally certified accountant. Due to their larger size and to the external control by accountants, these businesses were more formalized even prior to the deduction reform. Consequently, our subsequent analysis shows that they are less sensitive to changes in the demand for receipts of deductible goods and services.

Value-Added Taxes (VAT) Apart from paying PIT, business owners in Ecuador face a value-added tax (VAT) liability of 12% on many products and services they sell. As is standard in a VAT system, the VAT paid on inputs serves as a credit towards the VAT businesses need to remit, effectively only charging VAT on the value-added by the enterprise. However, certain retail goods and services are 0%-rated within the VAT system. These 0%-VAT rates apply to the vast majority of those goods and services that can be deducted from PIT, particularly, basic food items, rental payments, and any health and education services. Consequently, the self-enforcing mechanisms of VAT (Kopczuk and Slemrod, 2006) have no or only severely dampened effects for this substantial part of the economy. The deductions policy is an attempt to create a paper trail and improve compliance at the so-called "last-mile" retail stage for this part of the economy.[13]

All business owners are obliged to regularly file the VAT tax declaration form F104 (see Figure A.2 in the Appendix).[14] This form contains comprehensive information on both the

[12]This simplified tax regime ("RISE") aims to reduce compliance costs and facilitate formalization for very small enterprises. The idea is that it is better to have the smallest firms registered in some way, even if their revenues are negligible and not subject to enforcement. A number of policies reduce the incentives for self-employed with higher revenue to be part of RISE. Besides strict rules limiting the type of activities allowed (no freelance professionals), these businesses are only allowed to emit a limited number of receipts and they have no access to input VAT recoveries.

[13]Please note that the demand for receipts created by this policy creates a paper trail for the retail stage but does not affect the upstream self-enforcement mechanisms of the VAT system. Moreover, even though technically selling goods at a 0% VAT rate allows businesses to claim refunds on input VAT payments, Ecuador puts severe restrictions on such VAT recoveries. Importantly, VAT on inputs can only be recovered or refunded in the same proportion with which the business sells goods or services at the regular VAT rate. If a business exclusively sells goods at the 0% rate, they cannot use any of their VAT inputs for VAT recoveries.

[14]As an exception, businesses operating under the simplified tax regime *RISE* make a lump-sum payment

sales and the acquisitions and payments businesses have made. The VAT declarations must be filed monthly, except when businesses only sell goods or services 0%-VAT rated, in which case the filing frequency is every six months.

3 Data Sources and Descriptives

We combine various sources of administrative data from Ecuador. The core data sources for our analysis are the universe of personal income tax declarations by self-employed individuals (F102A and F102) in the years 2006-2015 and the universe of value-added tax declarations (F104) in the years 2006-2015. We link these tax records to the Ecuadorian firm-registry (*Catastro de RUC*), where all businesses and self-employed are obliged to provide basic information on their business activities, including the location within administrative districts and the detailed industry affiliation using the 6-digit CIIU codes.

Regional variation Our analysis relies on regional variation in the exposure to the introduction of deduction possibilities. To this aim, we focus on variation across the 221 *cantones* in Ecuador.[15] The *cantones* in Ecuador are quite heterogeneous with respect to their size. Based on aggregate data from the Ecuadorian Census,[16] Table 1 shows that there are 65,777 inhabitants on average in a *cantón*. While some *cantones* have less than 2,000 inhabitants, the two largest cities in Ecuador, Quito and Guayaquil, have more than 2 million inhabitants each.

We use the universe of PIT declarations of wage earners to calculate the share of the population that reports income above the income tax exemption threshold in each *cantón*. Throughout this analysis, all dollar values are expressed in 2013 real USD. This ensures that the income tax exemption threshold is always at the same level (refer to Section 2 for details) and that estimates are comparable over the years. Moreover, all outcome variables are winsorized at the 99th percentile to reduce the effect outliers have on the estimation.

Table 1 provides descriptive statistics on the share of high-income earners at the regional level. On average, in 2007 only 0.5% of the Ecuadorian population earned income above the tax exemption threshold. This share rose to 1% in 2015. There is, however, quite substantial variation across regions. In 2007, four out of the 219 regions had no high-income earners. The median share is 0.23%, the highest shares can be found in the Ecuadorian capital, Quito, and on some of the Galapagos islands, reaching almost 10% of the population in 2007. The spatial distribution of the share of high-income earners in 2007—the year before the introduction of deduction possibilities—is depicted in Figure 1.

Table 1 also shows that the usage of deductions and the number of submitted tax declarations by self-employed individuals have increased over time. Naturally, the usage of deductions was zero in 2007 (before their introduction). It increased to more than 50 USD per inhabitant in

liberating them from any PIT and VAT obligations—and effectively forfeiting their VAT input credit.

[15] In this paper, we focus solely on *cantón* as the relevant administrative district. The smaller administrative division of *parroquia* is also available in the firm-registry data, however, population and socio-demographic indicators are not differentiated by *parroquia* in urban areas. Throughout the analysis we use data on 219 *cantones*. Two cantones ("La Concorida" and "El Pan") drop out because of missing comparable data on the number of inhabitants.

[16] Full population-wide Census from 2010, administered by INEC (*Instituto Nacional de Estadística y Censos*).

2015 (or 5000 USD per PIT payer). The average number of PIT declarations by self-employed per 10,000 inhabitants amounted to 17.7 in 2007 and rose to almost 200 in 2015. Again, there is substantial regional variation in both measures.

Registered professions We combine the PIT declarations with the civil registry (*registro civil*) to obtain information on the registered professions of self-employed individuals. Overall, the data on registered professions in the civil registry is very detailed and contains almost 2600 distinct categories. The registered profession is a central piece of information for Ecuadorian citizens and is, for instance, displayed on the official id card. Whenever individuals in Ecuador graduate from an educational institution or change occupation, they are asked to provide this information to the civil registry. Degrees from educational institutions can only be written into the registry after the individual has provided documentary evidence of graduating and the institution's accreditation. Therefore, individuals frequently use the civil registry as a method to assert the authenticity of their educational attainment. This provides an incentive to report degrees to the civil registry and guarantees good coverage of tertiary degrees within the population. For individuals working without or with little formal education, the entry on their economic activity in the civil registry is less informative.[17]

We map the occupational data from the civil registry to the deduction categories to determine whether the goods and services produced by an occupation are deductible from PIT. Professions offering deductibles are affected by the demand for formal receipts after the deduction reform, while professions offering non-deductibles are not affected. We classify professions in two ways. First, we focus on the more reliable information among highly formalized educational degrees for which individuals have an incentive to report degrees. We hand-pick high-skilled occupations which are clearly linked to specific deduction categories and for which we can define a plausible control group. In particular, we extract information on medical doctors (including dentists)—whose services can be deducted as health expenses—and self-employed workers offering education services that can be deducted in the education category. For comparison, we extract information on related professions that offer services that are comparable but cannot be deducted, in particular veterinary physicians and other social services professions such as social communications, social services, political communication, and publication services.

Second, we employ a machine learning approach that leverages the full set of occupations in the data. For each occupation, we predict whether the goods or services offered by this particular occupation are deductible or not. The prediction is based on similarity between the task description of the occupation (obtained from O*NET, a comprehensive source of information on occupations in the US)[18] and the description of deduction categories and deductible items in Ecuador (reproduced in Table A.1). We compute the cosine similarity between the word embeddings of occupations and deduction categories estimated using OpenAI's word-embeddings-ada-002 model. We then define an occupation to be offering deductibles if the similarity exceeds a threshold of 0.86 (see Appendix B for details and robustness checks).

[17] 32% of the sample is made up of one of the three categories "student", "private sector employee" or "employee", which provide little information on the type of occupation or industry an individual works in.

[18] We are not aware of a similar source of information specifically for Ecuador. However, due to standardized occupational classifications, information from O*NET applies more generally across many countries.

Panel A of Table 2 provides summary statistics on self-employed individuals for the full sample and separately for the different samples of affected and unaffected profession. We focus on 2007, the last year before the reform. 34% of self-employed are female, 69% are married, 42% have completed tertiary education, and the average age is about 44 years. The average reported annual profit is 766.57 USD. This number is surprisingly low and reflects the fact that only a small fraction of self-employed individuals actually reports positive profits. Compared to 2006, however, the amount of reported profits has increased substantially, on average by more than 400 percent. Columns 2-7 of Table 2, Panel A show the characteristics for the different subgroups. While some key demographics are different between medical doctors and veterinarians, they have similar levels and growth rates in reported profits prior to the deduction reform. Profits differ between self-employed workers with an educational profession and those with other social service professions. While self-employed individuals in social service professions had higher levels of profits, the growth rate was larger for workers in education. Self-employed workers predicted to be in a profession with deductible services by our machine-learning algorithm are more likely to be male and to hold a tertiary degree. However, the differences in profit growth before the treatment period are relatively small.

Industries For our analysis of VAT, we combine the VAT declarations with the firm registry to exploit variation in the exposure to the tax reform across industries. Similar to our analysis of occupations, we categorize industries into those that are affected by the reform because their primary business purpose is to sell products or services that are deductible from PIT and those that are not affected. We focus on two sets of comparisons related to deductions in the food category. First, we extract information on restaurants—an affected industry that sells goods which are subject to VAT payments—and compare it to hotels—a comparable industry that is not affected (but also subject to VAT payments). Second, we focus on retail firms that sell basic food items—products that can be deducted from PIT but are not subject to VAT payments—and compare it to wholesale sellers of food items that neither face the direct consumer demand for PIT receipts nor regularly sell goods subject to VAT. In addition, we pursue a similar machine-learning based approach that uses similarity in industry descriptions with the deductions to classify affected and unaffected firms.

Panel C of Table 2 shows summary statistics on sales, costs and VAT payments prior to the reform for all firms and separately by industry. Overall sales amount to about 30,000 USD. The effective VAT rate (VAT incurred divided by sales minus costs) amounts to 6 percent and hence well below the standard VAT rate of 12%, indicating that a substantial part of the economy is characterized by the 0%-VAT rate. Both hotels and restaurants, however are liable to VAT and their effective VAT rate is much closer to 12% (it is even higher due to the fact that advance payments of VAT are typically too low and businesses hence have to remit more). While the levels of sales, costs, and VAT incurred differ substantially between hotels and restaurants, their growth rates in VAT incurred between 2006 and 2007 were very similar. Basic food items are 0%-VAT rated. As a consequence, the effective VAT rate in the food industry is particularly low. Within the food industry, we compare retail and wholesale businesses. We note, however, that the retail industry has been on a steeper growth path in terms of VAT incurred prior to the

reform, making our identification in this particular subgroup somewhat weaker. Finally, firms predicted to offer deductible goods or services were smaller and on a somewhat slower growth path than those predicted to offer non-deductibles.

4 Research Design and Results

In this section, we estimate the effect of the deductions policy on economic activity, in particular the behavior of self-employed individuals. Our identification strategy is based on regional variation in the bite of the reform that arises from differences in the pre-reform share of high-income earners who benefit from claiming deductions. We proceed in four steps. First, we document how the bite of the reform differs across regions. Second, we exploit these differences in a difference-in-differences strategy with a continuous treatment on the regional level. Third, we use individual-level tax returns to estimate triple-difference regressions that additionally exploit variation across affected and non-affected professions. Fourth, we use detailed VAT data to assess effects of the reform to a different tax base.

4.1 Regional variation in the bite of the reform

Our identification strategies rely on the fact that the deductions in personal income tax (PIT) are only useful to individuals with sufficiently high income. As described in Section 2, PIT is levied at the relatively high level of about 10,000 USD annual income.[19] The regional variation in the share of individuals with high income documented in Figure 1 leads to variation in the use of deductions across regions. This makes it likely that the demand for receipts—and hence the pressure on businesses to issue them and to become more formalized—varies across regions.[20] To quantify the impact of the introduction of deduction possibilities, we compute a measure of reform intensity at the regional level. Our measure of reform intensity is defined as the standardized (divided by the cross-regional standard deviation) share of high-income earners in the local population for the year 2007—the last year before the reform. This measure proxies the potential demand for receipts faced by businesses in each region. We use the pre-reform shares of high-income earners rather than the actual amount of deductions claimed in a region to avoid endogeneity issues related to potentially correlated regional demand shocks that affect both deduction claiming and business profits.

In a first step, we show that the variation in reform intensity indeed leads to variation in the demand for formal receipts. We split the Ecuadorian regions into quintiles according to our measure of reform intensity. For each quintile in the distribution of reform intensity, Panel (a) of Figure 2 shows the average amount of deductions per capita over time. Prior to the reform, there were no deductions possible in any region. After the reform, however, we observe a stark increase in the deductions claimed in regions with a high reform intensity while there is almost

[19] This exemption threshold changes yearly according to inflation, its value ranges from 7850 USD in 2008 to 10800 USD in 2015. As all monetary values are deflated to 2013 USD, we use the exemption threshold of 2013 (10180 USD) throughout this analysis.

[20] We implicitly assume that individuals predominantly consume goods and services in their region of residence. Due to the nature of the deductibles as goods and services that meet basic needs we believe that this is a plausible assumption.

no change in regions with a low reform intensity. In addition, Appendix Figure A.3 Panel (a) shows the cross-sectional relation between the share of high-income earners in 2007 and the amount of deductions per capita in 2008. The graph shows a strong positive relation between both variables. The R^2 of a linear approximation is 0.97.

4.2 The effect of the reform on the aggregate level

We continue by showing that differences in our measure of reform intensity led to strong differences in the effect of the reform on reported economic activity of self-employed individuals at the regional level. Using the universe of tax declarations for self-employed individuals, we aggregate reported self-employment profits (i.e., income reported by self-employed minus their costs as detailed in Section 2) at the regional level and divide them by the regional population. The result provides a regional measure for reported self-employed business profits per capita (inhabitant). We measure reported profits per capita for two size categories of self-employed businesses. First, we consider self-employed individuals with income below 100,000 USD (but larger than the micro-businesses under a simplified tax regime, see Section 2 for details). Second, we consider reported profits per capita for large self-employed businesses obliged to report not just revenue and deductible costs, but comprehensive accounting information.[21] These larger formal sector businesses were mostly already formalized prior to the reform.

Figure 2 provides a first, purely descriptive analysis of the evolution of these regional aggregates of reported self-employment profits. Panel (b) of Figure 2 shows the development of self-employment profits per capita from 2006 to 2015 at five quintiles of the (population-weighted) distribution of the reform intensity. Prior to the reform, there are generally very low values of reported self-employment profits and only minor differences across quintiles. After the introduction, there are large jumps for regions that have a higher share of high-income earners while regions with low shares of high-income earners experience much smaller changes in reported profits. In contrast, Panel (c) of Figure 2 shows no discernible changes in the development of profits of larger, more formalized businesses around the time of the reform.

Panel (d) of Figure 2 shows that the strong increase in profits for high-income regions is at least partly driven by the number of reported tax declarations with non-zero profits. The graph shows a strong and persistent increase in the number of self-employed tax declarations reporting positive profits. The increase is most pronounced in those regions with a higher reform intensity. This finding suggests that the reform triggers a substantial response at the extensive margin and more self-employed businesses are pulled into the formal tax system.

Appendix Figure A.3, Panels (b) to (d) show the cross-sectional relation between the share of high-income earners in 2007 and the three outcomes in 2008 on the left side of each panel. For self-employment profits and the number of tax declarations with non-zero profits there is a strong and positive correlation with the share of high-income earners (R^2 of 0.79 and 0.75). In contrast, the relation is less strong for profits of large businesses (R^2 of 0.23). The graph looks very similar when relating the outcomes to the actual amount of deductions in 2008 on the right side of each panel.

[21] These self-employed business owners have capital exceeding 60,000 USD or annual revenue in excess of 100,000 USD. See Section 2 for details.

Difference-in-differences with a continuous treatment We proceed by quantifying the effect of the reform using a difference-in-differences estimation framework with a continuous treatment variable (see Callaway et al., 2024). The identifying variation arises from variation in reform intensity, i.e., our proxy of the regional heterogeneity in the demand for receipts. We proceed in two ways. We start by estimating classical two-way fixed effects regressions that control for heterogeneity in the outcome across regions and years. In addition, we use recent advances in the literature on difference-in-differences estimation with continuous treatment effects (Callaway et al., 2024) to address some shortcomings of the two-way fixed effects estimator.

Our two-way fixed effects regression equation is:

$$Y_{rt} = \gamma_r + \lambda_t + \sum_{n \neq 2007} \beta^n (\mathbb{1}_{t=n} \times Intensity_r) + \epsilon_{jt}, \tag{1}$$

where Y_{rt} is one of the outcome variables described above for region r at time t. Two-way fixed effects for region (γ_r) and year (λ_t) are included throughout and control for unobserved level differences between regions and over time. $Intensity_r$ is the standardized measure of reform intensity, i.e., the pre-reform (2007) share of high-income earners divided by its standard deviation. We interact this measure of reform intensity with indicators for each year of observation (leaving out the year before the introduction of the deduction possibilities). We weight the regional observations by the size of their population. Standard errors are two-way clustered at the regional level and the year level.

Figure 3 shows the estimated coefficients β^n for our different outcome variables. Panel (a) shows a steep increase in the usage of deductions among all taxpayers after the reform for high intensity regions compared to low intensity regions. The gradual increase in deductions after the reform is consistent with the learning dynamics identified in Bohne and Nimczik (2024). Panel (b) indicates a large jump in reported self-employment profits per capita after the reform. After 2008, there are only small changes. In contrast, the effect on profits of larger self-employed businesses with additional accounting requirements in Panel (c) is economically very small and noisy. Panel (d) shows a sharp and persistent increase in the number of submitted tax declarations with positive self-employment profits for high-intensity regions compared to low-intensity regions.

We summarize the estimation results in a single estimate for the treatment effect of the reform in Table 3, panel A. In these regressions, we interact our measure of reform intensity with an indicator $Post_t$ that equals one in all periods after the introduction of the reform in 2008. On average, the reform led to an increase of deductions, reported self-employment profits, and tax declarations with positive profits at the regional level. The effects are sizeable and statistically significant. An increase in the share of high-income earners by one standard deviation is associated with 73 USD more deductions claimed per capita and with 90 USD higher self-employment profits per capita. The number of tax declarations increases by roughly 58 per 10,000 inhabitants. One standard deviation in the share of high-income earners equals 0.01 and corresponds to moving from a region at the 25th percentile of the distribution of the share of high-income earners to a region at the 90th percentile in the distribution.

While statistically marginally significant (p-value=0.082), the effect on profits of larger self-

employed businesses with additional accounting requirements is economically very small. We rationalize this finding with the fact that these larger businesses were already formalized before the introduction of the reform.

Alternative Estimation Procedure Callaway et al. (2024) examine the properties of the two-way fixed effects estimator in the case of a continuous treatment and show that it can be interpreted in different ways. A popular interpretation is that the estimates correspond to an "average causal response", indicating by how much the effect of the treatment on the outcome changes due to a small increase in the treatment. In other words, a unit increase in treatment intensity is associated with an estimated *additional* effect on the outcome. We have exemplified this interpretation above. However, as Callaway et al. (2024) show, this interpretation is only valid under the "strong parallel trends assumption", requiring parallel trends in outcomes at all quantiles of the distribution of intensity in absence of the reform. A second drawback of this classical interpretation is that—while providing an insight into how changes in the treatment intensity *change* the effect of the treatment on the outcome—it does not lend itself to assessing how the treatment intensity is associated with the overall *level* effect of the treatment on the outcome.

An alternative interpretation sees the two-way fixed effects estimator as a weighted average of different level treatment effects, each receiving a particular level of treatment intensity d, averaged across all possible intensities. One of these level treatment effects is the average treatment effect of receiving a treatment intensity d for those treated with intensity level d. Under the weaker (and better known) assumption of parallel trends (i.e., for all possible treatment intensities, the outcome would have developed in parallel to an untreated control unit), this is identified as the average treatment effect on the treated $ATT(d|d) = E[\Delta Y|Intensity = d] - E[\Delta Y|Intensity = 0]$. In other words, the ATT is the difference between the expected changes in outcomes at treatment intensity d and the untreated control unit. The two-way fixed effects estimator then estimates a weighted average of all ATTs, $\beta = \int w(\ell)ATT(\ell|\ell)d\ell$. Such interpretation can be used to assess the average impact of the treatment on the level of the outcome variable, for example to compute the impact of the policy on the fiscal gains examined in Section 6. A potentially problematic result of Callaway et al. (2024) is that some of the weights $w(d)$ implicitly used by the two-way fixed effects estimator can be negative.

To address the challenges associated with the two-way fixed effects estimator, we estimate a non-parametric alternative of the average level effect of the treatment in line with the suggestions in Callaway et al. (2024). In particular, for each treatment intensity level d, we compute the change in the outcome between a given year after treatment and 2007 (the last pre-treatment period). We then subtract the change in the outcome during the same period for all untreated regions, in our case the four regions without any high-income earners in 2007 that have intensity level $d = 0$. We finally aggregate these individual ATTs using population weights, which by definition cannot be negative and sum to one.

Table 3 shows the results from this non-parametric plug-in estimator, both for 2008 and 2015, with bootstrapped standard errors. Similar to the two-way fixed effects estimator, we observe significant positive effects of the treatment on deductions, self-employment profits, and

the number of tax declarations. Again, the effect on profits of larger self-employed businesses is small and insignificant. We find that across all regions, the average effect of the treatment on the amount of deductions in treated regions is an increase by 55.53 USD per capita in 2008. This average level effect increases to 165.86 USD in 2015. The effect on self-employed profits is relatively stable at around 180 USD per capita. The effect on the number of self-employed individuals slightly increases from 129 to 170 workers.

Extensive and Intensive Margin To gauge the relative importance of the extensive and intensive margin effects at the aggregate level, we calculate the shares of all reported self-employment profits accruing to "new" (extensive margin) or "prior" (intensive margin) filers. Only 5.7% of the total reported self-employment profits analyzed in panel (b) of Figure 3 were reported by taxpayers already filing positive profit amounts before the reform (i.e., in 2006 or 2007). The vast majority of profits (94%) was reported by self-employed who start reporting profits in their tax returns after the reform. In contrast, for highly formalized larger businesses with additional accounting requirements (studied in panel (c) of Figure 3), about 52% of the reported business activity after the reform accrues to businesses already filing tax returns prior to 2008. This suggests that new entrants into the formal sector play a significantly smaller role among larger businesses after the reform.

Robustness In Appendix Table A.2 Panel A, we examine how sensitive our results are to excluding the few regions with a particularly high share of high-income earners. We still find statistically significant and sizable effects when dropping all regions in the highest quintile of the distribution of high-income earners.

In Appendix Table A.2 Panel B, we examine an alternative definition of treatment intensity by focusing on the share of individuals in a region that earn an income above the fourth kink in the tax schedule (rather than the first kink). These individuals have a higher incentive to ask for receipts because their marginal tax rate is 20% (rather than 5%). If anything, however, we find smaller effects on self-employment profits.

In Appendix Table A.2 Panel B, we explore an additional estimation strategy. We estimate the effect of the (potentially endogenous) amount of claimed deductions in a region on self-employment profits and tax declarations using the pre-treatment share of high-income earners in 2007 as an instrumental variable. Thus, the regression of claimed deductions on the share of high-income earners in our previous two-way fixed effects specification represents the first stage of this approach. The F-statistic of 255.44 supports a strong first stage. In the second stage, we regress the three remaining outcomes on the predicted deductions based on the pre-treatment share of high-income earners. Our previous regressions of outcomes on intensity could thus be interpreted as the reduced form of this IV approach. The advantage of the IV specification is an alternative quantification of the effects of the policy: if deductions claimed increase by one dollar (per population), reported self-employment profits increase by 1.37 USD (per population). In line with our main estimates, the IV also shows a negligible effect on profits of larger businesses, but a sizable effect on the number of self-employed reporting positive profits.

Summary Our results provide evidence for a strong effect of the deduction policy on reported self-employment profits at the aggregate level. Regions with higher demand for receipts—proxied by a higher share of high-income earners prior to the reform—experienced larger increases in reported profits. The extensive margin effect is particularly strong. We document a strong increase in the number of tax declarations reporting positive profits, and these new tax declarations constitute the vast majority of all reported profits.

We obtain similar results using a traditional two-way fixed effects estimation approach and a recently suggested non-parametric estimation approach. In the following, we will therefore rely on the more standard fixed effects estimation that can be extended to exploit additional variation. We will return to the non-parametric estimation in our net impact analysis in Section 6 as it allows us to conveniently aggregate the estimated impact of the reform on the level of the outcome across the population.

The temporal pattern of the effect points to an immediate jump in reported profits in the first year after the reform with only minor increases in subsequent years. In contrast, after an initial jump, the value of the deductions constantly increases during the period of analysis. This suggests that the presence of *some* consumer demand for receipts triggers the observed increase in reported profits, while the subsequent increase in the value of these receipts does not seem to further increase the effect of the reform. It seems that some base level of demand for receipts is sufficient to "jump-start" formalization and induce businesses to comply, independent of the amount of receipts requested. Consistently, we also do not find stronger effects when we examine the effect of a larger share of individuals in high tax brackets who have a particularly strong incentive to ask for formal receipts. These observations are in line with models in which business owners do not make case-by-case choices about which transactions to evade or not, but make a more general choice about if or how much of their true revenues to evade. If the demand for receipts is sufficiently large, self-employed can be pushed into changing their business model towards higher tax compliance.

4.3 Affected versus non-affected professions

In this section, we use as an additional source of variation the difference between professions that are directly affected by the reform because their goods and services can be deducted from PIT by consumers and professions that are not directly affected by the reform because their goods and services are not deductible. Variation across affected and non-affected professions within regions allows us to address a potential issue in our identification strategy relying on cross-regional variation in reform intensity. In particular, the different regions may differ in their underlying economic trends, with location-specific demand shocks correlated with the prevalence of high-income earners. This might be particularly relevant given the short observation period before the reform. We observe only two pre-periods, making a compelling visual assessment or formal tests of pre-trends in the difference-in-differences setup challenging. Introducing variation across different occupations alleviates these challenges.

We estimate a set of triple-difference regressions with data on the responses of *individual* self-employed taxpayers. We focus on three distinct samples, each consisting of a group of affected self-employed with registered professions offering deductible goods or services and a

control group of unaffected self-employed in registered professions that offer non-deductible goods or services.

First, we compare medical doctors and dentists—whose services can be deducted as health expenses—to veterinary physicians—whose business activities cannot be deducted from PIT. Second, we compare self-employed workers with a university degree in education (who may work as contracted auxiliary teachers in public or private schools, or offer private schooling or tutoring) to those with a degree in other social professions (who offer non-deductible services like social communications, social services, political services, and publication services). Third, we compare professions that are predicted to offer deductible goods or services by our machine learning algorithm (see Section 3 and the details in Appendix B) to those that are predicted to not offer deductibles.

We estimate the following triple-difference regression equation:

$$Y_{irt} = \alpha_i + \lambda_t + \sum_{n \neq 2007} \delta^n (\mathbb{1}_{t=n} \times Intensity_r \times Affected_i) + \sum_{n \neq 2007} \kappa_1^n (\mathbb{1}_{t=n} \times Intensity_r) + \sum_{n \neq 2007} \kappa_2^n (\mathbb{1}_{t=n} \times Affected_i) + \epsilon_{irt} \quad (2)$$

with Y_{irt} now measured at the level of individual self-employed business owner i residing in canton r at year t. As outcomes, we consider the reported profits of an individual self-employed business owner and an indicator for an individual business owner submitting a tax declaration with profits above the tax exemption threshold. The regional treatment intensity is given by the dose variable $Intensity_r$, defined as before. The individual treatment assignment is the dummy $Affected_i$ which, depending on the sample under study, equals one for the affected professionals (doctors, teachers, or professions predicted to be affected by the machine-learning algorithm) and equals zero for an unaffected control group (veterinary physicians, social service professions, or professions predicted to be unaffected by the machine-learning algorithm). The equation includes a full set of interactions between the treatment indicator and the yearly dummy variables (with year 2007 before the reform serving as the base year). As before, we include individual (α_i) and time (λ_t) fixed effects.[22] The coefficients δ^n measure the triple-difference estimates we are interested in.

Figure 4, Panel (a) plots the estimates for doctors in relation to veterinary physicians. After the reform, medical doctors increase their reported profits significantly more than veterinary physicians. The effect can be interpreted as larger profit differentials between doctors and veterinarians in regions with a higher intensity in the demand for receipts. In contrast, there are no significant differences prior to the reform. The effect after the reform is large and persistent, with the triple-difference estimators corresponding to an increase in reported profits of around 2000 USD per affected doctor. This estimated effect is associated with a one-standard deviation increase in the share of pre-treatment high-income earners. This estimate measures the overall effect of the reform at the self-employed level and takes into account both extensive

[22] As the occupation of a self-employed business varies at the individual level, we cannot interact individual and time fixed effects. In Appendix Table A.2 Panel C we provide results for an alternative specification that includes region-by-year fixed effects.

and intensive margin effects. In the extensive-margin plot on the right side of panel (a), the outcome is defined as an indicator for filing profits above the tax exemption threshold. The triple difference-in-differences estimator indicates a strong increase in the share of doctors reporting taxable profits relative to veterinarians.

Figure 4, Panel (b) plots the estimates for teachers versus other social service professions. While not as pronounced as the effect for health workers and showing more of a gradual increase after the reform, there is again a significantly higher increase in reported profits by teachers compared to other social service professions after the reform. The same holds for the extensive margin. Teachers in highly affected regions are significantly more likely to report profits above the tax exemption threshold.

Figure 4, Panel (c) shows the differential effect among professions predicted to be affected by the reform relative to those predicted to be unaffected. After the introduction of deductions, affected professions have statistically significantly higher levels of profits and a higher likelihood to report profits above the tax exemption threshold. Before the treatment, the differences were negative and marginally significant.

Table 3, Panel B presents the results using a single triple-differences estimator for the post-reform period. We compare doctors to veterinarians and show that the overall effect (taking into account both extensive and intensive margin) amounts to an estimated triple-difference effect of 2200 USD higher reported profits. The estimated effect can be associated with a one-standard deviation increase in the share of pre-treatment high-income earners. Column 2 of panel (b) presents the pre versus post extensive margin effect, with the triple differences estimator amounting to a 4.9 pp increase in the probability of filing profits subject to taxes. Lastly, column 3 presents results for the intensive margin by focusing on a small subset of self-employed that were already filing profits above the tax exemption threshold before the reform. Also for this very small subset of businesses our estimate picks up a positive and significant effect.

Our findings are similar when comparing teachers to social service professions. The effects all point in the same direction: teachers more exposed to reform report higher profits and are more likely to report profits subject to taxation. The magnitudes for this subset are slightly smaller and the intensive margin effect within this small subsample is not statistically significant.

Similarly, we find significant differences overall and at the extensive and intensive margin when comparing professions predicted to be affected by the reform to the remaining professions. This sample comprises all self-employed workers in Ecuador (with non-missing occupational information). While being somewhat smaller in magnitude, the effects are strong with low p-values.

We corroborate the previous extensive margin regression result with an additional descriptive analysis of medical professionals. Appendix Figure A.4 shows two measures of the number of medical doctors and dentists per 10,000 inhabitants. Panel (a) shows the number of doctors and dentists per 10,000 inhabitants from the *Registro Estadístico de Recursos y Actividades de Salud*, a combination of various non-tax related administrative records coupled with a recurring survey of all medical facilities in Ecuador administered by the National Institute of Statistics and Censuses (*INEC*). Panel (b) shows the number of tax declarations with non-zero income claimed

by doctors and dentists from 2008 on. In contrast to the smooth increase in the overall number of doctors and dentist in the non-tax administrative records, the number of tax declarations increases sharply after the reform. This pattern suggests that the response is driven by the tax reporting behavior of doctors and dentists rather than an actual increase of practitioners in the professions.

Summary Our results indicate that the introduction of generous deduction possibilities from PIT in 2008 spurred an increase in business activity of self-employed individuals reported to tax authorities, both at the intensive and extensive margin. We use regional variation in the intensity of the reform to identify its effect. Further, to increase the credibility of our estimates we show that the reform differentially affects self-employed depending on the deductibility of the goods and services of their professions. Our findings add a novel perspective to the literature on tax compliance because they shed light on a part of the economy that is largely outside of the regular VAT system, and hence under less scrutiny—both from tax audits and from academic research. However, the introduction of deduction possibilities might also cause effects on VAT payments as some of the deductible categories are also subject to VAT. Moreover, there could even be spillover effects on non-deductible goods and services, which we address next.

4.4 Value-Added Taxes

Due to the importance of value-added taxes (VAT) for overall tax revenue, recent policies have focused on self-enforcing mechanisms in the VAT system aiming to increase the demand for receipts by final consumers (e.g., Pomeranz, 2015; Naritomi, 2019). This addresses the well-known "last-mile" issue in VAT: in contrast to intermediary producers, final consumers have almost no incentives to ask for receipts (Kopczuk and Slemrod, 2006).

In this section, we examine potential direct and indirect effects of the deductions policy in the PIT system on tax payments in the VAT system. We distinguish between direct and indirect effects because—unlike in policies previously examined such as receipt lotteries—the incentive for consumers to demand formal receipts mainly affected products and services subject to 0% VAT rates.

Direct effects pertain to the few products that are both deductible from PIT and subject to VAT. For these products, the increased demand for formal receipts after the reform could directly induce an increase in reported sales and, hence, in VAT payments. As an example, we consider food consumption in restaurants and show how the deduction policy triggered direct effects on VAT payments.

Indirect effects pertain to goods that are non-deductible, but subject to VAT. In many instances, deductible goods are sold together with other non-deductible goods that are subject to VAT. If firms cannot easily issue separate receipts for the different categories, an increase in the demand for receipts will affect both the reported sales of goods subject to 0% and standard VAT rates. We consider such spillover effects by concentrating on firms classified as mainly selling basic food items. While basic food items are deductible from PIT and face 0% VAT, they are often sold together with VAT-liable goods. The summary statistics in Table 2 show that indeed a fraction of the goods sold by the food industry are liable to VAT payments.

To estimate the effect of the deductions policy on VAT compliance, we draw on a similar triple-difference estimation framework as in the previous section. For VAT, we abstain from estimating the double difference-in-differences framework that only uses variation at the regional level. The reason is that concurrently to the deductions reform, the Ecuadorian government put a strong emphasis on improving tax compliance, in particular regarding VAT (refer to Section 2 for a general overview). Moreover, it could be that the VAT-enforcement activities of authorities are correlated with regional economic prosperity. Even though we have no data on audits to assess whether this concern is relevant, the triple difference-in-differences framework controls for potential regional differences in enforcement strategies by comparing affected to not affected businesses within the same geographic region.

We use detailed data on industry affiliation to classify firms into those that are affected by the deduction policy (because they sell goods for which expenses can be claimed as a deduction from PIT) and those that are not affected by the deductions policy (because expenses for their goods cannot be deducted). In particular, we estimate the following regression based on the sample of value added tax returns from 2006 to 2015:

$$Y_{jrt} = \phi_j + \theta_t + \sum_{n \neq 2007} \gamma^n (\mathbb{1}_{t=n} \times Intensity_r \times Affected_j) + \sum_{n \neq 2007} \psi_1^n (\mathbb{1}_{t=n} \times Intensity_r) + \sum_{n \neq 2007} \psi_2^n (\mathbb{1}_{t=n} \times Affected_j) + \epsilon_{jrt}, \quad (3)$$

where the outcome variable is VAT liability of firm j in region r in year t. Our regional measure of reform intensity is defined as above. The model includes fixed effects for each firm, ϕ_j, and each year, θ_t. Standard errors are two-way clustered at the region and year level.

For each firm, we carry out two separate classifications. First, we classify firms based on whether they provide deductible goods and services. Second, we classify firms based on whether they offer goods subject to VAT or 0%-VAT rated products.

In Panel (a) of Figure 5 we examine a manual classification of firms in the food sector. The left part of the figure investigates the direct effect by focusing on firms in the "Hotels and Restaurants" industry, which are all subject to VAT. Food consumed in restaurants is both deductible and liable to VAT. We therefore label the food industry as $Affected = 1$. In contrast, stays in hotels are not deductible (but somewhat comparable and also liable to VAT) and are labeled as $Affected = 0$. The graph plots the triple-difference coefficients γ and indicates that—while there was no different trend in VAT liability in the two periods observable before the reform—after the reform there was a stronger increase in VAT liability in restaurants than in hotels.

The right part of the figure examines the spillover effects by focusing on firms in the wholesale and retail industry that are associated with the sales of basic food items. Basic food items are 0%-rated in the VAT system. Within the food industry, the graph contrasts the retail sector that is directly facing consumer demand for formal receipts after the reform with the wholesale sector. The graph shows that—while there was no different trend in VAT liability in the two periods observable before the reform—after the reform there was a stronger increase in VAT

liability in retail relative to wholesale. This triple difference effect can be interpreted as larger differentials in VAT liability between retail and wholesale firms in regions with a higher demand for receipts.

In Panel (b) of Figure 5, we pursue a second approach using a machine-learning algorithm to classify firms regarding both the deductibility and the VAT-ratings of their goods or services. In particular, the algorithm examines the similarity between industry descriptions, the deduction categories, and the VAT-ratings (see Section 3 and the details in Appendix B). For industries that are classified to be subject to VAT (left part of the figure), we observe a significant and positive effect of being predicted to offer deductible goods after the introduction of the reform, albeit at a lower level compared to the restaurants sector. For industries that are classified to be 0%-VAT rated (right part of the figure), we observe a small and delayed effect, indicating that the indirect effects are somewhat lower overall compared to the food sector examined in Panel (a) of Figure 5.

Table 4 summarizes the findings using a single triple-differences estimator for the post-reform period. In the food sector, we find that after the reform VAT payments of restaurants (deductible) increase significantly by 375 USD more for a one standard-deviation increase in reform intensity than VAT payments of hotels (non-deductible). We also find a significantly stronger increase for retail firms (deductible) as compared to wholesale firms (non-deductible) in the food industry by about 59 USD. The magnitude is substantially smaller for these mostly 0%-VAT rated goods and services. The results are qualitatively similar when we extend the analysis to all industries using our AI approach to predict which industries are subject to VAT and which industries offer deductible goods and services. Among firms subject to VAT, firms in deductible industries increase VAT payments on average by 28 USD more for a one standard deviation increase in reform intensity. The coefficient is only half as big in firms predicted to be 0%-VAT rated.

Summary Taken together, the evidence suggests that the introduction of deduction possibilities in the PIT system in 2008 triggered both direct and (to a lesser extent) indirect effects in the VAT system. Industries that were affected by the policy because they offer deductible goods increase their VAT payments more than non-affected industries, and this effect was stronger in high-exposure regions.

5 Aggregate Demand Effects

While the deduction reform increased incentives to demand formal receipts, it might also have generated changes in the demand for deductible goods as it changed the effective prices taxpayers face for these goods and services. In this section, we leverage household consumption survey data to analyze whether the reform triggered changes in consumption patterns.

The data stems from the National Survey of Income and Expenditures of Urban Households (ENIGHU), the only systematic survey on household consumption activities in Ecuador conducted by the Ecuadorian National Office for Statistics and Census (*Instituto Nacional de Estadística y Censos*, INEC) in 2004 (INEC, 2005) and in 2011/12 (INEC, 2012). During

in-person visits, enumerators collected extensive information on household composition and demographics, dwelling characteristics, income sources, and expenditure habits. The first wave was conducted only in urban areas and is designed to be representative for all urban centers in Ecuador, excluding the Amazonian region and Galapagos islands. The second wave was conducted between April 2011 and March 2012 as a separate cross-section, covering all regions in Ecuador. To ensure comparability, we only consider observations in the second wave sharing the same overarching geographic characteristics as those in the first wave.[23]

The two survey waves cover household consumption patterns before (2004) and after (2011/12) the deduction reform. To prepare the data for our analysis, we map the individual consumption products listed in the survey (2,091 distinct items in the 2004 wave and 3,563 items in the 2011/12 wave) to the five deduction categories.[24] The survey includes information on monetary expenditures and in-kind expenditures (gifts or exchange of goods without monetary payments). We restrict the data to pure monetary expenditures to capture the purchasing behavior of households in regular markets subject to taxation (results are robust to including in-kind expenditures). To alleviate issues of data entry errors, we winsorize all variables at the 1% and 99% levels.[25]

To examine whether the introduction of deductions changed household demand behavior, we compare a group of "affected" households—whose highest earning member reports taxable income above the tax exemption threshold and thereby has an incentive to use deductions—to a control group of households who do not have to pay PIT. We restrict control households to those at most half a standard deviation below the tax exemption threshold.[26]

Appendix Table A.3 provides summary statistics on demographic characteristics and expenditure behavior. Columns 1-3 refer to affected households, columns 4-6 refer to control households. Affected households are slightly smaller and the household head is slightly older and considerably more educated. In line with their higher income, affected households report higher expenditures per capita. Overall, households spend a large share of their expenditures on deductible goods. Before the reform, affected households spend 54% of their expenditures on deductibles while control households spend about 61% on deductibles. After the reform, the

[23] In particular, in the second wave we exclude all observations from the Amazonian region, the Galapagos islands, and all rural locations. Therefore, our data stems from urban households in the overarching regions "Mountains" and "Coast". According to the 2010 Ecuadorian Census, just 5.3% of the population lives in either the Galapagos islands or the Amazonian region. About 63% of the population lives in urban centers (INEC, 2024).

[24] We conducted an initial correspondence using the AI-technology provider *ChatGPT*, but then manually refined the classifications according to the specific rules of the deduction categories.

[25] Appendix Table A.4 shows that the results also hold without winsorizing.

[26] The income values used for this analysis stem from the household survey data and include both gross wage earnings and profits from self-employment activities. For 2011/12, main earners in affected households receive annual income above 9,210 USD (the tax exemption threshold) and main earners in control households between 6,216 and 9,210 USD. The difference corresponds to half a standard deviation within the 2011/12 distribution of highest household earners. These cutoff values correspond to the 66th and 80th percentile of the income distribution of highest earners in 2011, respectively. For 2004, affected households are defined as those whose main earners earn more than 6,588 USD per year. This value corresponds to the 2008 tax exemption threshold of 7,850, discounted with the cumulative consumer price index change between 2004 and 2008. The control households of 2004 are those whose highest earners report income above 4,542 USD per year, again half a standard deviation below the affected threshold. The relative income positions in 2004 correspond to the 75th and 87th percentile, respectively. The results reported here are robust to changes in the definition and the cutoff values used for the control group.

share has risen to 56% for affected households and to 63% for control households.

Figure 6 depicts the observed changes in household demand for deductible expenses, separately by affected and control groups. Each panel reports the median[27] of the share of household expenditures going to the respective category, with the upper left panel depicting all deductible goods and services and the following panels each category individually. For almost all deductible categories, we observe parallel expenditure trends between affected and control households. The only exception are the expenditures for education, which decreased more strongly for affected households than for control households. However, we do not interpret this as evidence for a negative effect of the deductions on education expenditures. During the time span, the government massively invested in education, which according to this figure may have had a particularly large effect on crowding out private education expenditures for high-income households.

We substantiate the visual inspection with a difference-in-differences regression approach that accounts for possible changes in the composition of households over time. The major data limitation is that the survey was conducted as two repeated cross sections and does not allow us to employ standard panel inference. We therefore create a pseudo-panel by grouping observations based on comparable household demographics in both waves. In particular, we create cohort-education-gender cells, grouping observations by (bi-annual) birth cohorts, 3 groups of educational attainment, and gender of the household head. This process renders 46 distinct observation cells based on these three variables.[28] We compute the average outcome of interest (e.g., the average share of income spent on deductible items) within each demographic cell for affected and control households separately. The outcome of this process is a pseudo-panel with affected and control demographic cells in both waves.

To examine the effect of the deductions on household demand, we use the pseudo-panel and estimate a simple difference-in-differences regression with one pre- and one post-observation per demographic cell:

$$Y_{ctl} = \theta_c + \beta Post_t \times Affected_{cl} + \alpha Post_t + \gamma Affected_{cl} + \phi X_{ctl} + \epsilon_{ctl} \quad (4)$$

where Y_{ctl} is the relevant average outcome within pseudo-panel cell c at time t (the two survey waves) for income group l. $Post_t$ is an indicator for an observation in the post period and $Affected_{cl}$ an indicator for an observation belonging to the affected (high-income) group. θ_c are cell-level fixed effects and β measures our parameter of interest. X_{ctl} represents a vector of control variables, in particular cell-level averages of the share of households stemming from the mountain region, the household size, the number of household members below 5 years of age, between 6 and 12 years of age and between 13 and 18. The regressions are weighted according to the number of households in each pseudo cell. Standard errors are clustered at the pseudo cell level. We restrict the sample to cells that include at least 5 underlying observations in the household data and to cells in which we have a pre and post value for both affected and control groups, hence creating a balanced pseudo-panel. Our results are robust to changing

[27] Results are very similar when using the mean instead of the median.

[28] To guarantee comparability and sufficient data coverage, we restrict the analysis to households with household heads born between 1946 and 1979. Thereby the age span across the waves lies between 25 and 65 years of age.

these restrictions.

Table 5 presents the difference-in-differences regression results. Panel A shows that the overall effect of the reform on the share of household expenditures going towards deductibles is close to zero and insignificant. Panel B focuses on each deduction category separately. Affected households spend significantly more on clothing and significantly less on education due to the reform, but there are no significant effects for food, health, and housing expenditures. While the positive coefficient for clothing might be interpreted as evidence for demand effects, the estimate for education indicates that affected households *reduce* their educational spending. Reduced demand in face of a price reduction is hard to reconcile with standard demand theory. As indicated above, we believe that this coefficient also picks up differential crowding-out effects of private educational spending by high-income households. Moreover, the point estimates, including those of the significant effects, are very small compared to the pre mean in the control group. Lastly, we would like to point out that the strongest formalization results in our paper accrue to the health and food sector, for which we find no evidence for demand effects. Taken together, our analysis of household expenditure data demonstrates that the introduction of deductions did not have generalized effects on the demand behavior of households.

6 Net Revenue Impact Analysis

Our empirical evidence suggests that the introduction of deduction possibilities in the PIT system successfully triggered the intended consequences on formalization. We observe a stark increase in the number of tax declarations among self-employed businesses and in the reported profits of these self-employed businesses exactly in those regions and occupations that are more exposed to the reform. Regional exposure to the reform is proxied by the share of high-income earners in the local population who have an incentive to collect formal receipts because they can deduct the corresponding expenses from PIT. Occupational exposure implies that the business owner's occupation is associated with one of the deduction categories. Similarly, we document an increase in VAT payments for firms in regions with high income earners and in industries affected by the deductions.

While triggering an increase in tax compliance, the generous deduction policies also generate foregone PIT payments. An important open question therefore is whether the fiscal gains in terms of additional tax revenue outweigh these costs.

6.1 Fiscal costs of the deduction policy

We use information on the universe of PIT claims and compute the difference between the total PIT liability of all Ecuadorian taxpayers and their hypothetical liability in the absence of any deduction possibilities.[29] To this aim, we construct a tax simulator that incorporates the marginal tax rate for each bracket in the Ecuadorian PIT system. For each taxpayer, we then simulate the PIT liability if their gross earnings were taxed without the deduction possibilities, and subtract the true PIT liability based on their gross earnings net of their claimed deductions.

[29] Based on the absence of changes in demand patterns documented in Section 5, we believe that the implicit assumption of inelastic demand is reasonable in our context.

Aggregating over all taxpayers gives us an upper bound of foregone PIT due to the deduction policy.

Our calculations indicate that the PIT payments foregone by introducing the generous deduction possibilities amount to 6 USD per capita (i.e., inhabitant) in 2008, rising to 17 USD per capita in 2015. The increase is due to the growing fraction of the eligible body of PIT payers who actually claim these deductions (Bohne and Nimczik, 2024). Naturally, the average amount of foregone PIT payments hides a large degree of heterogeneity. Most Ecuadorians earn income below the threshold that would require them to pay PIT (or do not work formally at all). As detailed in Section 3, less than one percent of the population earns income liable to PIT. For these high-income earners, however, the deduction policy implies a substantial possible reduction in PIT payments. As an example, consider an individual with an annual income of 20,000 USD. Without claiming deductions, this individual pays 934 USD of PIT.[30] When claiming the 5,090 USD that can be deducted without presenting receipts to the tax authority, the same individual would only pay 351.5 USD,[31] amounting to 600 USD of forgone PIT for the government. The black line in Figure A.5 depicts, for each year, the per-capita amount of foregone PIT averaged across the entire population.

6.2 Fiscal gains of the deduction policy

To estimate (a part of) the fiscal gains of the deduction policy, we have to rely on our identification strategy that exploits regional variation in the exposure to the reform to tease out its causal effect on the taxation of self-employed individuals. In Section 4, we have estimated the effect of the reform using a range of different estimators. As these estimators have different advantages and properties, we provide estimates of the fiscal gains of the deduction policy based on each of them and compare the results.

Non-parametric ATT Callaway et al. (2024) show that the non-parametric estimation strategy introduced in Section 4 provides a very simple and intuitive estimator of the average treatment effect on the treated (ATT), aggregated across all intensity levels. Identification relies on the availability of untreated units and exhibits asymptotically valid inference (see their equation 4.13). Intuitively, the non-parametric ATT estimate compares all treated regions to the four untreated regions (where no high-income earner resided in 2007) and computes an average overall treatment effect on the treated. According to our results in Table 3, the ATT on self-employment profits per capita across all treated regions is 179 USD in 2008. It remains relatively stable over time and increases slightly to 186 USD per capita in 2015. In order to compute the fiscal gains of the deduction policy generated by additional profits reported by the self-employed, we adjust these profits for three facts. First, self-employed businesses only have to pay PIT on profits *above* the tax exemption threshold. Second, profits above the tax exemption threshold are translated into tax liability according to the Ecuadorian marginal tax schedule. Third, self-employed businesses can deduct their personal expenses according to the new policy themselves. We therefore create a tax simulator for self-employed businesses in Ecuador and compute the

[30] We calculate this number as (12,970-10,180)*0.05 + (16,220-12,970)*0.1 + (19,470-16,220)*0.12 + (20,000-19,470)*0.15 = 934 USD

[31] (12,970-10,180)*0.05 + (14,910-12,970)*0.1 = 333.5 USD

tax liability for each self-employed based on their reported profits and deductions. We then estimate the non-parametric ATT with the personal income tax liability as the outcome. This leads to estimated fiscal gains of the deduction policy caused by increased tax payments of self-employed businesses of 9.62 USD per inhabitant in 2008. In line with our estimates, this number remains quite stable over time and fluctuates between 8 and 10 USD until 2015.

Alternative Definitions of Control Regions The non-parametric ATT relies on a control group of untreated regions to which all other regions are compared. Only four out of the 219 regions in our sample have a treatment intensity of exactly zero. These regions might be quite specific and might not form a suitable control group. We therefore compute an alternative version of our non-parametric ATT where we use all regions in the bottom quintile of the treatment intensity distribution as the control group. These regions comprise 20 percent of the Ecuadorian population and 40 percent of all regions. They are treated with a very low intensity (on average the share of high-income earners in these regions amounts to 0.08 percent of the population with a maximum of 0.16 percent). The estimated fiscal gains using this alternative control group amount to 8.89 USD per capita in 2008, only slightly less than in our baseline, and fluctuates between 8 and 10.7 USD over time. As a second alternative, we consider all regions in the bottom two quintiles of the treatment intensity distribution as the control group. In these regions, the average share of high-income earners is 0.2 percent with a maximum of 0.4 percent. The estimated fiscal gain in 2008 using this control group amounts to 7.96 USD per capita and fluctuates between 7.3 and and 9.7 USD over time.

Two-way Fixed-effects Estimator A more classical approach is to base the aggregate effect across the population on the estimate obtained by the two-way fixed effects estimator. We use the coefficient from our differences-in-differences estimate, based on the adjusted outcome using the tax simulator as above. For each region, we then multiply the coefficient with the observed treatment intensity and aggregate across all regions. The advantage of this procedure is that we explicitly use the intensive variation in the treatment intensity. The disadvantage is that the coefficient is potentially biased due to the implicit weighting (see the discussion in Section 4.2). The estimated fiscal gains, however, are very similar to those obtained by the non-parametric ATT. In 2008, the estimated gains amount to 7.63 USD per capita and fluctuate between 7 and 9.3 USD over time.

Instrumental Variables Finally, we provide estimates for the net revenue impact of the reform based on the IV strategy presented in Appendix Table A.2. Again using our tax simulator, we find that in 2008 each additional dollar of deductions results in 0.14 USD additional tax liability of self-employed individuals. In 2015, the additional tax liability per dollar of deductions decreased to 0.05 USD. Applying a tax simulator to all high-income earners in Ecuador, the marginal fiscal costs of a dollar of deductions amounts to 0.11 USD in 2008 and 0.09 USD in 2015.

Results Figure 7 visualizes the net revenue impact analysis. Panel (a) shows the ratio of the estimated fiscal gains of the reform due to increased tax liability of self-employed individuals

to the foregone PIT in the full population. All estimators show a similar pattern: Initially higher gains are overtaken by higher costs after a short period. The reason is the discrepancy between rising costs due to the gradual spread of the use of deductions (documented in Table 1 and rationalized by information frictions in Bohne and Nimczik, 2024) and the relative stable level of additional tax liability of self-employed. As shown in Figure 3, self-employed individuals immediately react to the increased pressure of demand for receipts by increasing reported profits, mostly at the extensive margin, but do not further increase the amount of reported profits over time.

Tax payments by self-employed businesses, however, are not the only source of fiscal gains of the policy. Following the same estimation strategies as for PIT gains, we find additional gains that accrue from increased VAT liability due to the reform. Panel (b) of Figure 7 shows the ratio of the estimated fiscal gains of the reform from both sources to the foregone PIT. Overall, the benefits of the deduction policy outweigh its costs. At the end of our sample period, the benefits are roughly twice as high as the costs. However, while the time patterns are very similar across the different estimators there is some variation in the estimated level of the fiscal gains from VAT payments due to the deduction policy, presumably due to less stringent identification.[32]

Finally, a few words of caution are warranted regarding the conclusions from our net revenue impact analysis. First, we only measure the direct fiscal benefits of the reform in terms of contemporaneous PIT and VAT tax revenue. We are not able to quantify further benefits accruing to other tax bases or future tax revenue. At the same time, the analysis focuses on direct fiscal implications and is not a comprehensive welfare analysis. As Keen and Slemrod (2017) note, cost-effectiveness of a tax reform is not necessarily welfare-improving due to compliance costs or potential distortions of real business activity by preventing certain transactions in the economy. Our analysis of the consumption patterns in Section 5 as well as the medical staff in Appendix Figure A.4 indicates that there was no change in consumption patterns or the number of medical doctors actually practicing in Ecuador around the time of the reform. At the same time, the reported income by providers of consumption goods and services and the number of medical doctors reporting positive profits increased drastically. A thorough analysis of the welfare effects of the deduction reform is beyond the scope of this paper, but our evidence suggests that the reform affected tax compliance, but not the overall level of services.

7 Conclusion

Previous research has shown that self-employed individuals are particularly prone to tax evasion and tax avoidance. Inducing self-employed business owners to correctly report their income can therefore have large effects on the tax base. Our study shows that this is indeed the case in Ecuador. Creating the pressure of reporting business income by stimulating customers' demand for formal receipts that could be used as a basis for third-party reporting of business activity appears to be a cost-effective way to enlarge the tax base in a middle-income country like

[32] As noted above, due to the increase in auditing of VAT that coincided with the introduction of the deduction policy, the assumption of parallel trends is less plausible for VAT. As discussed above, the audits in the VAT system might have been more targeted towards more affluent regions and thus confound the treatment effect of these regional-level regressions.

Ecuador.

We examine an innovative reform that aims to improve tax compliance and increase participation in the formal economy by providing generous possibilities to deduct expenses from PIT payments. Exploiting variation in the bite of the reform across regions, occupations, and industries, we show positive effects on profits reported by self-employed individuals, in particular the extensive margin, as well as direct and indirect effects on VAT liability. The pattern of large and stable effects over time indicates that a given demand for receipts "jump-starts" the formalization process and creates lasting improvements in tax compliance. Contrasting the fiscal gains from the deduction policy with its costs in terms of foregone PIT revenue, we assess its cost-effectiveness. Our estimates show that the fiscal gains outweigh the costs.

While the overall results point to a strong increase in tax compliance following the Ecuadorian deductions policy, it is of course unclear whether these findings can be generalized to other policies or settings. Most comparable policies either employ receipt lotteries or apply to a few specific sectors. In contrast, the Ecuadorian policy covers about 60% of typical household expenditures, crucially also including expenses not subject to VAT. Therefore, it remains unclear if these results can be extrapolated to reforms of a more limited scope. Moreover, Ecuador as an upper-middle-income country might be ideally situated in the developmental spectrum to benefit from such a reform: While having high potential for improvements in terms of tax compliance, it has relatively strong institutions and enforcement capabilities.

An exciting avenue for future research would be to compare the relative performance of different policies that aim to increase tax revenue and trigger the formalization of the economy in emerging economies. Moreover, evidence on how to best design formalization policies depending on prevalent formalization levels would be extremely valuable.

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Table 1: Summary Statistics: Regional Level

	(1)	(2)	(3)	(4)
	Mean	Std.Dev.	Min.	Max.
Population				
2007	65,777	224,128	1,823	2,350,915
Share high-income individuals				
2007	0.005	0.010	0.0000	0.099
2009	0.007	0.012	0.0000	0.113
2011	0.008	0.014	0.0002	0.121
2013	0.01	0.017	0.0002	0.144
2015	0.01	0.02	0.00	0.19
Deductions per capita				
2007	0.00	0.01	0.00	0.08
2009	22.12	51.05	0.00	424.02
2011	28.38	51.18	0.00	416.28
2013	38.52	68.38	0.00	542.57
2015	52.53	81.82	0.00	633.99
Tax declarations per 10,000 inhabitants				
2007	17.7	12.9	0.0	76.7
2009	129.1	95.2	11.9	608.7
2011	160.4	117.3	17.9	793.2
2013	188.5	134.8	21.2	890.0
2015	198.7	136.6	16.8	883.5
Observations	219			

This table presents descriptive statistics at the regional (*cantón*) level for 219 regions. Two regions drop out due to missing comparable data on the number of inhabitants (the cantones "La Concorida" and "El Pan"). The share of high-income individuals refers to the share of individuals with taxable income above the PIT exemption threshold. Deduction per capita refers to the sum of deduction claims per inhabitant. Tax declarations per 10,000 inhabitants refers to the number of tax declarations of self-employed with positive profits.

Table 2: Summary Statistics: Individual Level Tax Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Self-employed individuals							
	All Self-employed	Doctors	Veterinary Physicians	Education	Social Services	AI Predicted	AI Control
Share female	0.34	0.34	0.12	0.55	0.48	0.42	0.33
Share married	0.69	0.74	0.76	0.69	0.58	0.69	0.69
Share tertiary degree	0.42	1.00	1.00	1.00	1.00	0.91	0.41
Average age	43.95	46.73	43.83	42.94	37.64	42.60	44.14
Average profits in USD	766.57	749.79	735.38	859.69	1,394.44	867.25	764.93
Δ profits in USD (2007-2006)	623.65	639.55	615.21	721.68	1,085.18	712.66	617.25
Percent Δ profits (2007-2006)	436.39	580.13	511.93	522.94	350.90	460.98	417.95
Observations	379,002	16,688	1,461	5,174	534	12,974	351,119
Panel B. Self-employment structure in population							
	2006	2007	2008	2009	2011	2013	2015
Share declaring	0.0215	0.0263	0.0321	0.0327	0.0415	0.0465	0.0449
Share declaring positive profits	0.0007	0.0030	0.0208	0.0233	0.0284	0.0317	0.0313
Share declaring taxable profits	0.0003	0.0009	0.0092	0.0096	0.0114	0.0124	0.0115
Panel C. VAT firms							
	All	Food industry				AI	
	Industries	Restaurants	Hotels	Retail	Wholesale	Predicted	Control
Average sales	30,430.74	18,213.60	66,140.22	14,767.97	80,203.10	21,743.05	36,414.05
Average costs/sales	0.40	0.68	0.59	0.70	0.56	0.47	0.40
Average VAT incurred	1,044.30	898.64	3,814.15	256.85	637.65	400.83	1438.84
Effective VAT rate	0.06	0.15	0.14	0.06	0.02	0.03	0.07
Δ VAT incurred (2007-2006)	112.68	103.53	445.67	25.79	1.20	38.09	155.72
Percent Δ VAT incurred (2007-2006)	12.09	13.02	13.23	11.16	0.19	10.50	12.14
Observations	749,010	21,375	2,220	49,661	9,908	214,019	420,622

This table presents summary statistics for our individual-level data on self-employed (Panels A and B) and VAT-paying firms (Panel C). Demographic characteristics in Panel A are measured in the pre-reform period 2007. Average profits refer to average profits in the relevant subgroup in the year 2007. Δ profits refers to average absolute growth of profits between 2006 and 2007, with missing values in 2006 treated as 0. Percent Δ profits is the average percentage change in profits between 2006 and 2007 across all self-employed in the respective sample. Panel B shows the development over time for the number of self-employment tax declarations, self-employment tax declarations with positive profits, and self-employment tax declarations with profits above the tax exemption threshold, all divided by the total population. In Panel C, average sales, the ratio of costs in sales, and average VAT incurred are measured in 2007. The effective VAT rate is calculated as the ratio of VAT incurred to sales minus costs in 2007. Δ VAT incurred is the average level difference between VAT incurred in 2007 and 2006 across firms. Percent Δ VAT incurred is the average percentage change in VAT incurred between 2006 and 2007.

Table 3: The effect of the reform on deductions, profits, and tax declarations

	(1)	(2)	(3)	(4)
Panel A: Difference-in-differences regressions at the regional level, per inhabitant				
	Deductions	Self-employment Profits	Profits Large Businesses	# Tax Declarations
TWFE: Intensity × Post	73.04	90.42	0.852	57.96
	(7.014)	(4.442)	(0.436)	(5.252)
Observations	2,190	2,190	2,190	2,190
Non-parametric ATT: 2008	55.53	178.76	-0.779	128.96
	(23.119)	(52.128)	(2.684)	(28.456)
Non-parametric ATT: 2015	165.86	185.70	-0.219	170.27
	(70.570)	(61.939)	(4.690)	(43.277)
Observations	219	219	219	219
Panel B: Triple-differences at self-employed level				
	Total Effect: Profits	Extensive Margin: # Declarations	Intensive Margin: Incumbents' Profits	
Doctors versus veterinarians				
Intensity × Doc × Post	2199.7	0.0486	4917.0	
	(388.8)	(0.0109)	(1052.6)	
Observations	247,495	247,495	4,348	
Teachers vs. social service professions				
Intensity × Teacher × Post	1130.3	0.0343	3702.1	
	(345.3)	(0.00668)	(2292.3)	
Observations	86,482	86,482	1,178	
Predicted vs. non-predicted				
Intensity × Predicted × Post	813.4	0.0250	1334.2	
	(73.72)	(0.00218)	(207.0)	
Observations	5,056,340	5,056,340	99,395	

Panel A presents results from the difference-in-differences regression at the region (*cantón*) level in Equation (1). The outcome in column 1 is the sum of the deductions claimed on all PIT tax declarations within a given region, divided by population (number of inhabitants). The outcome in column 2 is the sum of all self-employment profits reported on self-employed tax declarations (F102A) within the region per population. Column 3 examines the sum of all profits of large businesses filing a self-employed tax declaration with detailed accounting information (F102) per population. Column 4 reports the total number of self-employed tax declarations (F102A) in a given region reporting positive profits, per 10,000 inhabitants. In each column, we report the estimate of the interaction term between the intensity measure – the standardized pre-treatment share of high-income earners – and an indicator for years after the reform. The two-way fixed effects (TWFE) model includes region and year fixed effects. The non-parametric ATT aggregates differences to the non-treated regions. Regressions are weighted by regional population levels. **Panel B** provides results for the triple-difference regressions from Equation (2) at the individual self-employed level (tax declaration F102A). The regressions compare affected and unaffected professions. We report the estimate of the triple interaction term between the intensity measure, an indicator for affected occupations, and an indicator for time periods after the reform. Fixed effects at the self-employed and year level are included. Column 1 considers business profits of self-employed individuals (at the individual level). Column 2 considers indicators for filing taxes with reported profits exceeding the tax exemption threshold. Column 3 again examines business profits, but the sample is restricted to businesses already filing profits above the tax exempt threshold in 2006 or 2007. Affected and unaffected professions are doctors and dentists versus veterinary physicians, teachers versus other social service professions, and a group of professions identified as affected versus not affected by our machine learning algorithm. Standard errors in parentheses are two-way clustered at the region (cantón) and year level.

Table 4: The effect of the reform on VAT incurred: Triple Differences with Affected vs. Non-affected Firms

	(1)	(2)
Triple-differences at firm level		
	Subject to VAT	0%-VAT rated
Food Sector		
Intensity × Affected × Post	375.2	59.22
	(85.82)	(15.79)
Observations	245,164	587,051
AI-predicted Industries		
Intensity × Affected × Post	27.90	14.94
	(2.728)	(7.836)
Observations	4,428,514	2,956,761

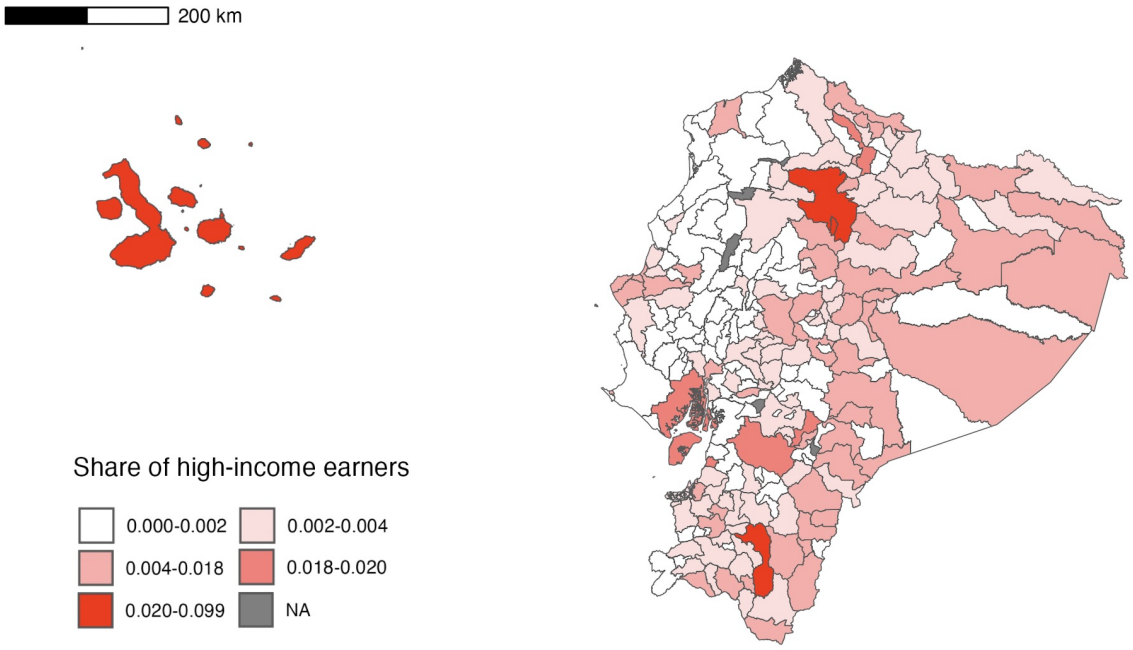
This table presents results from triple-difference regressions at the firm-level in Equation (3). The outcome variable is VAT incurred. We report the estimate of the triple interaction term between the intensity measure, an indicator for affected industries, and an indicator for time periods after the introduction of the reform. The first row reports coefficients for the food industry. Column 1 refers to the comparison of restaurants (deductible) to hotels (non-deductible). Services from restaurants and hotels are both subject to VAT. Column 2 refers to the comparison of retail sellers (deductible) to wholesale sellers (non-deductible) in the food industry. Basic food items are 0%-VAT rated. The second row reports coefficients for all firms based on the AI predictions. Column 1 refers to the comparison of industries predicted to be subject to VAT, distinguishing between those predicted to offer deductible and those predicted to offer non-deductible goods and services. Column 2 refers to the comparison of industries predicted to be 0%-VAT rated, again distinguishing deductible and non-deductible industries. Fixed effects at the firm and year level are included. Standard errors in parentheses are two-way clustered at the region (cantón) and year level.

Table 5: Changes in the Demand for Deductible Goods: Pseudo Panel from the Household Survey Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: All Deductibles										
Post × Affected	-.012	-.013								
	(.009)	(.009)								
Mountain region		.021								
		(.029)								
Household size		-.016								
		(.011)								
Hh member below 5		.028								
		(.021)								
... between 6 & 12		.013								
		(.014)								
... between 13 & 18		.013								
		(.018)								
R^2	0.82	0.82								
Observations	184	184								
Control pre mean	.62	.62								
Panel B: Deduction Categories										
	Clothing		Education		Food		Health		Housing	
Post × Affected	.007	.006	-.015	-.011	-.007	-.006	-.003	-.005	.005	.003
	(.003)	(.003)	(.005)	(.004)	(.006)	(.006)	(.003)	(.004)	(.004)	(.004)
Mountain region		.007		.016		-.005		-7.3e-04		.004
		(.011)		(.013)		(.027)		(.011)		(.015)
Household size		5.5e-06		.009		-.012		-.008		-.005
		(.003)		(.006)		(.010)		(.004)		(.006)
Hh member below 5		-.004		-.016		.042		.013		-.007
		(.008)		(.010)		(.018)		(.009)		(.013)
... between 6 & 12		-.005		.027		-.003		-.010		.004
		(.005)		(.007)		(.010)		(.005)		(.007)
... between 13 & 18		-.013		.019		.027		-.006		-.013
		(.006)		(.010)		(.014)		(.005)		(.008)
R^2	0.70	0.73	0.71	0.81	0.88	0.89	0.54	0.63	0.65	0.68
Observations	184	184	184	184	184	184	184	184	184	184
Control pre mean	.10	.10	.099	.099	.29	.29	.058	.058	.073	.073

This table presents results from difference-in-differences regressions according to Equation (4) using the pseudo panel based on the household survey described in Section 5. The observations represent averages of demographic cells, differentially for high and low income households, and for the pre and post period. The demographic cells are constructed by interacting bi-annual year of birth, education and gender groups. The outcomes are the share of expenditures for deductibles relative to total household expenditures. The regressions are weighted according to the number of underlying survey observations the cells are based on. Standard errors are clustered at the demographic cell-level and reported in parentheses. "Control pre mean" reports the mean values of the control group cells in the pre period, weighted according to the number of underlying survey observations. This regression is drawing on cell-level observations each based on at least 5 underlying survey observations and restricted to a balanced panel with each cell observable in pre, post, affected and treatment scenarios.

Figure 1: Spatial Distribution of High-Income Earners before the Reform (2007)

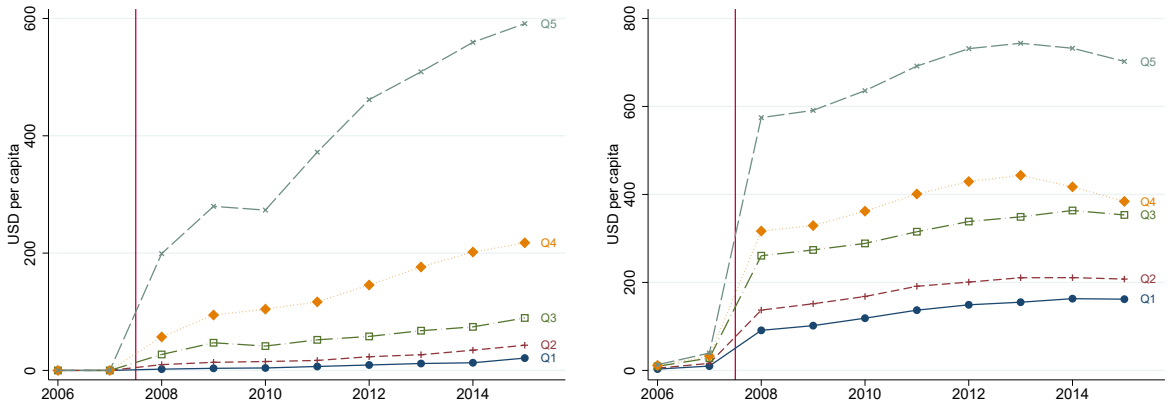


This figure depicts the spatial distribution of high-income earners in the last period before the reform (2007). Darker colors represent a higher share; the boundaries present cantón borders. Note that for better readability the Galapagos Islands in the West have been moved closer to the mainland of Ecuador.

Figure 2: Deductions, Reported Self-employment Profits, and Tax Declarations: Descriptives by Quintiles of Reform Intensity

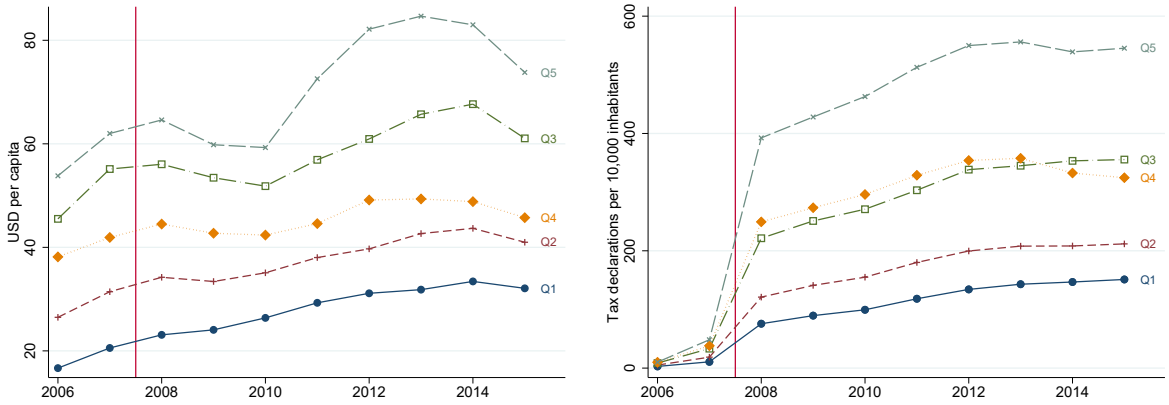
(a) Deductions per capita

(b) Self-employment profits per capita



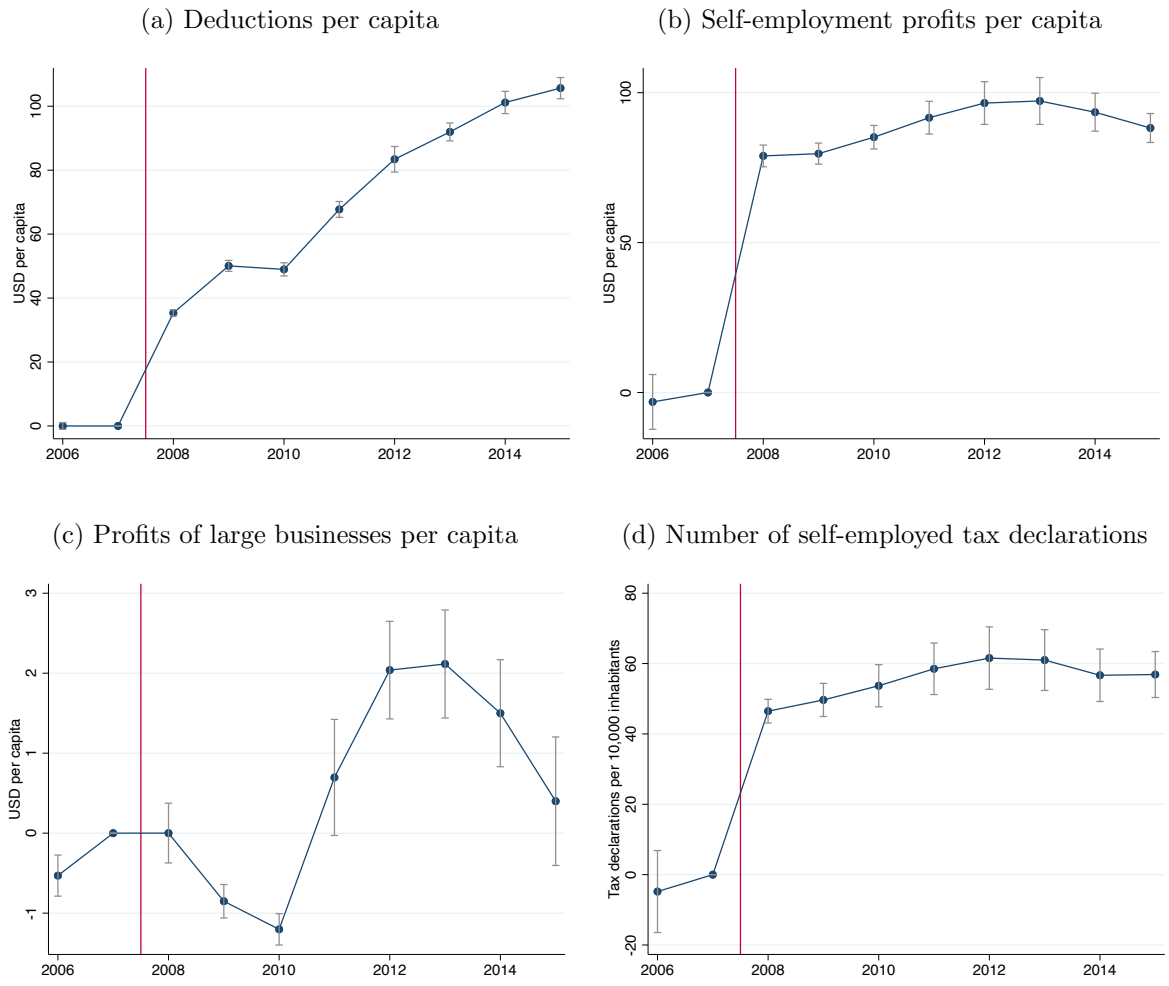
(c) Profits large businesses per capita

(d) Number of self-employed tax declarations



This figure descriptively depicts regional averages by quintiles of reform intensity for the main outcome variables used in the analysis. The regions are binned according to quintiles in the distribution of the share of pre-treatment high-income earners. Both the generation of quintiles and the calculation of the averages within each quintile are weighted by population size of the different regions. The range of values for the share of high-income earners in the quintiles are Q1: 0.000-0.002; Q2: 0.002-0.004; Q3: 0.004-0.018; Q4: 0.018-01020; Q5: 0.020-0.099. Panel (a) depicts the sum of deductions claimed on PIT declarations, divided by population (number of inhabitants). Panel (b) depicts the sum of self-employment profits claimed by regular self-employed (filing F102A) per population. Panel (c) provides the same for large self-employed businesses (filing F102), and panel (d) depicts the number of regular self-employed tax declarations reporting positive profits per 10,000 inhabitants.

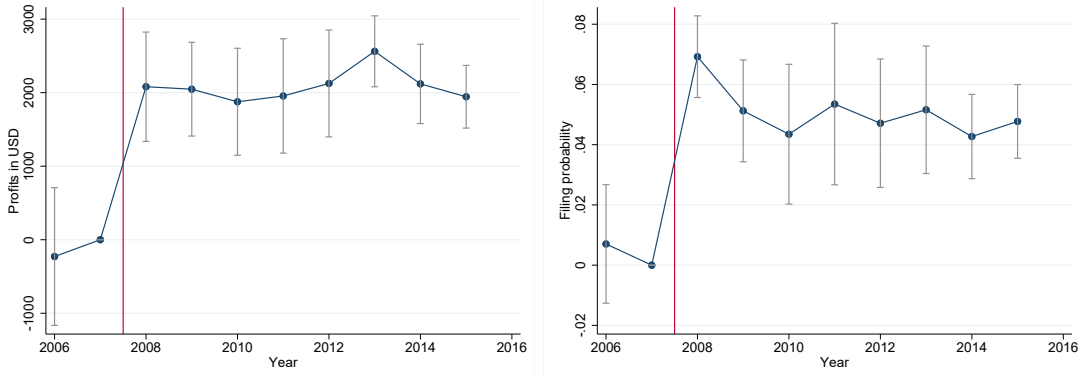
Figure 3: The Effect of the Reform on Deductions, Reported Self-employment Profits, and Tax Declarations: Difference-in-Differences at the Regional Level



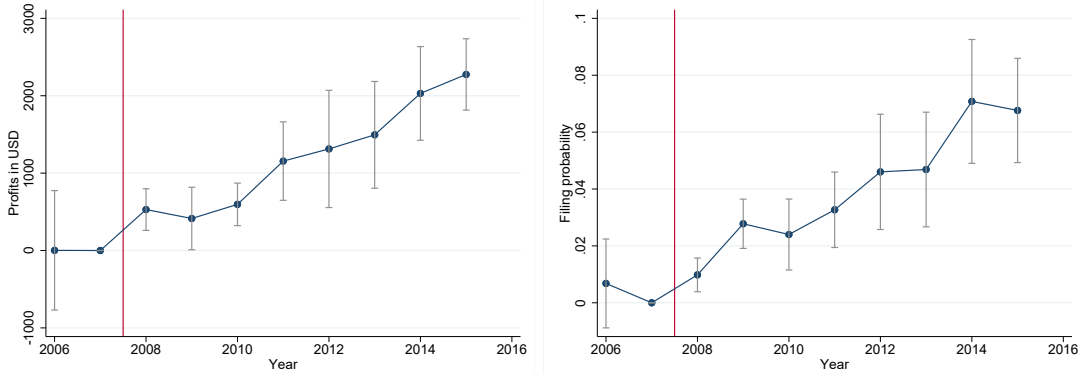
This figure depicts event study estimates according to Equation (1). The figure shows estimates of coefficient for the interaction of the intensity measure – the standardized pre-treatment share of high-income earners – with year dummies, with the year 2007 being normalized to 0. The observations are at the region (*cantón*) level and weighted by population. Panel (a) reports deductions per population (number of inhabitants), panel (b) self-employment profits per population, panel (c) profits of large self-employed businesses per population, and panel (d) the number of regular self-employed tax declarations with positive profits per 10,000 inhabitants. The 95% confidence intervals are depicted in gray lines, standard errors are two-way clustered at the regional (cantón) level and the year level.

Figure 4: The Effect of the Reform on Reported Self-employment Profits and Tax Declarations: Triple Differences with Affected vs. Non-Affected Professions

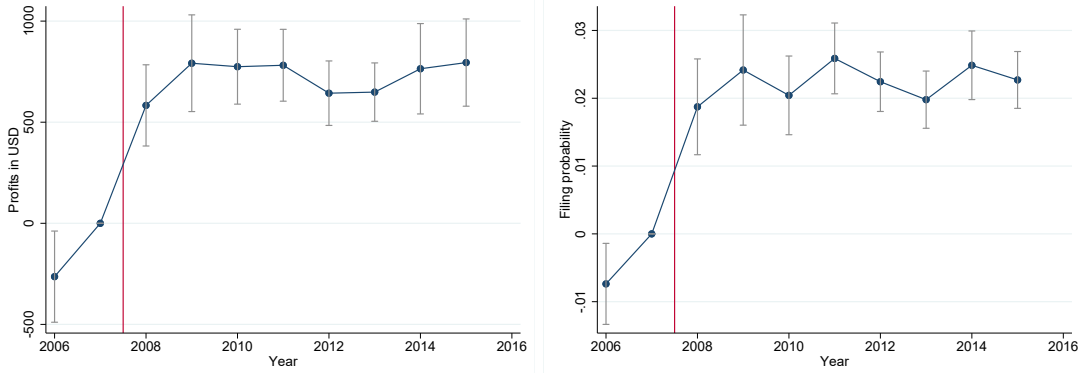
(a) Doctors versus veterinarians



(b) Teachers versus social service



(c) Data driven method

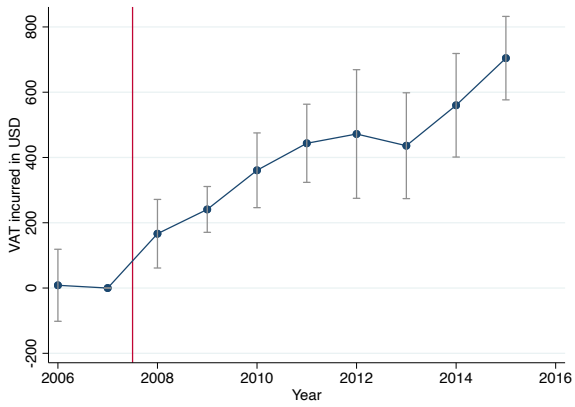


Overall Extensive

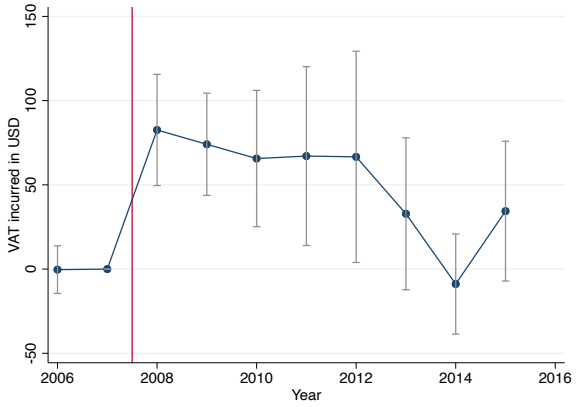
This figure depicts results from estimating Equation (2) at the individual self-employment level (tax declaration F102A). The regressions compare affected and unaffected professions. We report the estimates of the triple interaction terms between the intensity measure, an indicator for affected occupations, and year dummies, with the year 2007 being normalized to 0. Fixed effects at the self-employed and year level are included. The outcome variable in the left column is reported self-employment profits, the outcome variable in the right column is an indicator for filing taxes with reported profits exceeding the tax exemption threshold. Panel (a) compares doctors and dentists to veterinary physicians. Panel (b) compares teachers to other social service professionals (social communications, social services, political services, and publication services). Panel (c) compares professions predicted to offer deductible goods or services by our machine-learning algorithm to those predicted to offer non-deductibles. 95% confidence intervals are depicted in gray, standard errors are clustered at the regional (cantón) level.

Figure 5: The Effect of the Reform on VAT Payments: Triple Differences with Affected and Non-affected Industries

(a) Food Sector

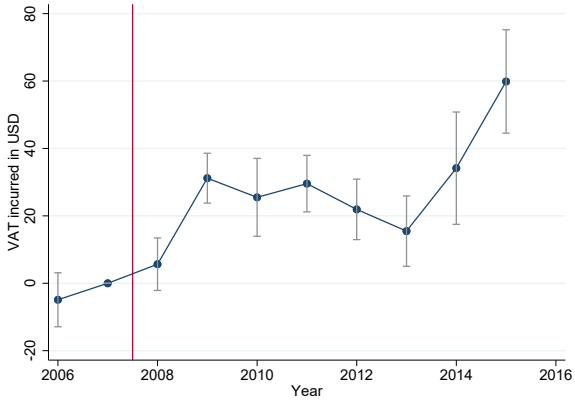


Restaurants vs. Hotels (subject to VAT)

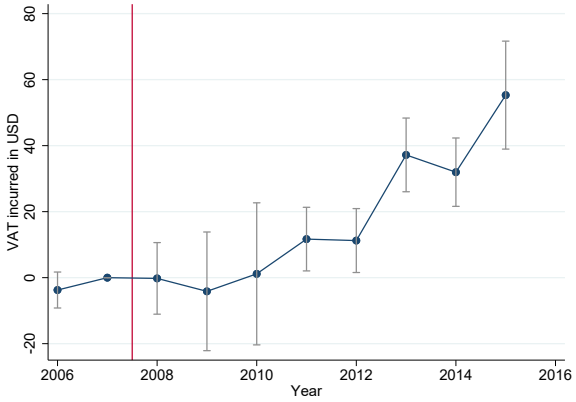


Retail vs. Wholesale (0%-VAT rated)

(b) Predicted Industries



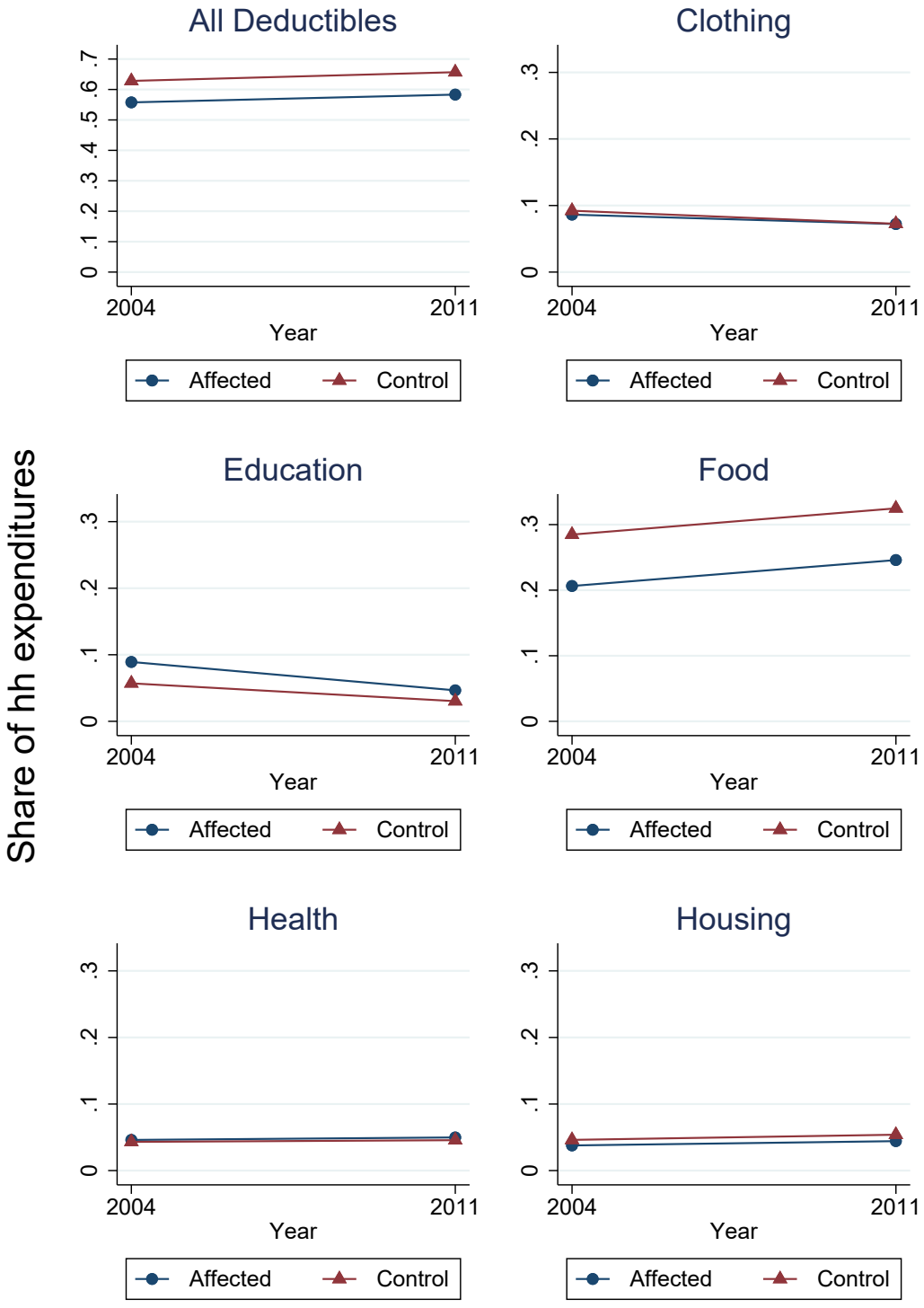
Industries predicted to be subject to VAT



Industries predicted to be 0%-VAT rated

This figure depicts estimates of Equation (3) at the firm level. The regressions compare affected and unaffected industries. We report the estimates of the triple interaction terms between the intensity measure, an indicator for affected industries, and year dummies, with the year 2007 being normalized to 0. Fixed effects at the firm and year level are included. The outcome variable is VAT incurred by the firm. Panel (a) considers the food sector. The left graph compares restaurants (deductible) to hotels (non-deductible). Services from restaurants and hotels are subject to VAT. The right graph compares retail sellers (deductible) to wholesale sellers (non-deductible) in the food industry. Basic food items are 0%-VAT rated. Panel (b) considers coefficients for all firms based on the AI predictions. The left graph compares industries predicted to be subject to VAT, distinguishing between those predicted to offer deductible and those predicted to offer non-deductible goods or services. The right graph compares industries predicted to be 0%-VAT rated, again distinguishing between deductible and non-deductible industries. 95% confidence intervals are depicted in gray, standard errors are two-way clustered at the regional (cantón) level and the year level.

Figure 6: The Share of Expenditures for Deductible Goods: Descriptives from the Household Survey Data

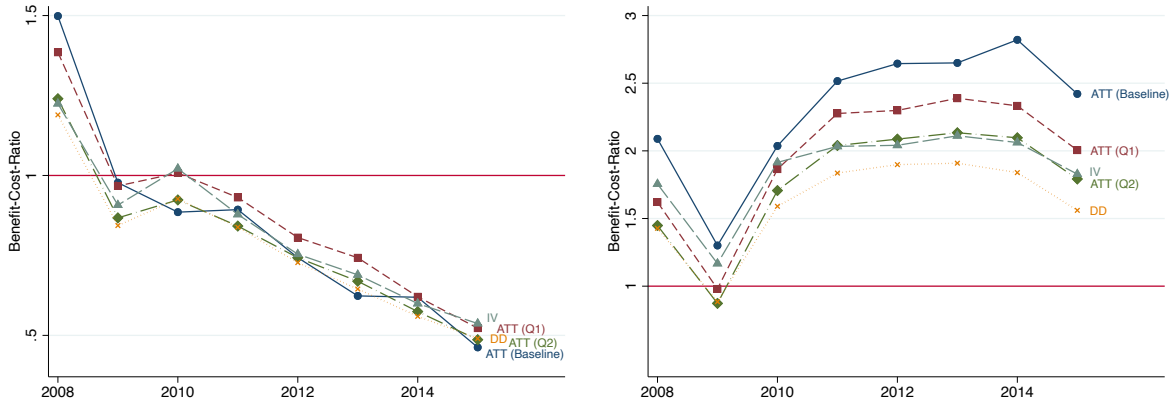


This figure depicts descriptive trends in observed expenditure shares on deductible household expenses using the two waves of cross-sectional survey data introduced in Section 5. The vertical axes depict the median (p50) share of household expenditures going towards the indicated category. The samples are divided into "Affected" and "Control" group, depending on whether the income of the highest earner is above or below the tax exemption threshold. Note that the vertical axis for the upper left panel on all deductibles has a different scaling than the other axes.

Figure 7: Net Revenue Impact Analysis

(a) Only self-employed profits

(b) Including VAT



This figure shows the ratio of the fiscal gains from the policy to the foregone PIT for various ways of computing the effect of the reform. Panel A computes fiscal gains only based on increased tax payments from self-employed individuals. Panel B includes the fiscal gains from increased VAT payments. We use alternative estimates for our calculations of the fiscal gains. Our baseline estimate (solid blue line with dots) uses our non-parametric estimator of the ATT where the untreated control group consists of four regions without any high-income earners. Our alternative estimators are a non-parametric ATT where we compare regions in quintiles 2-5 of the distribution of treatment intensity to regions in the lowest quintile (dashed red line with squares), a non-parametric ATT where we compare regions in quintiles 3-5 of the distribution of treatment intensity to regions in the lowest two quintiles (dashed green line with diamonds), an extrapolation from our regional Difference-in-Differences estimates based on two-way fixed effects estimator (dotted yellow line with crosses), and an IV estimate of the additional gain induced by one additional dollar of deductions (dashed gray line with triangles).

ONLINE APPENDIX

A Additional Tables and Figures

Table A.1: List of Deduction Categories and Deductible Items

Category	Subcategory	Examples
Housing		
	Rent	Rent of a single property used for housing
	Mortgage loan interest	The interests of mortgage loans granted by authorized institutions, intended for the expansion, remodeling, restoration, acquisition or construction, of a single dwelling used for housing.
	Basic services	Payments for basic services that include water, gas, electricity, landline telephone, and condominium fee for a single property used for housing.
	Property tax	Property taxes for a single real estate property used for housing.
	Alimony	Alimony, duly supported by a mediation agreement or court ruling.
	Other expenses	Allocated for the acquisition, construction, remodeling, expansion, improvement, and maintenance of a single real estate property.
Education		
	Enrollment and Tuition	Enrollment and tuition at all levels of the educational system, including early education, basic general education, high school, and higher education. School transportation. Graduation rights. Payment of interest on educational credits granted by duly authorized institutions.
	School supply and textbooks	School supplies, textbooks, computer equipment, and educational materials used in education.
	Education for people with disabilities	Special education services for people with disabilities.
	Child care and/or development	Services provided by child care and/or development centers.
	Uniforms	
Health		
	Professional health fees	Fees for doctors and health professionals with professional degrees.
	Health services	Health services provided by authorized clinics, hospitals, laboratories, and pharmacies.
	Medication and others	Medications, medical supplies, glasses, orthotics, prosthetics and other health accessories.
	Prepaid medicine and health insurance premia	Prepaid medicine and health insurance premium in individual and corporate contracts.
	Insurance deductible	The non-reimbursed deductible from the private insurance settlement.
	Alimony	Alimony, duly supported by a mediation agreement or court resolution.
	Other expenses	Related to physical and mental well-being, as well as those aimed at prevention, recovery, and rehabilitation of health.
Nutrition		
	Food	Purchases of food for human consumption and other natural or artificial products.
	Alimony	Alimony, duly substantiated in a mediation agreement or court ruling.
	Restaurants	Purchase of food at prepared food distribution centers.
Clothing		
	Clothing	Any expenditure on any type of clothing will be considered as clothing expenses.
	Alimony	Alimony, duly supported by a mediation agreement or court ruling.

This table shows the five deduction categories and lists examples for each category, translating the official document provided by the *Servicio de Rentas Internas* of Ecuador.

Table A.2: Estimation - Sensitivity Checks and Instrumental Variables Estimation

	(1)	(2)	(3)	(4)
Panel A. DiD - Excluding Regions with a High Share of High-income Earners				
	Deductions	Self-employment Profits	Profits Large Businesses	# Tax Declarations
TWFE: Intensity × Post	69.30	131.1	-2.636	104.4
	(11.19)	(12.53)	(0.711)	(19.15)
Observations	2,130	2,130	2,130	2,130
Non-parametric ATT: 2008	24.48	115.86	-0.852	93.19
	(6.930)	(25.615)	(2.799)	(14.607)
Non-parametric ATT: 2015	77.51	113.47	-0.963	123.97
	(26.416)	(35.458)	(4.477)	(30.727)
Observations	213	213	213	213
Panel B. DiD - Alternative Treatment (High-income Earners in Upper Half of Tax Schedule)				
	Deductions	Self-employment Profits	Profits Large Businesses	# Tax Declarations
TWFE: Intensity × Post	71.27	85.53	0.880	52.56
	(6.07)	(3.58)	(0.336)	(3.55)
Observations	2,190	2,190	2,190	2,190
Non-parametric ATT: 2008	51.68	167.63	1.335	112.16
	(22.91)	(50.09)	(0.564)	(28.45)
Non-parametric ATT: 2015	154.77	176.81	-5.258	136.61
	(70.81)	(56.79)	(1.861)	(36.52)
Observations	219	219	219	219
Panel B. Instrumental Variables Approach				
IV: Deductions × Post		1.37	0.009	0.91
		(0.104)	(0.004)	(0.098)
Observations		2190	2190	2190
First-stage F-stat		255.44	255.44	255.44
Panel C: Triple-differences with Region × Year Fixed Effects				
	Total Effect: Profits	Extensive Margin: # Declarations	Intensive Margin: Incumbents' Profits	
Doctors versus veterinarians				
Intensity × Doc × Post	2426.0	0.0539	6521.2	
	(518.5)	(0.0111)	(1788.2)	
Observations	247,367	247,367	4,056	
Teachers vs. social service professions				
Intensity × Teacher × Post	873.1	0.0246	526.1	
	(529.4)	(0.0177)	(2056.2)	
Observations	86266	86266	882	
Predicted vs. non-predicted				
Intensity × Predicted × Post	574.0	0.0169	1155.2	
	(195.8)	(0.00499)	(737.1)	
Observations	5,056,340	5,056,340	99,395	

The table presents sensitivity checks of our main results from the difference-in-differences regression at the region (*cantón*) level in Equation (1) and the triple difference regression with affected and unaffected professions at the self-employed level in Equation (2). All definitions correspond to those for the main results in Table 3. In Panel A, we estimate Equation (1) excluding all regions in the highest quintile in the (population-weighted) distribution of high-income earners, i.e., all regions where the share of high-income earners exceeds 0.02. In Panel B, we estimate the effect of the (potentially endogenous) amount of deductions in a region on self-employment profits and tax declarations using the pre-treatment share of high-income earners in 2007 as an instrumental variable. In Panel C, we estimate Equation (2) using interacted region-by-year fixed effects.

Table A.3: Household Characteristics and Demand for Deductibles: Descriptives from the Household Survey Data

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pre Reform (2004)						
	Affected Households (N=1,420)			Control Households (N=1,278)		
	Mean	sd	p50	Mean	sd	p50
Demographics						
Age hh head	45.44	11.53	44.00	44.73	12.31	43.00
Female hh head	0.12	0.32	0.00	0.14	0.34	0.00
High school degree	0.27	0.44	0.00	0.38	0.49	0.00
Tertiary education	0.63	0.48	1.00	0.39	0.49	0.00
Number hh members	4.17	1.65	4.00	4.29	1.77	4.00
... below 5	0.43	0.68	0.00	0.51	0.72	0.00
... between 6 & 12	0.59	0.79	0.00	0.65	0.83	0.00
... between 13 &18	0.55	0.77	0.00	0.52	0.76	0.00
Mountain region	0.60	0.49	1.00	0.56	0.50	1.00
Expenditures						
Expenditure per capita	278.04	237.01	213.21	162.29	153.88	124.31
Share deductible	0.54	0.17	0.56	0.61	0.16	0.63
Share clothing	0.09	0.06	0.09	0.10	0.06	0.09
Share education	0.11	0.10	0.09	0.09	0.09	0.06
Share food	0.22	0.13	0.21	0.29	0.14	0.28
Share health	0.06	0.05	0.05	0.06	0.06	0.04
Share housing	0.06	0.05	0.04	0.07	0.07	0.05
Panel B: Post Reform (2011/12)						
	Affected Households (N=4,594)			Control Households (N=3,222)		
	Mean	sd	p50	Mean	sd	p50
Demographics						
Age hh head	47.44	12.27	47.00	45.16	13.09	44.00
Female hh head	0.16	0.36	0.00	0.16	0.37	0.00
High school degree	0.28	0.45	0.00	0.43	0.50	0.00
Tertiary education	0.59	0.49	1.00	0.31	0.46	0.00
Number hh members	3.98	1.59	4.00	4.15	1.76	4.00
... below 5	0.41	0.64	0.00	0.48	0.71	0.00
... between 6 & 12	0.53	0.73	0.00	0.62	0.78	0.00
... between 13 &18	0.48	0.71	0.00	0.51	0.74	0.00
Mountain region	0.61	0.49	1.00	0.55	0.50	1.00
Expenditures						
Expenditure per capita	465.07	455.66	345.68	249.30	187.53	199.81
Share deductible	0.56	0.16	0.58	0.63	0.14	0.66
Share clothing	0.08	0.05	0.07	0.08	0.06	0.07
Share education	0.07	0.08	0.05	0.06	0.08	0.03
Share food	0.26	0.13	0.25	0.33	0.14	0.32
Share health	0.07	0.07	0.05	0.07	0.08	0.05
Share housing	0.08	0.09	0.04	0.09	0.09	0.05

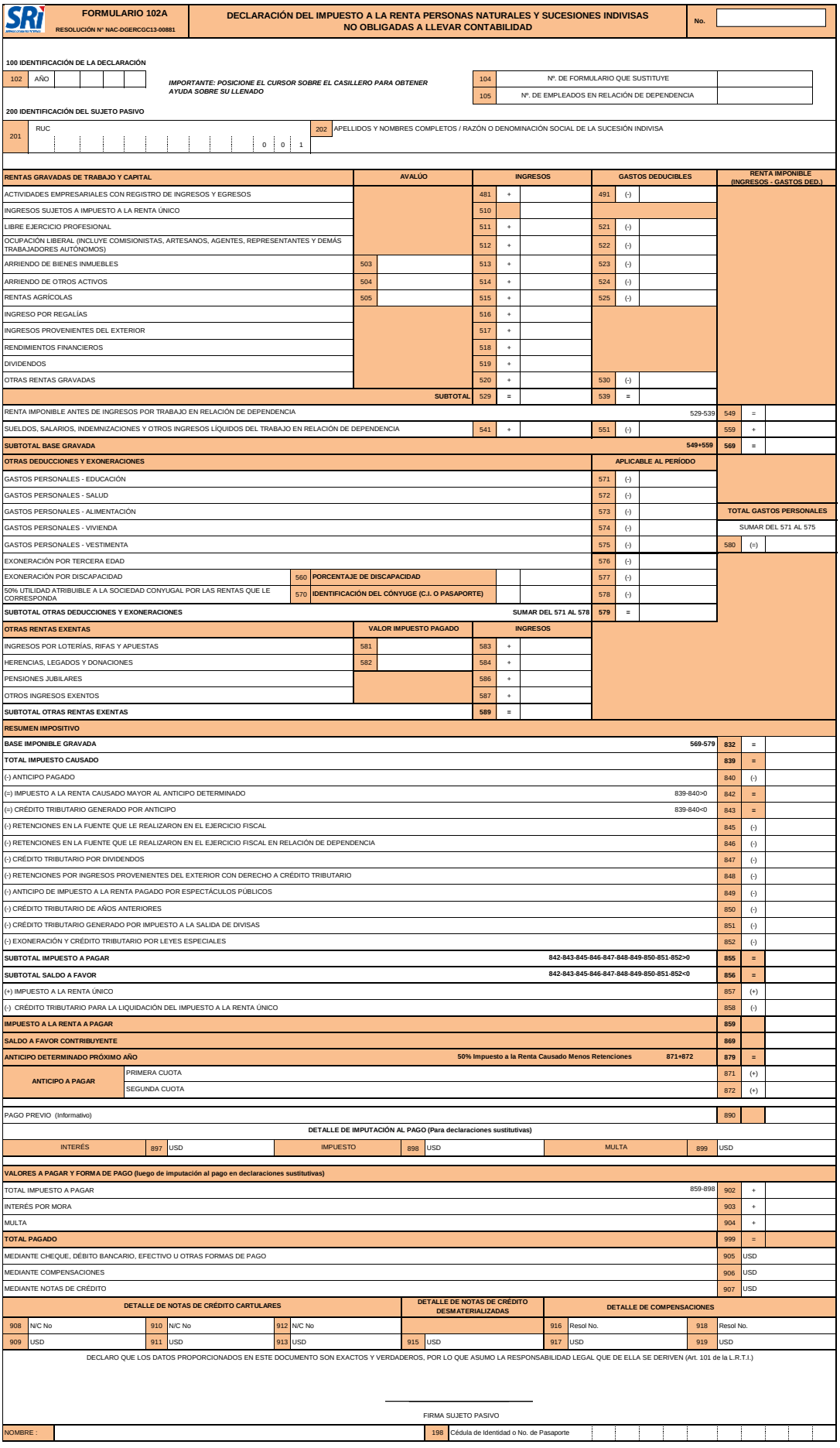
This table presents descriptive statistics of the household survey data used in the analysis of demand effects in Section 5. Panel A reports summary statistics for the pre-reform wave in 2004, panel B for the post-reform wave in 2011/12. The table reports both demographics and expenditure information at the household level. Households are divided into "Affected" and "Control" households depending on whether the income of the highest earner is above or below the tax exemption threshold. Educational attainment refers to the highest level of education of the household head. Tertiary education is defined as any additional education after a high school degree. The left out category is primary school education or less. Expenditure per capita is given in nominal USD. Share deductible is the share of total household spending in any of the five deductible categories. N refers to the number of households in each sample.

Table A.4: Aggregate Demand Effects - Sensitivity to Sample Definition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Alternative Definition of Treatment Group										
	All Deductibles									
Post=1 × Affected=1	-.004	-.008								
	(.011)	(.011)								
R^2	0.59	0.61								
Observations	136	136								
Control pre mean	.62	.62								
	Clothing		Education		Food		Health		Housing	
Post=1 × Affected=1	.009	.009	-.009	-.010	7.6e-04	-.003	-.003	-.003	-.002	-.002
	(.003)	(.003)	(.007)	(.006)	(.01)	(.011)	(.005)	(.005)	(.006)	(.005)
R^2	0.701	0.729	0.588	0.698	0.792	0.816	0.430	0.516	0.520	0.592
Observations	136	136	136	136	136	136	136	136	136	136
Control pre mean	.1	.1	.099	.099	.28	.28	.055	.055	.076	.076
Panel B: No Winsorization										
	All Deductibles									
Post=1 × Affected=1	-.012	-.012								
	(.008)	(.009)								
R^2	0.73	0.74								
Observations	184	184								
Control pre mean	.63	.63								
	Clothing		Education		Food		Health		Housing	
Post=1 × Affected=1	.008	.006	-.021	-.017	-.008	-.007	-.002	-.004	.011	.010
	(.003)	(.003)	(.006)	(.005)	(.006)	(.006)	(.004)	(.004)	(.007)	(.007)
R^2	0.68	0.71	0.69	0.80	0.88	0.88	0.54	0.63	0.50	0.52
Observations	184	184	184	184	184	184	184	184	184	184
Control pre mean	.1	.1	.1	.1	.29	.29	.058	.058	.079	.079

This table presents sensitivity analyses to Table 5 analyzing the pseudo panel based on the household survey described in Section 5. **Panel A** depicts results for an alternative definition of the treatment group based on a narrower window of income above the tax exemption threshold (0.5 standard deviation above to symmetrically reflect the control group of 0.5 standard deviation below). The sample size of the pseudo panel is smaller due to fewer cohort-education-gender cells meeting the data requirements set out in section 5. Apart from the sample definition, the approach and estimation equation is unchanged (Equation (4) in the main text). The estimates for the control variables region, household size, and household demographic composition have been excluded for brevity. Standard errors are clustered at the demographic cell-level and reported in parentheses. "Control pre mean" reports the mean values of the control group cells in the pre period, weighted according to the number of underlying survey observations. **Panel B** presents results for the same regression of the pseudo panel based on an alternative dataset without the application of winsorization of the top and bottom 1% observations. The treatment group in Panel B is defined like in the main paper as all households where at least one member earns income above the tax exemption threshold. Unreported control variables and standard errors are exactly like those explained in Panel A.

Figure A.1: Tax Declaration Form F102A for Regular Self-Employed



FORMULARIO 102A
RESOLUCIÓN Nº NAC-DGERCGC13-00881

DECLARACIÓN DEL IMPUESTO A LA RENTA PERSONAS NATURALES Y SUCESIONES INDIVISAS NO OBLIGADAS A LLEVAR CONTABILIDAD

No.

100 IDENTIFICACIÓN DE LA DECLARACIÓN

102 AÑO

IMPORTANTE: POSICIONE EL CURSOR SOBRE EL CASILLERO PARA OBTENER AYUDA SOBRE SU LLENADO

104 Nº. DE FORMULARIO QUE SUSTITUYE

105 Nº. DE EMPLEADOS EN RELACIÓN DE DEPENDENCIA

200 IDENTIFICACIÓN DEL SUJETO PASIVO

201 RUC (0 0 1)

202 APELLIDOS Y NOMBRES COMPLETOS / RAZÓN O DENOMINACIÓN SOCIAL DE LA SUCESIÓN INDIVISA

RENTAS GRAVADAS DE TRABAJO Y CAPITAL	AVALÚO		INGRESOS			GASTOS DEDUCIBLES			RENTA IMPONIBLE (INGRESOS - GASTOS DED.)
ACTIVIDADES EMPRESARIALES CON REGISTRO DE INGRESOS Y EGRESOS			481	+		491	(-)		
INGRESOS SUJETOS A IMPUESTO A LA RENTA ÚNICO			510						
LIBRE EJERCICIO PROFESIONAL			511	+		521	(-)		
OCUPACIÓN LIBERAL (INCLUYE COMISIONISTAS, ARTESANOS, AGENTES, REPRESENTANTES Y DEMÁS TRABAJADORES AUTÓNOMOS)			512	+		522	(-)		
ARRIENDO DE BIENES INMUEBLES	503		513	+		523	(-)		
ARRIENDO DE OTROS ACTIVOS	504		514	+		524	(-)		
RENTAS AGRÍCOLAS	505		515	+		525	(-)		
INGRESO POR REGALÍAS			516	+					
INGRESOS PROVENIENTES DEL EXTERIOR			517	+					
RENDIMIENTOS FINANCIEROS			518	+					
DIVIDENDOS			519	+					
OTRAS RENTAS GRAVADAS			520	+		530	(-)		
SUBTOTAL			529	=		539	=		
RENTA IMPONIBLE ANTES DE INGRESOS POR TRABAJO EN RELACIÓN DE DEPENDENCIA					529-539			549	=
SUELDOS, SALARIOS, INDEMNIZACIONES Y OTROS INGRESOS LÍQUIDOS DEL TRABAJO EN RELACIÓN DE DEPENDENCIA			541	+		551	(-)	559	+
SUBTOTAL BASE GRAVADA					549+559			569	=

OTRAS DEDUCCIONES Y EXONERACIONES			APLICABLE AL PERÍODO		
GASTOS PERSONALES - EDUCACIÓN			571	(-)	
GASTOS PERSONALES - SALUD			572	(-)	
GASTOS PERSONALES - ALIMENTACIÓN			573	(-)	
GASTOS PERSONALES - VIVIENDA			574	(-)	
GASTOS PERSONALES - VESTIMENTA			575	(-)	
EXONERACIÓN POR TERCERA EDAD			576	(-)	
EXONERACIÓN POR DISCAPACIDAD	560	PORCENTAJE DE DISCAPACIDAD	577	(-)	
50% UTILIDAD ATRIBUIBLE A LA SOCIEDAD CONYUGAL POR LAS RENTAS QUE LE CORRESPONDA	570	IDENTIFICACIÓN DEL CÓNYUGE (C.I. O PASAPORTE)	578	(-)	
SUBTOTAL OTRAS DEDUCCIONES Y EXONERACIONES		SUMAR DEL 571 AL 578	579	=	

TOTAL GASTOS PERSONALES
SUMAR DEL 571 AL 575
580 (=)

OTRAS RENTAS EXENTAS	VALOR IMPUESTO PAGADO		INGRESOS		
INGRESOS POR LOTERÍAS, RIFAS Y APUESTAS	581		583	+	
HERENCIAS, LEGADOS Y DONACIONES	582		584	+	
PENSIONES JUBILARES			586	+	
OTROS INGRESOS EXENTOS			587	+	
SUBTOTAL OTRAS RENTAS EXENTAS			589	=	

RESUMEN IMPOSITIVO			
BASE IMPONIBLE GRAVADA	569-579	832	=
TOTAL IMPUESTO CAUSADO		839	=
(-) ANTICIPO PAGADO		840	(-)
(=) IMPUESTO A LA RENTA CAUSADO MAYOR AL ANTICIPO DETERMINADO	839-840>0	842	=
(=) CRÉDITO TRIBUTARIO GENERADO POR ANTICIPO	839-840<0	843	=
(-) RETENCIONES EN LA FUENTE QUE LE REALIZARON EN EL EJERCICIO FISCAL		845	(-)
(-) RETENCIONES EN LA FUENTE QUE LE REALIZARON EN EL EJERCICIO FISCAL EN RELACIÓN DE DEPENDENCIA		846	(-)
(-) CRÉDITO TRIBUTARIO POR DIVIDENDOS		847	(-)
(-) RETENCIONES POR INGRESOS PROVENIENTES DEL EXTERIOR CON DERECHO A CRÉDITO TRIBUTARIO		848	(-)
(-) ANTICIPO DE IMPUESTO A LA RENTA PAGADO POR ESPECTÁCULOS PÚBLICOS		849	(-)
(-) CRÉDITO TRIBUTARIO DE AÑOS ANTERIORES		850	(-)
(-) CRÉDITO TRIBUTARIO GENERADO POR IMPUESTO A LA SALIDA DE DIVISAS		851	(-)
(-) EXONERACIÓN Y CRÉDITO TRIBUTARIO POR LEYES ESPECIALES		852	(-)
SUBTOTAL IMPUESTO A PAGAR	842-843-845-846-847-848-849-850-851-852>0	855	=
SUBTOTAL SALDO A FAVOR	842-843-845-846-847-848-849-850-851-852<0	856	=
(+) IMPUESTO A LA RENTA ÚNICO		857	(+)
(-) CRÉDITO TRIBUTARIO PARA LA LIQUIDACIÓN DEL IMPUESTO A LA RENTA ÚNICO		858	(-)
IMPUESTO A LA RENTA A PAGAR		859	
SALDO A FAVOR CONTRIBUYENTE		869	
ANTICIPO DETERMINADO PRÓXIMO AÑO	50% Impuesto a la Renta Causado Menos Retenciones 871+872	879	=
ANTICIPO A PAGAR — PRIMERA CUOTA		871	(+)
ANTICIPO A PAGAR — SEGUNDA CUOTA		872	(+)
PAGO PREVIO (Informativo)		890	

DETALLE DE IMPUTACIÓN AL PAGO (Para declaraciones sustitutivas)

INTERÉS	897	USD	IMPUESTO	898	USD	MULTA	899	USD

VALORES A PAGAR Y FORMA DE PAGO (luego de imputación al pago en declaraciones sustitutivas)				
TOTAL IMPUESTO A PAGAR	859-898	902	+	
INTERÉS POR MORA		903	+	
MULTA		904	+	
TOTAL PAGADO		999	=	
MEDIANTE CHEQUE, DÉBITO BANCARIO, EFECTIVO U OTRAS FORMAS DE PAGO		905	USD	
MEDIANTE COMPENSACIONES		906	USD	
MEDIANTE NOTAS DE CRÉDITO		907	USD	

DETALLE DE NOTAS DE CRÉDITO CARTULARES						DETALLE DE NOTAS DE CRÉDITO DESMATERIALIZADAS		DETALLE DE COMPENSACIONES			
908	N/C No	910	N/C No	912	N/C No			916	Resol No.	918	Resol No.
909	USD	911	USD	913	USD	915	USD	917	USD	919	USD

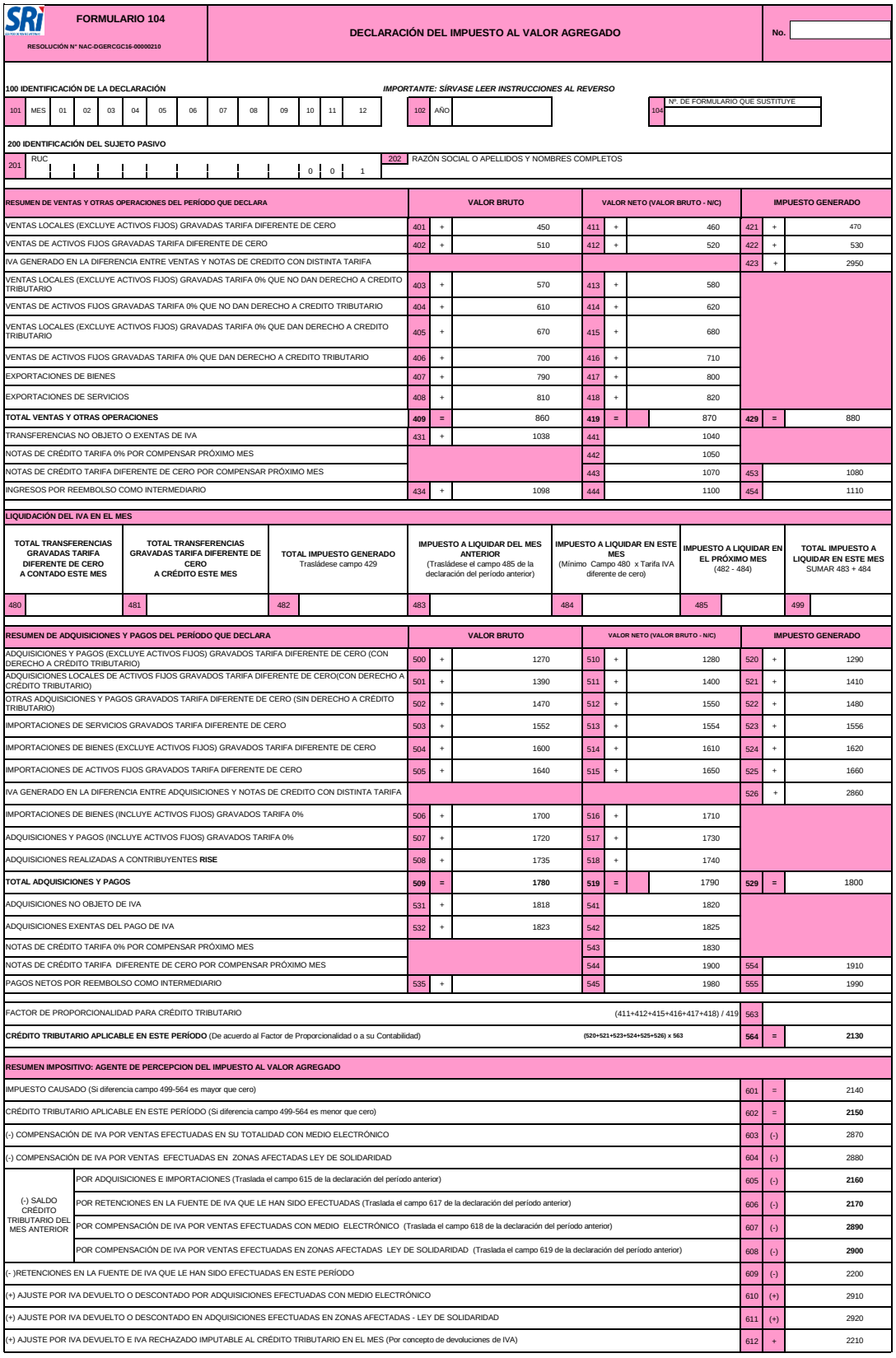
DECLARO QUE LOS DATOS PROPORCIONADOS EN ÉSTE DOCUMENTO SON EXACTOS Y VERDADEROS, POR LO QUE ASUMO LA RESPONSABILIDAD LEGAL QUE DE ELLA SE DERIVEN (Art. 101 de la L.R.T.I.)

FIRMA SUJETO PASIVO

NOMBRE : | 198 Cédula de Identidad o No. de Pasaporte

This figure depicts the tax declaration form F102A used for filing PIT declaration for regular self-employed individuals.

Figure A.2: Value-Added Tax Declaration Form F104



FORMULARIO 104 — RESOLUCIÓN N° NAC-DGERCGC16-00000210

DECLARACIÓN DEL IMPUESTO AL VALOR AGREGADO

No.

100 IDENTIFICACIÓN DE LA DECLARACIÓN — *IMPORTANTE: SÍRVASE LEER INSTRUCCIONES AL REVERSO*

101 MES: 01 02 03 04 05 06 07 08 09 10 11 12 — 102 AÑO — 104 Nº. DE FORMULARIO QUE SUSTITUYE

200 IDENTIFICACIÓN DEL SUJETO PASIVO

201 RUC (0 0 1) — 202 RAZÓN SOCIAL O APELLIDOS Y NOMBRES COMPLETOS

RESUMEN DE VENTAS Y OTRAS OPERACIONES DEL PERÍODO QUE DECLARA	VALOR BRUTO			VALOR NETO (VALOR BRUTO - N/C)			IMPUESTO GENERADO		
VENTAS LOCALES (EXCLUYE ACTIVOS FIJOS) GRAVADAS TARIFA DIFERENTE DE CERO	401	+	450	411	+	460	421	+	470
VENTAS DE ACTIVOS FIJOS GRAVADAS TARIFA DIFERENTE DE CERO	402	+	510	412	+	520	422	+	530
IVA GENERADO EN LA DIFERENCIA ENTRE VENTAS Y NOTAS DE CREDITO CON DISTINTA TARIFA							423	+	2950
VENTAS LOCALES (EXCLUYE ACTIVOS FIJOS) GRAVADAS TARIFA 0% QUE NO DAN DERECHO A CREDITO TRIBUTARIO	403	+	570	413	+	580			
VENTAS DE ACTIVOS FIJOS GRAVADAS TARIFA 0% QUE NO DAN DERECHO A CREDITO TRIBUTARIO	404	+	610	414	+	620			
VENTAS LOCALES (EXCLUYE ACTIVOS FIJOS) GRAVADAS TARIFA 0% QUE DAN DERECHO A CREDITO TRIBUTARIO	405	+	670	415	+	680			
VENTAS DE ACTIVOS FIJOS GRAVADAS TARIFA 0% QUE DAN DERECHO A CREDITO TRIBUTARIO	406	+	700	416	+	710			
EXPORTACIONES DE BIENES	407	+	790	417	+	800			
EXPORTACIONES DE SERVICIOS	408	+	810	418	+	820			
TOTAL VENTAS Y OTRAS OPERACIONES	**409**	=	860	**419**	=	870	**429**	=	880
TRANSFERENCIAS NO OBJETO O EXENTAS DE IVA	431	+	1038	441		1040			
NOTAS DE CRÉDITO TARIFA 0% POR COMPENSAR PRÓXIMO MES				442		1050			
NOTAS DE CRÉDITO TARIFA DIFERENTE DE CERO POR COMPENSAR PRÓXIMO MES				443		1070	453		1080
INGRESOS POR REEMBOLSO COMO INTERMEDIARIO	434	+	1098	444		1100	454		1110

LIQUIDACIÓN DEL IVA EN EL MES

TOTAL TRANSFERENCIAS GRAVADAS TARIFA DIFERENTE DE CERO A CONTADO ESTE MES		TOTAL TRANSFERENCIAS GRAVADAS TARIFA DIFERENTE DE CERO A CRÉDITO ESTE MES		TOTAL IMPUESTO GENERADO Trasládese campo 429		IMPUESTO A LIQUIDAR DEL MES ANTERIOR (Trasládese el campo 485 de la declaración del período anterior)		IMPUESTO A LIQUIDAR EN ESTE MES (Mínimo Campo 480 x Tarifa IVA diferente de cero)		IMPUESTO A LIQUIDAR EN EL PRÓXIMO MES (482 - 484)		TOTAL IMPUESTO A LIQUIDAR EN ESTE MES SUMAR 483 + 484	
480		481		482		483		484		485		499	

RESUMEN DE ADQUISICIONES Y PAGOS DEL PERÍODO QUE DECLARA	VALOR BRUTO			VALOR NETO (VALOR BRUTO - N/C)			IMPUESTO GENERADO		
ADQUISICIONES Y PAGOS (EXCLUYE ACTIVOS FIJOS) GRAVADOS TARIFA DIFERENTE DE CERO (CON DERECHO A CRÉDITO TRIBUTARIO)	500	+	1270	510	+	1280	520	+	1290
ADQUISICIONES LOCALES DE ACTIVOS FIJOS GRAVADOS TARIFA DIFERENTE DE CERO(CON DERECHO A CRÉDITO TRIBUTARIO)	501	+	1390	511	+	1400	521	+	1410
OTRAS ADQUISICIONES Y PAGOS GRAVADOS TARIFA DIFERENTE DE CERO (SIN DERECHO A CRÉDITO TRIBUTARIO)	502	+	1470	512	+	1550	522	+	1480
IMPORTACIONES DE SERVICIOS GRAVADOS TARIFA DIFERENTE DE CERO	503	+	1552	513	+	1554	523	+	1556
IMPORTACIONES DE BIENES (EXCLUYE ACTIVOS FIJOS) GRAVADOS TARIFA DIFERENTE DE CERO	504	+	1600	514	+	1610	524	+	1620
IMPORTACIONES DE ACTIVOS FIJOS GRAVADOS TARIFA DIFERENTE DE CERO	505	+	1640	515	+	1650	525	+	1660
IVA GENERADO EN LA DIFERENCIA ENTRE ADQUISICIONES Y NOTAS DE CREDITO CON DISTINTA TARIFA							526	+	2860
IMPORTACIONES DE BIENES (INCLUYE ACTIVOS FIJOS) GRAVADOS TARIFA 0%	506	+	1700	516	+	1710			
ADQUISICIONES Y PAGOS (INCLUYE ACTIVOS FIJOS) GRAVADOS TARIFA 0%	507	+	1720	517	+	1730			
ADQUISICIONES REALIZADAS A CONTRIBUYENTES **RISE**	508	+	1735	518	+	1740			
TOTAL ADQUISICIONES Y PAGOS	**509**	=	**1780**	**519**	=	1790	**529**	=	1800
ADQUISICIONES NO OBJETO DE IVA	531	+	1818	541		1820			
ADQUISICIONES EXENTAS DEL PAGO DE IVA	532	+	1823	542		1825			
NOTAS DE CRÉDITO TARIFA 0% POR COMPENSAR PRÓXIMO MES				543		1830			
NOTAS DE CRÉDITO TARIFA DIFERENTE DE CERO POR COMPENSAR PRÓXIMO MES				544		1900	554		1910
PAGOS NETOS POR REEMBOLSO COMO INTERMEDIARIO	535	+		545		1980	555		1990

FACTOR DE PROPORCIONALIDAD PARA CRÉDITO TRIBUTARIO	(411+412+415+416+417+418) / 419	563	
CRÉDITO TRIBUTARIO APLICABLE EN ESTE PERÍODO (De acuerdo al Factor de Proporcionalidad o a su Contabilidad)	(520+521+523+524+525+526) x 563	**564**	= **2130**

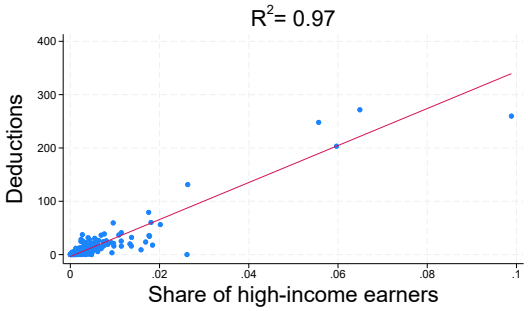
RESUMEN IMPOSITIVO: AGENTE DE PERCEPCION DEL IMPUESTO AL VALOR AGREGADO

IMPUESTO CAUSADO (Si diferencia campo 499-564 es mayor que cero)		601	= 2140
CRÉDITO TRIBUTARIO APLICABLE EN ESTE PERÍODO (Si diferencia campo 499-564 es menor que cero)		602	= **2150**
(-) COMPENSACIÓN DE IVA POR VENTAS EFECTUADAS EN SU TOTALIDAD CON MEDIO ELECTRÓNICO		603	(-) 2870
(-) COMPENSACIÓN DE IVA POR VENTAS EFECTUADAS EN ZONAS AFECTADAS LEY DE SOLIDARIDAD		604	(-) 2880
(-) SALDO CRÉDITO TRIBUTARIO DEL MES ANTERIOR	POR ADQUISICIONES E IMPORTACIONES (Traslada el campo 615 de la declaración del período anterior)	605	(-) **2160**
	POR RETENCIONES EN LA FUENTE DE IVA QUE LE HAN SIDO EFECTUADAS (Traslada el campo 617 de la declaración del período anterior)	606	(-) **2170**
	POR COMPENSACIÓN DE IVA POR VENTAS EFECTUADAS CON MEDIO ELECTRÓNICO (Traslada el campo 618 de la declaración del período anterior)	607	(-) **2890**
	POR COMPENSACIÓN DE IVA POR VENTAS EFECTUADAS EN ZONAS AFECTADAS LEY DE SOLIDARIDAD (Traslada el campo 619 de la declaración del período anterior)	608	(-) **2900**
(-)RETENCIONES EN LA FUENTE DE IVA QUE LE HAN SIDO EFECTUADAS EN ESTE PERÍODO		609	(-) 2200
(+) AJUSTE POR IVA DEVUELTO O DESCONTADO POR ADQUISICIONES EFECTUADAS CON MEDIO ELECTRÓNICO		610	(+) 2910
(+) AJUSTE POR IVA DEVUELTO O DESCONTADO EN ADQUISICIONES EFECTUADAS EN ZONAS AFECTADAS - LEY DE SOLIDARIDAD		611	(+) 2920
(+) AJUSTE POR IVA DEVUELTO E IVA RECHAZADO IMPUTABLE AL CRÉDITO TRIBUTARIO EN EL MES (Por concepto de devoluciones de IVA)		612	+ 2210

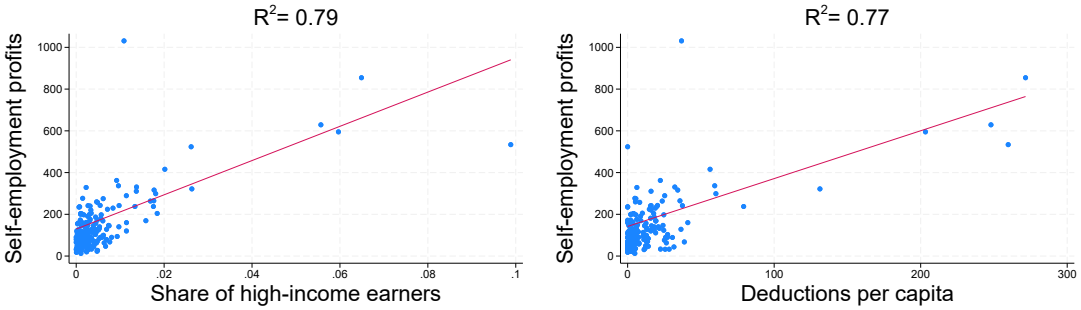
This figure depicts the tax declaration form F104 used for filing Value-Added Taxes in Ecuador.

Figure A.3: The Relation between High-income Earners and Deductions, Profits, and Tax Declarations across Regions (2008)

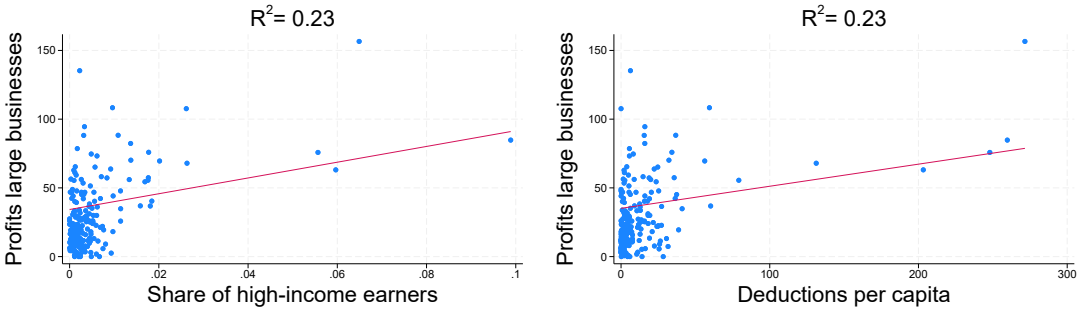
(a) Deductions per capita



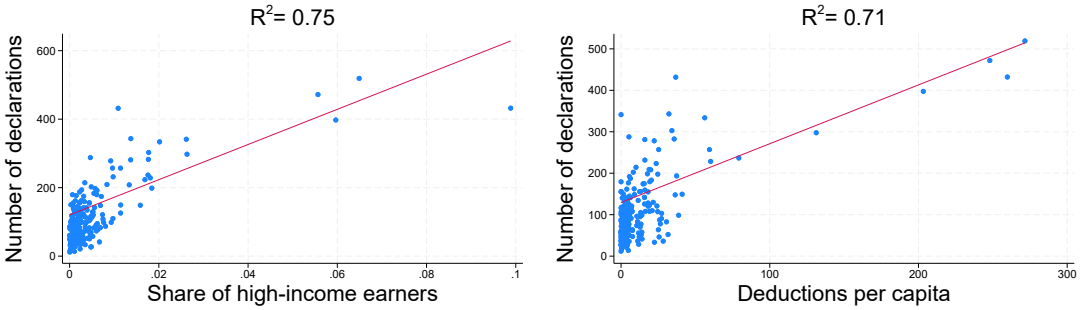
(b) Self-employment profits per capita



(c) Profits large businesses



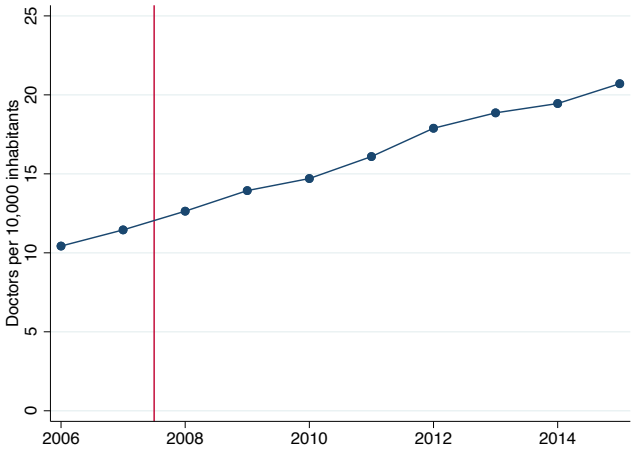
(d) Number of self-employed tax declarations



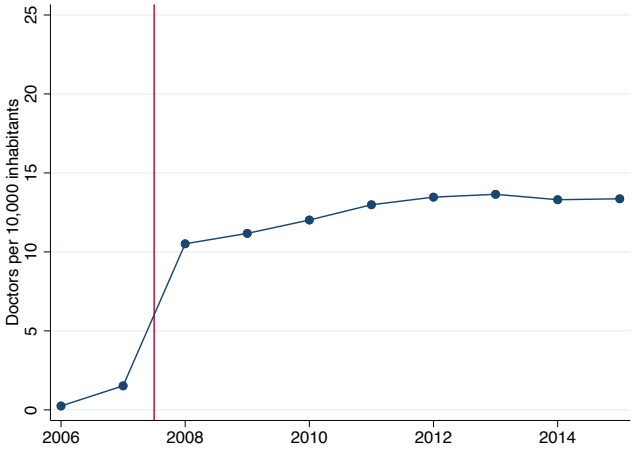
Notes: This figure provides cross-sectional descriptive evidence at the regional level for the year 2008. Each graphic is a scatterplot where a dot represents a region. The red lines depict linear fits between the two variables, weighted by population size. The R^2 of the linear fit is written above each plot. Panel (a) presents the relationship between the pre-reform share of high-income earners in 2007 and claimed deductions in 2008. The left graphs of Panels (b)-(d) depict the relationship between the outcome and the pre-reform share of high-income earners, while the right graphs depict the deductions per capita in 2008 on the horizontal axis. The vertical axis is always given by the respective outcome in 2008.

Figure A.4: Number of Doctors and Doctors' Tax Declarations

(a) Doctors according to non-tax administrative records per 10,000 inhabitants (INEC)

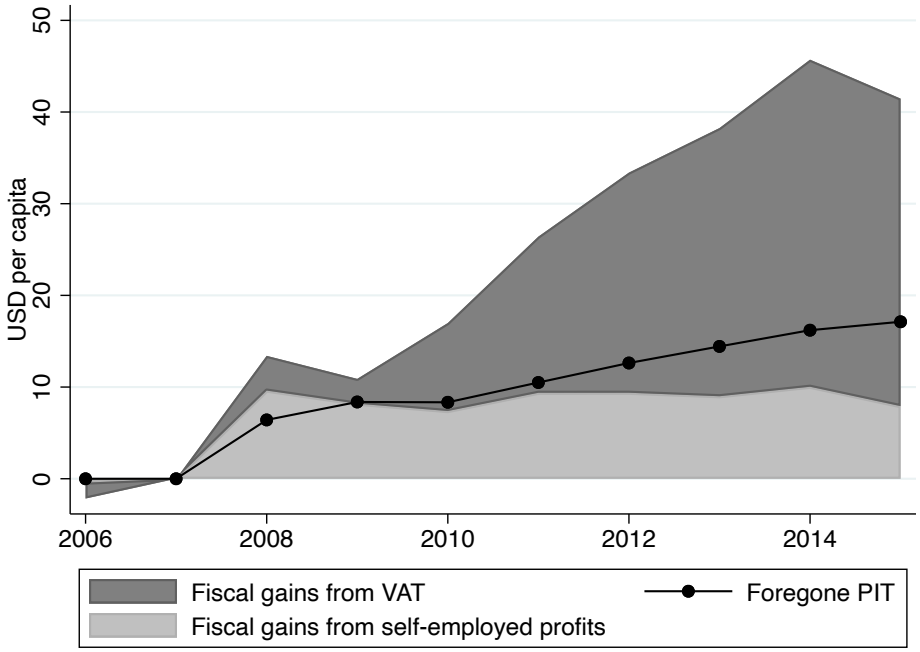


(b) Tax declarations of doctors with positive profits per 10,000 inhabitants



This figure contrasts two sources of information on the number of doctors in Ecuador. Panel (a) reports the number of doctors per 10,000 inhabitants according to the *Registro Estadístico de Recursos y Actividades de Salud*, a combination of non-tax administrative records coupled with a recurring survey administered by the National Institute for Statistics *INEC*. Panel (b) depicts the number of self-employed tax declarations of doctors reporting positive profits, per 10,000 inhabitants from our tax data.

Figure A.5: Net Revenue Impact Analysis



This figure depicts the results of our net revenue impact analysis. The black line shows per-capita values of foregone PIT, obtained by calculating the difference in tax liability between a hypothetical scenario without any deduction possibilities and the actual tax liability for the universe of PIT payers in Ecuador. The light-gray shaded area shows our estimates of the per-capita fiscal gains that accrue due to increased tax filing and reporting by self-employed individuals. The estimates are based on our non-parametric estimator of the impact of deductions on self-employment profits. We apply a tax simulator to the reported self-employment profits to obtain their actual tax liability. The dark-gray shaded area shows our estimates of the per-capita fiscal gains that are due to increased reporting of VAT payments. The estimates rely on our identification strategy based on regional differences in the exposure to the introduction of deduction possibilities, again using our non-parametric estimator. We discuss the underlying assumptions and provide details on their plausibility in Section 6.

B Machine-learning Approach to Predict Affected Occupations and Industries

Occupations To predict whether an occupation is offering deductible services or goods, we employ a machine learning approach. We start with the list of all occupations contained in the civil registry data. We then use the ChatGPT API to translate these occupations into English. Next, we match the translated Ecuadorian occupations with the occupations contained in the O*net data (https://www.onetcenter.org/dictionary/20.1/excel/task_statements.html). The matching is achieved by collecting word embeddings for both the translated Ecuadorian occupation and the O*net occupation, using OpenAI's word-embedding-ada-002 model, computing pairwise cosine similarities, and selecting the match with the largest similarity score. The match with the O*net occupational data allows us to leverage the detailed tasks descriptions included in the O*net data. We obtain word embeddings for these detailed task descriptions and the descriptions of the deduction categories (see Appendix Table A.1), again using the word-embedding-ada-002 model. We focus on tasks listed as core tasks in the O*net occupational database. We then compute the cosine similarity between each occupation and each deduction category. Finally, we classify an occupation to offer deductible goods or services if the cosine similarity between its word embedding and at least one deduction category exceeds a pre-determined threshold. In our baseline, we choose the threshold to equal 0.86. This threshold is chosen such that 10% of all occupations are classified as offering deductible goods or services. As a result, 3.8% of all self-employed individuals are predicted to be affected by the deduction possibilities (because their occupation is predicted to produce deductible goods or services). We then implement our triple differences regressions using the AI-generated classification as an alternative to our hand-picked categorization into affected and unaffected professions. Table B.1, Panel A provides sensitivity checks, varying the threshold that we use to delineate affected and unaffected occupations. Results are very similar to our baseline if the threshold remains in a reasonable range.

Industries We pursue a similar approach to predict whether industries are affected by the deduction policy. We start with the list of all industries included in our data and translate them into English using ChatGPT. Next, we match the translated Ecuadorian industries to ISIC industry names based on the closest match in cosine similarity of word embeddings. The ISIC industry code data includes detailed descriptions for each industry. We use these descriptions to compute word embeddings and calculate cosine similarity with the deduction category descriptions in Appendix Table A.1. In addition, we also compute cosine similarities of industry descriptions with a list of Ecuadorian goods that are 0% VAT-rated. For each industry, this procedure results in two scores: A similarity score to the closest deduction category and a similarity score to the closest 0%VAT-rated good or service. We then classify industries to be deductible if the similarity to the deduction data exceeds the threshold of 0.81 (30 percent of all firms are classified to produce deductibles); we classify industries to be not subject to VAT if the similarity to the list of 0%-ratings exceeds 0.795 (40 percent of all firms are classified as 0%-VAT rated). We provide sensitivity checks, varying the choice of the two thresholds in Panel B of Table B.1.

Table B.1: Sensitivity to Changes in Classification Threshold

	(1)	(2)	(3)
Panel A. Affected vs. non-affected occupations			
	Overall Effect	Extensive # Declarations	Intensive Margin
Baseline (3.8% deductible)			
Intensity × Predicted × Post	813.4	0.0250	1334.2
	(73.72)	(0.00218)	(207.0)
Observations	5,056,340	5,056,340	99,395
Decreasing threshold to 0.85 (5.5% deductible)			
Intensity × Predicted × Post	771.2	0.0264	2252.5
	(86.34)	(0.00279)	(342.3)
Observations	5,056,340	5,056,340	99,395
Increasing threshold to 0.87 (3.5% deductible)			
Intensity × Predicted × Post	886.4	0.0255	1670.0
	(72.75)	(0.00216)	(202.3)
Observations	5,056,340	5,056,340	99,395
Panel B. Affected vs. non-affected industries			
	Subject to VAT	0%-VAT rated	
Baseline (30.5% deductible, 40% 0%-VAT rated)			
Intensity × Affected × Post	27.90	14.94	
	(2.728)	(7.836)	
Observations	4,428,514	2,956,761	
Decreasing deduction threshold to 0.8 (46.4% deductible)			
Intensity × Affected × Post	34.82	26.70	
	(1.358)	(6.030)	
Observations	4,428,514	2,956,761	
Increasing deduction threshold to 0.82 (24.4% deductible)			
Intensity × Affected × Post	43.66	14.84	
	(1.840)	(7.092)	
Observations	4,428,514	2,956,761	
Decreasing exemption threshold to 0.79 (42.7% 0%-VAT rated)			
Intensity × Affected × Post	30.67	9.697	
	(2.401)	(7.154)	
Observations	4,230,550	3,154,725	
Increasing exemption threshold to 0.81 (21.6% 0%-VAT rated)			
Intensity × Affected × Post	21.64	30.27	
	(0.361)	(9.319)	
Observations	5,790,682	1,594,593	

Panel A presents sensitivity checks for our triple-differences results based on the machine-learning predictions whether the goods or services provided by an occupation are deductible or not. Column 1 shows the regression coefficient for the triple interaction using self-employed profits as outcome variable. Column 2 shows the coefficient for an indicator of whether the self-employed files a tax declaration with reported profits exceeding the tax exemption threshold. Column 3 shows the coefficient for reported business profits in the sample of businesses already filing profits above the tax exempt threshold in 2006 or 2007. In the baseline, an occupation is classified as offering deductibles if the cosine similarity between the word embeddings of the occupational task description and the deduction categories exceeds 0.86. We vary this threshold to 0.85 and 0.87, substantially in- and decreasing the share of self-employed who are classified as offering deductibles. Panel B provides sensitivity checks for our triple-difference regressions based on the machine-learning predictions of whether the goods or services provided by an industry are deductible or 0%-VAT rated. Column 1 shows the regression coefficient for the triple interaction among industries predicted to be subject to VAT while column 2 shows the coefficient among industries predicted to be 0%-VAT rated. In the baseline, an industry is predicted to offer deductible goods if the cosine similarity between the industry description and the deduction categories exceeds 0.81. We vary this threshold to 0.8 and 0.82, substantially in- and decreasing the share of firms that are classified as offering deductibles. In the baseline, an industry is predicted to offer 0%-VAT rated goods if the cosine similarity between the industry description and the list of 0%-VAT rated goods exceeds 0.795. We vary this threshold to 0.79 and 0.81, substantially in- and decreasing the share of firms that are classified as offering 0%-VAT rated goods. Standard errors in parentheses are two-way clustered at the region (cantón) and year level.

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